Universidad de La Laguna

2Shift'25 TENERIFE

Book of Abstracts

SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS

Tenerife,
Canary Islands,
Spain,
13-17 October 2025

WELCOME LETTER:

Dear colleagues, dear SHIFTERS:

Yes...we are back! After successful previous editions SHIFT 2017 and SHIFT 2022, SHIFT MUST GO ON! We are back and stronger than ever! SHIFT MUST GO ON!! SHIFT2025 at Tenerife, Canary Islands (Spain), 13-17th October 2025, Universidad de La Laguna. We are very pleased to welcome each of you on board at SHIFT2025

With an outstanding list of Plenary, Keynote and Invited Speakers including Professor Ben L. Feringa (University of Groningen, The Netherlands) NOBEL LAUREATE in 2016 in Chemistry for "the design and synthesis of molecular machines", along with other relevant colleagues in the field as Jennifer Dionne (USA), Luis Carlos (Portugal), Philippe Goldner (France), Nazario Martín (Spain), Luisa de Cola (Italy), Xiaogang Liu (Singapore), Laura Lechuga (Spain), Rebecca Abergel (USA), Cherie Kagan (USA) and many others!

SHIFT 2025: Spectral shaping for biomedical and energy applications" SHINING A LIGHT ON: wavelength conversion processes (up-conversion, down shifting, TTA), photochemistry, photocatalysis, solar fuels, artificial photosynthesis, plasmonics, photoelectrocatalysis, luminescent solar concentrators, dye-sensitized solar cells, perovskites solar cells, light trapping devices, nanophotonics, anti-counterfeiting, bioimaging, fluorescent bioprobes, nanothermometry, nano-optical sensors, phototherapy, nano-bio interaction, light induced reactions, light-activated machines…and many other promising and not yet fully explored routes. But attendees will not only represent academia. SHIFT2025 will attract a number of representatives from industry and government who share common objectives both in terms of fundamental science and commercial applications. Industrial companies (hi-tech companies, medium or large, spin-off, start-ups...) will also benefit from special low tax incentives for R+D that the Canary Islands offer, and also as a strategic logistic platform, a tri-continental hub.

SHIFT MUST GO ON!

Sincerely yours,

Dr. Jorge Méndez-Ramos (Universidad de La Laguna, Tenerife)
SHIFT 2025 Chairman, jmendezr@ull.edu.es

On behalf of the SHIFT 2025 organizing committee:
Eva Hemmer (Univ. of Ottawa, Canada); José Marqués-Hueso (Univ. Valencia, Spain) and Fiorenzo Vetrone (Université du Québec Canada)

Welcome to the...

2Shift'25 TENERIFE

Tenerife, Canary Islands, Spain,
13-17 October 2025

SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS

Aplicaciones de la luz en energías renovables, biomedicina, nanotecnología y tecnologías fotónicas

Universidad de La Laguna · Springer · Optical Materials · Frontiers in Chemistry · Nanoscale · Journal of Materials Chemistry C · San Blas · Barceló Tenerife · tenerife convention bureau

Sponsored by: INtech Parque Científico y Tecnológico de Tenerife · ITER · Gobierno de Canarias, Consejería de Universidades, Ciencia e Innovación y Cultura, Agencia Canaria de Investigación, Innovación y Sociedad de la Información · GLOBAL Science & Technology

In collaboration with: Canarias ZEC · Excmo. Ayuntamiento de San Cristóbal de La Laguna · Arquimea Research Center · Biosigma · Edinburgh Instruments · Chemicals 101 · Litografía Romero · SILO · EVM Group · pwc

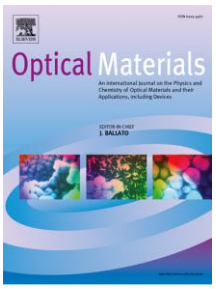
TALKS AND MUSIC – SHIFT2025

OUTREACH EVENT

TALKS AND MUSIC – SHIFT2025 is scheduled to take place on Wednesday, October 15th, 2025, at "Auditorio de Tenerife"

Open to the general public, featuring outreach talks by the 2016 Nobel Prize in Chemistry, Prof. Ben Feringa (University of Groningen, Netherlands), Nazario Martín (Univ. Complutense Madrid) and Isabel Béjar from CERN, Switzerland, accompanied by music, from rock band "Marvel Hill" to traditional ethnic music from Canary Islands by Benito Cabrera with José Manuel Ramos, followed by Gala Dinner

SPECIAL ISSUE INFORMATION (OPTICAL MATERIALS)



"SHIFT 2025: Light on bio, energy and beyond. SHIFT must go on"

To submit your manuscript please go to Optical Materials (at https://www.sciencedirect.com/journal/optical-materials) and follow the procedures for manuscript submission.

When prompted for **'Enter Manuscript Information'** you can select our **Special Issue Article type as 'VSI: SHIFT 2025"** We welcome you to submit your manuscript(s) at any time before the submission deadline. For any inquiries about the appropriateness of contribution topics, please contact Dr. Jorge Méndez-Ramos via jmendezr@ull.edu.es

***Keywords*: Photovoltaic solar energy, "artificial photosynthesis", "green hydrogen", photocatalysis, nanophotonics, perovskites, anti-counterfeiting, bioimaging, fluorescent biosensors, nanothermometry.**

Submission Deadline: 01 March 2026

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Dr. Jorge Méndez-Ramos, University of La Laguna, Spain, jmendezr@ull.edu.es
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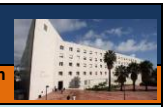
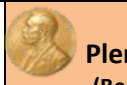
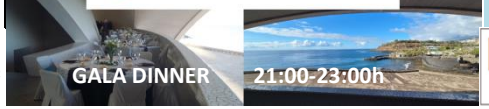
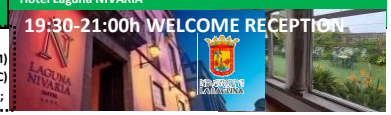
Dr. José Marqués-Hueso, University of Valencia, Spain, jose.marques@uv.es
Dr. Daniel Jaque García, Universidad Autónoma de Madrid, Spain, daniel.jaque@uam.es

SHIFT 2025 (13-17th OCTOBER, Tenerife, Canary Islands, Spain)

Universidad de La Laguna



	Monday, 13th	Tuesday, 14th	Wednesday, 15th	Thursday, 16th	Friday, 17th
8:45 -9:00	OPENING CEREMONY (Paraninfo – ULL) 		Institutional act *Blas Cabrera tribute*  CORREOS (Spanish Post Office)	*Excursion to "La Esperanza" and "EL TEIDE" National Park Departure and arrival: 9:00-19:00h (La Laguna)*	(Science Faculty -Physics ULL) Aula Magna "Blas Cabrera"
9:00 - 10:00	**Plenary Talk 1** (Ben L. Feringa)  	**Plenary Talk 4** (Xiaogang Liu) 	**Plenary Talk 6** (Jennifer Dionne) 		**Plenary Talk 8** (Philippe Goldner) 
10:00-11:00	**Plenary Talk 2** (Nazario Martín) 	P **KN-E3** Energy/others A. Meijerink; AP Bio Oral OB_{20}; C Oral OB_{21}; IC Oral OB_9 García P IE9; AM Ung IE10; Oral SJ OE_7 (Students session); Liu IB5; MacKenzie IB6; Oral OB_{10} (Students session) Oral OE_{28}; Oral OE_{29}; Oral OE_8 (Students session) AP **KN-B3** Wong Ka-Leung	P **KN-E8** Energy/others M. Murugesu; Bio AP Oral OB_{29} Ródenas P IE16; Suta SJ IE17; Skripka AM IE18; C Sun IE19; Oral IC OE_{14} (Students session); Oral OB_{30} Oral OE_{37}; Oral OE_{38}; Oral OE_{39}; Oral OE_{40}; Oral OE_{15} (Students session) AP **KN-B6** B. Viana	 Coffee break - Picnic La Esperanza (Las Raíces)	**Plenary Talk 9** (Cherie R. Kagan) 
11:00-11:30	*Coffee Break*	*Coffee Break*	*Coffee Break*		*Coffee Break*
11:30-13:00	P Energy/others **KN-E1** M. Lira-Cantú; AP Bio **KN-B1** M. Natile P Ortí I-E1; Oral AM OE_{18}; Oral C OE_{19}; Oral SJ OE_1 (Students session); AP Marin IB1; Oral IC OB_1 Chen I-E2; Brites I-E3; Oral OE_{20}; Oral OE_2 (Students session); Bednark IB2; Oral OB_2; Oral OB_3 (Students session) Oral OE_{21}; Oral OE_{22}; Albrecht I-E4; Oral OE_3 (Students session); Oral OB_{18}; Oral OB_4 (Students session)	AP León IE11; C Garnett IE12; Oral SJ OE_9 (Students session); P **KN-B4** D. Jaque Bio Oral OE_{30}; Oral OE_{31}; Oral OE_{10} (Students session); P Benayas IB7; AM Juárez IB8; Oral IC OB_{11} AP Energy/others **KN-E4** G. Tessitore; Speghini IB9; Oral OB_{23}; Oral OB_{12} (Students session) AP **KN-E5** O.L. Malta; Oral OB_{22}; Resch IB_{10}; Oral OB_{13} (Students session)	Energy/others **KN-E9** B.S. Richards; Bio AP Oral OB_{31}; Oral OB_{32} P **KN-E10** A.Pickel; Oral OB_{33} P Ferreira IE20; SJ Wang IE21; AM Béjar IE22; C Westin IE23; Oral IC OE_{16} (Students session); Oral OB_{34}; Oral OB_{35} Oral OE_{41}; Oral OE_{42}; Oral OE_{43}; Oral OE_{44}; Oral OE_{17} (Students session); Oral OB_{36}	  	**12:30h Concluding remarks Awards and closing ceremony** 
13:00-15:00	LUNCH	LUNCH	LUNCH		13:00-15:00h Farewell LUNCH Science Faculty ULL- Physics 
15:00-16:00	**Plenary Talk 3** (Laura Lechuga) 	**Plenary Talk 5** (Rebecca Abergel) 	**Plenary Talk 7** (Luisa de Cola) 		
16:00-17:30	P Energy /others **KN-E2** E. Palomares; AP **KN-B2** Bio A Camargo Alarcón P I-E5; Oral AM OE_{23}; Oral C OE_{24}; Oral SJ OE_4 (Students session); AP Marsal IB3; Oral IC OB_5 Escudero I-E6; Almeida I-E7; Oral OE_{25}; Oral OE_5 (Students session); Costa IB4; Oral OB_6; Oral OB_7 (Students session) Oral OE_{26}; Oral OE_{27}; Roscini I-E8; Oral OE_6 (Students session); Oral OB_{19}; Oral OB_8 (Students session)	Energy/others **KN-E6** G. Chen P; AP **KN-B5** Bio C. Flores **KN-E7** A. Vomiero P; Sigoli IB_{11} AP; Petoud IB_{12} C; Oral IC OB_{14} P Nieto IE13; AM Oral OE_{32}; Oral SJ OE_{11} (Students session); Oral OB_{24}; Eliseeva IB_{13}; Oral OB_{15} (Students session) Serna IE14; Oral OE_{33}; Oral OE_{12} (Students session) Alves IE15; Oral OE_{34}; Oral OE_{13} (Students session); Oral OB_{25}; Oral OB_{27}; Oral OB_{16} (Students session) OE_{35}; OE_{36}; Oral OB_{26}; Oral OB_{28}; Oral OB_{17}	Energy/others **KN-E11** J.R. Galán-Mascarós P Energy/others **KN-E12** C. Montes P Sørensen P IE24; Charbonn. SJ IE25; Camargo AM IE26; Oral C OE_{48}; Oral IC OE_{50}; AP Oral OE_{52} Oral OE_{45}; Oral OE_{46}; Oral OE_{47}; Oral OE_{49}; Oral OE_{51}; Oral OE_{53} 19:30-21:00h "Talks & Music"(Outreach event)  	CONFERENCE LUNCH and PHOTO at "EL TEIDE" National Park 	
17:30-19:00	18:00-19:00h PANEL Canary Islands, a leading hub: research business cases and opportunities P 17:30-19:00h POSTER SESSION C	18:00-19:00h PANEL Innovation & knowledge transfer P 18:00-19:00h POSTER SESSION C			
SOCIAL EVENTS	Hotel Laguna NIVARIA  19:30-21:00h WELCOME RECEPTION	*Students awards sponsored by:* Frontiers in Chemistry; Springer; Nanoscale; Journal of Materials Chemistry C			

CONFERENCE ROOMS:
Paraninfo (P); Aula Magna (AM)
Aula Polivalente (AP); Capilla (C)
Sala Juntas (SJ); I. Canarias (IC);

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PARANINFO	MONDAY, 13TH	TUESDAY, 14TH	WEDNESDAY, 15TH
9:00 - 10:00	Plenary Talk 1 (Ben L. Feringa) *chaired by Nazario Martín*	Plenary Talk 4 (Xiaogang Liu) *chaired by Philippe Goldner*	Plenary Talk 6 (Jennifer Dionne) *chaired by Jorge Méndez-Ramos*
10:00-11:00	Plenary Talk 2 (Nazario Martín) *chaired by Ben Feringa*	Keynote KN-E3 Andries Meijerink *chaired by Eva Hemmer* Antonio García-Martín IE9 *chaired by Jose Marqués-Hueso* Lukasz Marciniak OE_{28}	Keynote KN-E8 Muralee Murugesu *chaired by Eva Hemmer* Airán Ródenas IE16 *chaired by Luis Carlos* Ricardo Santos Baltieri OE_{37}
11:00-11:30	*Coffee Break*	*Coffee Break*	*Coffee Break*
11:30-13:00	Keynote KN-E1 Mónica Lira-Cantú *chaired by Emilio Palomares* Enrique Ortí I-E1 *chaired by Nazario Martín* Zhuoying Chen I-E2 *chaired by Antonio García-Martín* Christian Würth OE_{21}	Keynote KN-B4 Daniel Jaque *chaired by Luis Carlos* Antonio Benayas I-B7 *chaired by E. Hemmer* Adolfo Speghini I-B9 Fernando Lahoz OB_{22} *chaired by Antonio Benayas*	Keynote KN-E9 Bryce S. Richards *chaired by E. Hemmer* Keynote KN-E10 Andrea Pickel Rute A.S. Ferreira IE20 *chaired by Luis Carlos* Juan P. Martínez-Pastor OE_{41} *chaired by Jose Marqués-Hueso*
13:00-15:00	LUNCH	LUNCH	LUNCH
15:00-16:00	Plenary Talk 3 (Laura Lechuga) *chaired by Fiorenzo Vetrone*	Plenary Talk 5 (Rebecca Abergel) *chaired by Eva Hemmer*	Plenary Talk 7 (Luisa de Cola) *chaired by Fiorenzo Vetrone*
16:00-17:30	Keynote KN-E2 Emilio Palomares *chaired by Daniel Jaque* Esther Alarcón I-E5 *chaired by Airán Ródenas* María Escudero I-E6 *chaired by Jose Marqués-Hueso* Laura Francés Soriano OE_{26}	Keynote KN-E6 Guanying Chen *chaired by Jose Marqués-Hueso* Keynote KN-E7 Alberto Vomiero *chaired by Eva Hemmer* Emilio Nieto IE13 *chaired by Jose Marqués-Hueso* Rosalía Serna IE14 *chaired by Jose Marqués-Hueso* Diogo Alves IE15 *chaired by Eva Hemmer*	Keynote KN-E11 Jose Ramón Galán-Mascarós *chaired by Jose Marqués-Hueso* Keynote KN-E12 Carlos Montes *chaired by Jose Marqués-Hueso* Thomas Just Sørensen IE24 Pawel Karpinski OE_{45} *chaired by Airán Ródenas*
18:00-19:00	PANEL Canary Islands, a leading hub: research business cases and opportunities	PANEL Innovation & knowledge transfer	

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AULA POLIVALENTE (AP)	MONDAY, 13TH	TUESDAY, 14TH	WEDNESDAY, 15TH
10:00-11:00		Natalia Jurga OB20 chaired by Artur Bednarkiewicz	Hans Gorris OB29 *chaired by Riccardo Marin*
		Hong Liu I-B5 chaired by Artur Bednarkiewicz	Rogéria Rocha Gonçalves OB30
		Keynote KN-B3 Wong Ka-Leung chaired by Xiaogang Liu	Keynote KN-B6 Bruno Viana chaired by Oscar L. Malta
11:00-11:30	*Coffee Break*	*Coffee Break*	*Coffee Break*
11:30-13:00	Keynote KN-B1 Marta M. Natile chaired by Fiorenzo Vetrone	Fernando León I-E11 chaired by Jorge Méndez-Ramos	Dirk Ortgies OB31
	Riccardo Marin I-B1 *chaired by Eva Hemmer*	Humberto E. Sánchez-Godoy OE30 chaired by Jose Marqués-Hueso	Tomasz Grzyb OB32 *chaired by Artur Bednarkiewicz*
	Artur Bednarkiewicz I-B2		Chen Jiaye OB33
	Albenc Nexha OB18	Keynote KN-E4 Gabriella Tessitore chaired by Bruno Viana	K. David Wegner OB34 *chaired by Fiorenzo Vetrone*
		Keynote KN-E5 Oscar L. Malta chaired by Bruno Viana	Fernando E. Maturi OB35
			Celina Matuszewska OB36
13:00-15:00	LUNCH	LUNCH	LUNCH
16:00-17:30	Keynote KN-B2 Andrea Camargo chaired by Eva Hemmer	Keynote KN-B5 Carlos Flores chaired by Emilio Palomares	
	Lluis F. Marsal I-B3 *chaired by A. García-Martín*	Fernando Sigoli IB11 chaired by Oscar Malta	17:00h Adam Filipkowski OE52 *chaired by Fernando Sigoli*
			Marta Gordel-Wójcik OE53
	Jose Manuel Costa I-B4	Dominika Przybylska OB24 chaired by Oscar Malta	
	Tatiana Tozar OB19 *chaired by Riccardo Marin*	Miao Liu OB25 *chaired by Fernando Sigoli*	
		Bartosz Krajnik OB26	

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AULA MAGNA (AM)	MONDAY, 13TH	TUESDAY, 14TH	WEDNESDAY, 15TH
10:30-11:00		Gaël Ung I-E10 *chaired by Fiorenzo Vetrone*	Artiom Skripka I-E18 *chaired by Rui Almeida*
		York E. Serge Correales OE29	Simon Spelthann OE39
11:00-11:30	*Coffee Break*	*Coffee Break*	*Coffee Break*
12:00-13:00	12:00h Erving Ximendes OE19	12:00h Beatriz Juárez I-B8 *chaired by Lewis McKenzie*	12:30h María González Béjar I-E22 *chaired by Markus Suta*
	Carlos Brites I-E3 *chaired by Antonio Benayas*	I.Pompermayer Machado OB23	
	Celso de Mello Donega OE22	Ute Resch-Gerner I-B10	Stefano Giancola OE43
13:00-15:00	LUNCH	LUNCH	LUNCH
16:30-17:30	16:30h Jence Mulder OE24	17:00h Sergio Rey OE32 *chaired by A. García-Martín*	17:00h Pedro Camargo I-E26 *chaired by Esther Alarcón*
	Rui Almeida I-E7 *chaired by Carlos Brites*	Jorge Gutiérrez Cejudo OE33	Daan Methorst OE47
	Agata Szczeszak OE27	Przemysław Woźny OE34	
		Lauro J. Queiroz Maia OE35 *chaired by Claudio Roscini*	
		Beibei Shao OE36	

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CAPILLA (C)	MONDAY, 13TH	TUESDAY, 14TH	WEDNESDAY, 15TH
10:00-11:00		Ecem Tiryaki OB21 chaired by Jose Manuel Costa	
		Lewis MacKenzie I-B6 chaired by Jose Manuel Costa	10:30h Lining Sun I-E19 chaired by Jose Marqués-Hueso
			José Maurício Almeida Caiut OE40 chaired by Jose Marqués-Hueso
11:00-11:30	*Coffee Break*	*Coffee Break*	*Coffee Break*
11:30-13:00	12:00h Yoel Nergín OE19	Erik Garnett IE12 chaired by Esther Alarcón	
	Michal Zitnan OE20 *chaired by* Airán Ródenas	Airton Germano Bispo-Jr OE31 chaired by Esther Alarcón	12:30h Gunnar Westin IE23 chaired by Lewis Mackenzie
	Wiebke Albrecht I-E4 chaired by Airán Ródenas		Jung-Young-Son OE44 chaired by Lewis Mackenzie
13:00-15:00	LUNCH	LUNCH	LUNCH
16:30-17:30	Lorenzo Vallan OE24 chaired by Wiebke Albrecht	Stephane Petoud IB12 chaired by Luis Carlos	
	Felipe A. Garcés Pineda OE25 chaired by Wiebke Albrecht	Sveltana Eliseeva IB13 chaired by Luis Carlos	17:00h Elaina Galvin OE48
			Paulina Rajchel-Mieldzioć OE49 *chaired by* Erik Garnett
	Claudio Roscini I-E8 chaired by Wiebke Albrecht	Marcin Nyk OB27	
		Mario Díaz OB28 *chaired by* Stephane Petoud	

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SALA DE JUNTAS (SJ) Student´s sessions (Energy) OE1-OE13	MONDAY, 13TH	TUESDAY, 14TH	WEDNESDAY, 15TH
10:30-11:00		Zaida Curbelo Cano OE7	Markus Suta IE17 chaired by Ute Resch-Gerner
		Beatriz Castillo OE8	Sergio A M Lima OE38 chaired by Ute Resch-Gerner
11:00-11:30	*Coffee Break*	*Coffee Break*	*Coffee Break*
12:00-13:00	Yongwei Guo OE1	Shanas Fatima OE9	
	Rohit B Raj OE2	Maximilian Stremel OE10	12:30h Mengjiao Wang IE21 chaired by Oscar L. Malta
	Jan Moszczyński OE3		Beatriz S. Cugnasca OE42 chaired by Oscar L. Malta
13:00-15:00	LUNCH	LUNCH	LUNCH
16:30-17:30	Miguel Medina-Alayón OE4		
		17:00h Noel Muñoz Pérez OE11	
	Sheila Torres-García OE5	Ana Dávila OE12	
	Nikita Panov OE6	Esther Rincón OE13	17:00h Loïc Charbonniere IE25 chaired by Diogo Alves
			Vitezslav Jary OE46 chaired by Diogo Alves

Student´s sessions (Energy) from OE1-OE13 will be chaired by the student´s competition jury composed of several keynote/invited speakers and members of the Organizing Committee

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SALA ISLAS CANARIAS (IC) Student´s sessions (BIO) OB1-OB17 (Energy) OE14-OE17	MONDAY, 13TH	TUESDAY, 14TH	WEDNESDAY, 15TH
10:00-11:00		Liyan Ming OB9	
		Hana Mirmajidi OB10	10:30h Aleix Carrascull Marin OE14
			Loriane Monin OE15
11:00-11:30	*Coffee Break*	*Coffee Break*	*Coffee Break*
12:00-13:00	Piotr Kuich OB1	Naomi Weitzel OB11	
	Satyam Chaturvedi OB2	Ariel Stiber OB12	12:30h Fengchan Zhang OE16
	Jugal Barman OB3	Francis D. R. Garcia OB13	
	Ramon Raposo Filho OB4		Veronika Adolfs OE17
13:00-15:00	LUNCH	LUNCH	LUNCH
16:30-17:30	Pablo Camarero Linares OB5	Emily Andreato OB14	
	Alejandro Hernández Medel OB6	Cindy Shi OB15	
	Diego Lecumberri OB7	Zhen Mu OB16	17:00h Maja Szymczak OE50 chaired by Gunnar Westin
	Rebecca McGonigle OB8	Emil Milan OB17	Emmanuel Reyes-Francis OE51 chaired by Gunnar Westin

Student´s sessions (BIO) from OB1 to OB17 and (Energy) from OE14-OE17 will be chaired by the student´s competition jury composed of several keynote/invited speakers and members of the Organizing Committee

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AULA MAGNA BLAS CABRERA (Physics Faculty)	FRIDAY, 17TH
9:00-10:00	**Plenary Talk 8 (Philippe Goldner)** chaired by Andries Meijerink
10:00-11:00	**Plenary Talk 9 (Cherie R. Kagan)** chaired by Fiorenzo Vetrone
11:00-11:30	*Coffee Break*
11:30-12:30	**Plenary Talk 10 (Luis Carlos)** chaired by Daniel Jaque
12:30-13:00	***Concluding remarks Student´s awards and closing ceremony***
13:00-15:00	FAREWELL LUNCH

Updated 29th Sept 2025

Name	Insitution/Affiliation	Abstratct Title	Category	Code	Date/Time	Conference room
Ben L. Feringa	Univ. Groningen (Netherlands)	Light for Motion	Plenary	PL1	Monday 13th Oct, am	Paraninfo (P)
Nazario Martín	Universidad Complutense de Madrid (Spain)	Facing the Energy Challenge: Perovskite Solar Cells		PL2	Monday 13th Oct, am	Paraninfo (P)
Laura Lechuga	ICN2, Cataloina (Spain)	Ultrasensitive, Multiplexed Nanophotonic Biosensors for Next-Generation Point-of-Care Applications		PL3	Monday 13th Oct, pm	Paraninfo (P)
Xiaogang Liu	National Univ. Singapur (Singapur)	Nanocrystals at Work: Unlocking the Power of Lanthanide Doping		PL4	Tuesday 14th Oct, am	Paraninfo (P)
Rebecca Abergel	University of California -LBNL- Berkeley (USA)	Coordination Control, Light Sensitization, and Radiation Targeted Delivery in Actinide Molecular Systems		PL5	Tuesday 14th Oct, pm	Paraninfo (P)
Jennifer Dionne	Univ. Stanford (USA)	Exploring light and life: Nanophotonics for scalable molecular sensing and sequencing		PL6	Wed 15th Oct, am	Paraninfo (P)
Luisa de Cola	Universiry of Milano (Italy)	Seeing, understanding and detecting with light		PL7	Wed 15th Oct, pm	Paraninfo (P)
Phillipe Goldner	CNRS - PSL University (France)	Rare Earth Doped Crystals for Integrated Quantum Photonics		PL8	Friday 17th Oct, am	Paraninfo (P)
Cherie R. Kagan	University of Pennsylvania (USA)	Colloidal Nanocrystal Materials and Optical Devices with Extraordinary Structures and Functions		PL9	Friday 17th Oct, am	Paraninfo (P)
Luis D. Carlos	Univ. Aveiro (Portugal)	Water's hidden density dance: from charged interfaces to protein dynamics		PL10	Friday 17th Oct, am	Paraninfo (P)
Marta M. Natile	National Research Council (Italy)	Exploring the rational design of upconverting nanocrystals through experimental and theoretical synergies	Keynote - Bio	KNB1	Monday 13th Oct, am	Aula Polivalente (AP)
Andrea de Camargo	University of Jena / BAM (Germany)	Upconversion nanoparticles for chemical, physical and biological sensing: from functionalization to point of-care devices		KNB2	Monday 13th Oct, pm	Aula Polivalente (AP)
Gary Wong Ka-Leung	The Hong Kong Polytechnic University	Theranostic agents achieving PET-MRI fusion and photodynamic therapy		KNB3	Tuesday 14th Oct, am	Aula Polivalente (AP)
Daniel Jaque	Univ. Autónoma Madrid (Spain)	So far, so good: NIR imaging and sensing		KNB4	Tuesday 14th Oct, am	Paraninfo (P)
Carlos Flores	ITER - Tenerife (Spain)	Enabling large-scale genomics for precision medicine		KNB5	Tuesday 14th Oct, pm	Aula Polivalente (AP)
Bruno Viana	CNRS - PSL University (France)	Persistent luminescence nanoparticles for biosensors and bioimaging		KNB6	Wed 15th Oct, am	Aula Polivalente (AP)
Mónica Lira Cantú	ICN2, Cataloina (Spain)	Perovskite Solar Cells: Novel Nanomaterials for High Stability	Keynote - Energy/others	KNE1	Monday 13th Oct, am	Paraninfo (P)
Emilio Palomares	ICIQ, Cataloina (Spain)	The Chemistry of Small Molecules for Energy Applications		KNE2	Monday 13th Oct, pm	Paraninfo (P)
Andries Meijerink	Utrecht University (Netherlands)	Photonic Effects in Luminescence Spectroscopy		KNE3	Tuesday 14th Oct, am	Paraninfo (P)
Gabriella Tessitore	Université de Laval (Quebec City, Canada)	Charge carriers dynamics in quantum dots: from modeling to applications		KNE4	Tuesday 14th Oct, am	Aula Polivalente (AP)
Oscar L. Malta	Universidade Federal de Pernambuco (Brasil)	Revisiting the mechanisms of non-radiative energy transfer in lanthanide materials		KNE5	Tuesday 14th Oct, am	Aula Polivalente (AP)
Guanying Chen	Harbin Institute of Technology (China)	The size effects on luminescence of lanthanide upconversion nanoparticles		KNE6	Tuesday 14th Oct, pm	Paraninfo (P)
Alberto Vomiero	Luleå Univ. of Technol. (Sweden)/ Univ. of Venice	Advanced nanostructures for solar energy harvesting		KNE7	Tuesday 14th Oct, pm	Paraninfo (P)
Muralee Murugesu	University of Ottawa (Canada)	Synthetic Methodologies for Developing Lanthanide-Based Molecular Magnetic and Optical Materials		KNE8	Wed 15th Oct, am	Paraninfo (P)
Bryce S. Richards	Karlsruhe Institute of Technology (Germany)	Broadband Spectral Conversion and Light Management for Next Generation Greenhouses		KNE9	Wed 15th Oct, am	Paraninfo (P)
Andrea Pickel	University of Rochester (USA)	Taking Luminescence Thermometry to Extremes for Device, Energy, and Catalysis Applications		KNE10	Wed 15th Oct, am	Paraninfo (P)
Jose Ramón Galán Mascarós	ICIQ, Cataloina (Spain)	SUPERVAL: A European project towards solar-powered waste to added value chemicals		KNE11	Wed 15th Oct, pm	Paraninfo (P)
Carlos Glez Montesdeoca	ITER - Tenerife (Spain)	A Simplified Architecture for Air-Processed Perovskite Solar Cells: Carbon-Paste Back Contacts and Pathways to Improved Efficiency		KNE12	Wed 15th Oct, pm	Paraninfo (P)
Riccardo Marin	Ca'Foscari University of Venice (Italy)	Cross-sensitivity in Luminescence Sensing: From Foe to Friend	Invited - Bio	IB1	Monday 13th Oct, am	Aula Polivalente (AP)
Artur Bednarkiewicz	INTIBS (Poland)	Label free sub-diffraction imaging		IB2	Monday 13th Oct, am	Aula Polivalente (AP)
Lluis F. Marsal	Universitat Rovira i Virgili (Spain)	Tailored Nanostructured Anodic Alumina Platforms for Biomedical Applications		IB3	Monday 13th Oct, pm	Aula Polivalente (AP)
Jose Manuel Costa Hernandez	Universidad de Oviedo (Spain)	Functionalized Nanoparticles and Spectroscopy for High-Sensitivity Biomarker Quantification: Progress in Decentralized Diagnosis and Food Safety Control		IB4	Monday 13th Oct, pm	Aula Polivalente (AP)
Hong Liu	Shandong University, China	Material Cues Regulating Stem Cell Fate for Cell Therapy of Neurological Diseases		IB5	Tuesday 14th Oct, am	Aula Polivalente (AP)
Lewis E. MacKenzie	University of Strathclyde, Scotland (UK)	Exploring overlooked variables in upconversion nanoparticle synthesis: getting the basics in place for future biomedical applications		IB6	Tuesday 14th Oct, am	Aula Polivalente (AP)
Antonio Benayas	Universidad Autónoma de Madrid (Spain)	Luminescence thermometry 4.0: the probe testing heat transport within itself		IB7	Tuesday 14th Oct, am	Paraninfo (P)
Beatriz H. Juárez	Instituto Ciencia Materiales Madrid- CSIC (Spain)	Ag2S-based nanoparticles for luminescence nanothermometry		IB8	Tuesday 14th Oct, am	Aula Magna (AM)
Adolfo Speghini	University of Verona (Italy)	NanoLDHs for biomedical applications		IB9	Tuesday 14th Oct, am	Paraninfo (P)
Ute Resch-Gerner	Inst. Mat. Research Test. (BAM) (Germany)	From Multicolor Reporters and Sensors and Surface Functionalization to Multi-Method Nanoscale Reference Materials		IB10	Tuesday 14th Oct, pm	Aula Magna (AM)
Fernando Sigoli	UNICAMP (Brazil)	The Role of Molecular Symmetry in Modulating Downshifting and Upconversion Circularly Polarized Luminescence of Lanthanide(III) Systems		IB11	Tuesday 14th Oct, pm	Aula Polivalente (AP)
Stéphane Petoud	Center Molecular Biophysics, CNRS (France)	Lanthanide Compounds for Biological Imaging: Dual-mode Near-infrared Optical and Photoacoustic Imaging Agents with Low Energy Excitation Wavelengths		IB12	Tuesday 14th Oct, pm	Capilla (C)
Svetlana Eliseeva	Center for Molecular Biophysics, CNRS (France)	Luminescent Lanthanide(III)-Based Metallacrowns as Modular Scaffolds to Design NIR-II Imaging Agents		IB13	Tuesday 14th Oct, pm	Capilla (C)
Enrique Ortí	ICMOL Valencia (España)	Hole-Transporting Materials for Perovskite Solar Cells: Chemical Design and Charge Transport	Invited - Energy/others	IE1	Monday 13th Oct, am	Paraninfo (P)
Zhuoying Chen	ESPCI Paris - PSL (France)	Nanocomposites and Nanoscale Structural-Properties for More Stable Perovskite Solar Cells		IE2	Monday 13th Oct, am	Paraninfo (P)
Carlos Brites	University of Aveiro (Portugal)	SHIFTing Paradigms: Molecular Logic Meets Lanthanide Photonics		IE3	Monday 13th Oct, am	Aula Magna (AM)
Wiebke Albrecht	AMOLF institute, Amsterdam (Netherladns)	Single-particle structure-property correlation for optical fiber-based photocatalytic reactors		IE4	Monday 13th Oct, pm	Capilla (C)
Esther Alarcón	AMOLF institute, Amsterdam (Netherladns)	Efficient ultrathin solar cells enabled by nanoscale architectures with correlated disorder		IE5	Monday 13th Oct, pm	Paraninfo (P)
Maria Escudero	ICN2, Cataloina (Spain)	Tailored Electrochemical Interfaces for Renewable Energy Conversion		IE6	Monday 13th Oct, pm	Paraninfo (P)
Rui Almeida	Universidade de Lisboa (Portugal)	Up-conversion in sol-gel derived 1-D microcavities for photonic crystal assisted white light generation		IE7	Monday 13th Oct, pm	Aula Magna (AM)
Claudio Roscini	ICN2, Cataloina (Spain)	Low-cost and sustainable smart window films for energy savings		IE8	Monday 13th Oct, pm	Capilla (C)
Antonio García-Martín	IMN-CSIC (Spain)	VO2-Au coupling: photothermal and modulation effects		IE9	Tuesday 14th Oct, am	Paraninfo (P)
Gaël Ung	University of Connecticut; LBNL (USA)	Luminescence and Circularly Polarized Luminescence from Molecular Transuranic Complexes		IE10	Tuesday 14th Oct, am	Aula Magna (AM)
Fernando León	Banco de España (Spain)	Materials and Technology for Banknotes		IE11	Tuesday 14th Oct, am	Aula Polivalente (AP)
Erik Garnett	AMOLF institute, Amsterdam (Netherladns)	The Material Evolution Revolution		IE12	Tuesday 14th Oct, am	Capilla (C)
Emilio Nieto	Centro Nacional de Hidrógeno, CNH2 (Spain)	Hydrogen: present and Future		IE13	Tuesday 14th Oct, pm	Paraninfo (P)
Rosalía Serna	Instituto de Óptica, CSIC, Madrid (Spain)	Sustainable Semimetal Nanostructures for Unconventional Plasmonics : Promising Energy and Sensing Photonic Platforms		IE14	Tuesday 14th Oct, pm	Paraninfo (P)
Diogo Alves Gálico	University of Ottawa (Canada)	Magnetic Circularly Polarized Luminescence with Lanthanides(III)		IE15	Tuesday 14th Oct, pm	Paraninfo (P)
Airán Ródenas	LEAP Lab - Universidad de La Laguna (Spain)	Towards all-inside-crystal 3D nanophotonics for extreme-environment sensing		IE16	Wed 15th Oct, am	Paraninfo (P)
Markus Suta	Heinrich Heine Universität Düsseldorf (Germany)	Guidelines on the design of wide-range luminescent thermometers		IE17	Wed 15th Oct, am	Sala Juntas (SJ)
Artiom Skripka	Oregon State University (USA)	Photon avalanching in Nd3+-doped heavy-halides		IE18	Wed 15th Oct, am	Aula Magna (AM)
Lining Sun	Shanghai University (China)	Lanthanide Upconversion Luminescence: From Molecule-Nano-Micro Scale		IE19	Wed 15th Oct, am	Capilla (C)
Rute A. S. Ferreira	University of Aveiro (Portugal)	Luminescent Materials for Autonomous Energy Harvesting and Thermal Sensing in Photonic Devices		IE20	Wed 15th Oct, am	Paraninfo (P)
Mengjiao Wang	Politecnico di Torino (Italy)	Bismuth-based semiconductors for sustainable light-energy conversion		IE21	Wed 15th Oct, am	Sala Juntas (SJ)
Maria González Béjar	Universidad de Valencia (Spain)	Designing NIR-Responsive Nanohybrids: Conjugated Polymer Shells on Upconversion Nanoparticles		IE22	Wed 15th Oct, am	Aula Magna (AM)
Gunnar Westin	Uppsala University (Sweden)	On the complex nature of Eu-doped ZnO nano-sponges		IE23	Wed 15th Oct, am	Capilla (C)
Thomas Just Sørensen	University of Copenhagen (Denmark)	Shifting our perspective on the electronic structure of lanthanide(III) ions		IE24	Wed 15th Oct, pm	Paraninfo (P)
Loïc Charbonnière	University of Strasbourg (France)	Driving molecular upconversion with molecular wheels		IE25	Wed 15th Oct, pm	Sala Juntas (SJ)
Pedro Camargo	University of Helsinki (Finland)	Light-Switchable Plasmonic Catalysts: Smart Antenna-Reactor Nanomaterials for Energy and Environmental Applications		IE26	Wed 15th Oct, pm	Aula Magna (AM)

STUDENTS - ORAL

Biomedical applications	**OB1**	Piotr Kuich	Vesicular-type nanocarriers co-loaded with photosensitizers and persistent luminescence ZnGa2O4:Cr3+ nanomaterials for theranostics	Wroclaw University of Science and Technology
	OB2	Satyam Chaturvedi	Color Tunability and Optical Thermometry Study of Er3+ co-doped SrMoO4: Dy3+ phosphor	Indian Institute of Technology (BHU), Varanasi
	OB3	Jugal Barman	Microwave-assisted method for rapid synthesis of high-quality iron-oxide nanocubes using benzaldehyde as a key molecule	Italian Institute of Technology, Genova, Italy
	OB4	Ramon Raposo Filho	How surface charge controls the onset temperature of LDL fluctuations in ambient liquid water	CICECO – Aveiro Institute of Materials
	OB5	Pablo Camarero Linares	What Can CaF2:Nd,Y Nanothermometers Tell Us About Heating in U-87 Mg Multicellular Spheroids?	Universidad Autónoma de Madrid
	OB6	Alejandro Hernández Medel	Silica Shielding of Ag_2S Nanocrystals: Safeguarding Luminescence in Complex Biological Environments	Universidad Autónoma de Madrid
	OB7	Diego Lecumberri	Dual-Mode NIR-III Fluorescent and OCT Contrast Agents Based on Zinc-Doped Silver Telluride Quantum Dots	Universidad Autónoma de Madrid
	OB8	Rebecca McGonigle	The role of polyethyleneimine (PEI) molecular weight in tuning molecular binding, photophysical, and FRET properties of NaYF4:Yb,Er upconversion nanoparticles.	The University Of Strathclyde
	OB9	Liyan Ming	Luminescence-enabled three-dimensional temperature mapping	nanoBiG-Universidad Autónoma de Madrid
	OB10	Hana Mirmajidi	Biopolymer-Coated Lanthanide Nanoparticles for Enhanced Bioimaging	University of Ottawa
	OB11	Naomi Weitzel	Large Stokes Shift UV Emission from Fully Sensitized NaYbF4:Tm@NaYF4 Nanoparticles: Engineering Energy Migration and Shell Passivation for Bioactive Photochemistry	University of Regensburg
	OB12	Ariel Stiber	Advancing CAR T Cell Therapy with Surface-enhanced Raman-based Live Immune Cell Monitoring	Stanford University
	OB13	Francis D. R. Garcia	Integrated Photoluminescence-Based Volatile Organic Compounds Detection: Material Design and Miniaturized Sensor Development	São Carlos Institute of Chemistry (IQSC-USP)
	OB14	Emily Andreato	Indium-Based Fluoride Nanoparticles Doped with Chromium for Near Infrared Luminescence	nanoBiG-Universidad Autónoma de Madrid
	OB15	Cindy Shi	Mechanosensitive polymer-upconverting nanoparticle composites with biologically-relevant compliances	Stanford University
	OB16	Zhen Mu	Conditional Diffusion Reconstruction for Scintillator Based X ray Imaging	National University of Singapore
	OB17	Emil Milan	Upconverting colloidal nanocomposites for PDT	Università degli studi di Verona

Energy/others applications	**OE1**	Yongwei Guo	Exploring Water Beyond the Solvent: Insights into Density Fluctuations and Enhanced Green Fluorescent Protein (EGFP) Unfolding via Luminescence Thermometry	Universidade de Aveiro
	OE2	Rohit B Raj	Optical reactor for light-driven chemistry	AMOLF institute, Amsterdam (Netherlands)
	OE3	Jan Moszczyński	Force and Light (UV-NIR) emissions from Nd3+ and Mn2+ doped ZnS/CaZnOS Heterojunction for thermal and biological applications via Mechanolum. and Photolum.	Adam Mickiewicz University
	OE4	Miguel Medina-Alayón	Luminescence-encoded materials for next-generation security inks	Universidad de La Laguna, Spain
	OE5	Sheila Torres-García	Boosting Photoelectrochemical Hydrogen Generation via Up-Conversion in Rare-Earth-Doped Materials	Universidad de La Laguna, Spain
	OE6	Nikita Panov	Leveraging Cross-Sensitivity for Multiparameter Luminescence Sensing with Tunable Sensitivity-Specificity Balance.	Universidad Autónoma de Madrid
	OE7	Zaida Curbelo Cano	Synthesis of composites for 3D-printing of tuned luminescent objects using up-conversion rare-earth doped ceramics for anti-counterfeiting applications	IMDEA Nanociencia
	OE8	Beatriz Castillo	Towards chiral acoustoplasmonics	IMN-CSIC
	OE9	Shanas Fatima	Rare-Earth Doped $Cs_3Bi_2Cl_9$ for Optical Thermometry and Anticounterfeiting	Indian Institute of Technology, (BHU), Varanasi
	OE10	Maximilian Stremel	A Revival of Unusual Transition Metal Ions	Universidad de La Laguna, Spain
	OE11	Noel Muñoz Pérez	Ketocyanine-based materials for near infrared-to-visible thermochromism	Institut Català de Nanociència i Nanotecnologia (ICN2)
	OE12	Ana Dávila	NaYF4:Er3+, Yb3+ UCNP and their highly polarized luminescence as flow sensors	Nanomaterials for Bioimaging Group (nanoBIG)
	OE13	Esther Rincón	Optical trapping of upconverting nanoparticles on ferroelectric substrates	Universidad Autónoma de Madrid
	OE14	Aleix Carrascull Marin	Towards Photochromic Smart Windows: Nanodroplet Technology for Scalable and Durable Film Coatings	Institut Català de Nanociència i Nanotecnologia - ICN2
	OE15	Loriane Monin	Investigating the structural stability of GNR under pulsed light illumination inside the transmission electron microscope for light driven catalysis	AMOLF institute, Amsterdam (Netherlands)
	OE16	Fengchan Zhang	Plasmon-enhanced colloidal upconverting nanoparticles: brighter luminescence and controllable motion	Universidad Autónoma de Madrid
	OE17	Veronika Adolfs	2D-semiconductor nanoplatelets as laser gain medium in liquid-core-fibers	Leibniz University Hannover

REGULAR (Dr./Prof.) - ORAL

Biomedical applications	**OB18**	Albenc Nexha	Artificial seeds that fly and sense environmental parameters	INM - Leibniz Institute for New Materials
	OB19	Tatiana Tozar	Development and characterization of motexafin lutetium - loaded hydrogels for NIR-activated photodynamic therapy in breast cancer	National Institute for Laser, Plasma, and Radiation Physics
	OB20	Natalia Jurga	Effect of the synthesis route of Er3+-based photon-upconversion nanoparticles on immunoassays for disease biomarkers	Adam Mickiewicz University in Poznań
	OB21	Ecem Tiryaki	Engineered Ag@Au@Iron Oxide Trimers for Synergistic Magnetic and Photothermal Therapy of Heat-Resistant Glioblastoma	Istituto Italiano di Tecnologia (IIT)
	OB22	Fernando Lahoz	Random laser emission of fluorescent molecules for biomedical applications	Universidad de La Laguna
	OB23	Ian Pompermayer Machado	Exploring the Er,Yb-doped upconversion system for BW-I thermometry: does the detection system matter?	Ghent University
	OB24	Dominika Przybylska	Detection of specific analytes using upconverting nanoparticles coated by molecularly imprinted polymers as biomimetic receptors	Faculty of Chemistry, Adam Mickiewicz University in Poznań
	OB25	Miao Liu	Toward accurate photoluminescence nanothermometry using rare-earth doped nanoparticles	Institut National de la Recherche Scientifique
	OB26	Bartosz Krajnik	Single nanoparticle temperature mapping	Wroclaw University of Science and Technology
	OB27	Marcin Nyk	Two-photon excited luminescence of advanced colloidal nanomaterials for heavy metal ions detection	Wroclaw University of Science and Technology
	OB28	Mario Diaz	Optical and lasing properties of the novel antiestrogen derivative endoxifen-NBD (FLTX3) and its potential for the diagnosis of breast cancer resistance	Universidad de La Laguna
	OB29	Hans Gorris	Hybridization transfer assay based on UCNPs detects ultralow concentrations of DNA	Masaryk University
	OB30	Rogéria Rocha Gonçalves	From Synthesis to Application: Biocompatible Gd3TaO7 Nanoprobes for Multimodal Biomedical Imaging	University of Sao Paulo
	OB31	Dirk Ortgies	Nanotechnology-Enabled Contrast Agents for Rapid Detection of Myocardial Infarction	Universidad Autónoma de Madrid
	OB32	Tomasz Grzyb	Applying Luminescent Nanoparticles in Biological Research of Nano- and Microplastics	Adam Mickiewicz University, Poznań
	OB33	Chen Jiaye	Optical Nonlinearities in Excess of 500 through Sublattice Reconstruction	National University of Singapore
	OB34	K. David Wegner	Ag2S nanocrystals as next-generation, heavy-metal free short-wave infrared emitters for biomedical imaging and sensing applications	Federal Institute for Materials Research and Testing (BAM)
	OB35	Fernando E. Maturi	Multiparametric thermal sensing: how far can we go in luminescence thermometry?	nanoBIG - Universidad Autónoma de Madrid
	OB36	Celina Matuszewska	Mechanistic Insights into the Enhancement of Persistent Luminescence in ZnGa2O4: Cr3+ Nanoparticles upon H2O2 Exposure	Sorbonne Université

Energy/others applications	**OE18**	Erving Ximendes	Artificial Neural Networks as a Key Enabler for Advanced Luminescence Thermometry	Universidad Autónoma de Madrid
	OE19	Yoel Nergín	Engineering Metal–Semiconductor Nanostructures for Enhanced Photocatalysis	Photonics & Nanotechnology Group, King's College
	OE20	Michal Zitnan	TiO2-based heterojunction deposited on the membrane for photocatalytic wastewater treatment	Alexander Dubcek University in Trencin
	OE21	Christian Würth	Influence of Integrating Sphere Geometry on Absolute Measurements of Photoluminescence Quantum Yields of Light Scattering LED Converter Materials	BAM - Federal Institute of Material Science and Testing
	OE22	Celso de Mello Donega	Colloidal Nanocrystals for Quantum Dot-based Luminescent Solar Concentrators	Utrecht University
	OE23	Jence Mulder	Narrow-band Eu3+-based red phosphors for warm white lighting	Seaborough Research BV
	OE24	Lorenzo Vallan	Oil Nanodrops-based Luminescent Solar Concentrators	Institut Català de Nanociència i Nanotecnologia (ICN2)
	OE25	Felipe Andrés Garcés Pineda	Spin manipulation in electrochemistry: From catalyst design to energy applications	Institute of Chemical Research of Catalonia (ICIQ)
	OE26	Laura Francés Soriano	Artificial Photorepair of DNA ε-Adducts via NIR-Activated Upconversion Nanomaterials	Universitat Politècnica de València
	OE27	Agata Szczeszak	Rare-Earth Doped Molybdate–Tungstate Phosphors for Optical Thermometry and White LED Applications	Adam Mickiewicz University, Poznań
	OE28	Lukasz Marciniak	Eu3+ based luminescent ratiometric thermometer for thermal sensing and imaging? Phase transition in action	Institute of Low Temperature and Structure Research, Polish Academy of Scie.
	OE29	York Estewin Serge Correales	Extending NIR emission into the SWIR via cross-relaxation tuning in Tm3+-doped nanoparticles	University of Ottawa
	OE30	Humberto E. Sánchez-Godoy	Inverted Triple-Cation Perovskite Architectures Outperform Conventional Counterparts in Photovoltaic and Photodetector Applications	Instituto de Ciencia de los Materiales, Universidad de Valencia (Spain)
	OE31	Airton Germano Bispo-Jr	Investigating YbIII Quantum Cutting Emission in Molecular Systems Based on Coordination Polymers	University of São Paulo - Institute of Chemistry
	OE32	Sergio Rey	Er-enabled Cathodoluminescence Nanothermometry of Plasmonic Nanoparticles under Laser Excitation	NWO-I AMOLF
	OE33	Jorge Gutiérrez Cejudo	From Waste to Resource: The Potential of Recycled Lithium Batteries	EAVE Inc. (Spain)
	OE34	Przemysław Woźny	Whispering Gallery Modes in Rhodamine B-Doped Cellulose Microfibers for High-Sensitivity Optical Thermometry	Uniwersytet im. Adama Mickiewicza w Poznaniu
	OE35	Lauro June Queiroz Maia	Multifunctional lanthanide-doped YAB and YBO3 nanomaterials with visible and infrared emissions for photonic devices	Federal University of Goiás and University of São Paulo
	OE36	Beibei Shao	Bioinspired Intelligent Interface Materials and Self-powered Devices for Wearable/On-skin Health Monitoring	FUNSOM, Soochow University, Suzhou, China
	OE37	Ricardo Santos Baltieri	Luminescence Thermometry in Pure TeO_2 Glasses Doped with Er3+/Yb3+ and Eu3+: Remote Sensing Capability Across the Biological Temperature Range	University of São Paulo
	OE38	Sergio A M Lima	Multiparametric luminescent thermometry using a new series of iridiumIII complexes: unveiling temperature dependence via $^3LC–^1,^3MLCT$ hybrid states	São Paulo State University (Unesp)
	OE39	Simon Spelthann	Towards Measuring Spatial Thermal Gradients with Nanothermometers During Ultrafast Laser-Driven Dissipative Self-Assembly	Ruhr-University Bochum
	OE40	José Maurício Almeida Caiut	Ln3+-doped Cellulose Nanocrystals Cholesteric Films: Influence on Lanthanide Spectroscopy and Potential Photonic Applications	UNIVERSITY OF SÃO PAULO (USP)
	OE41	Juan P. Martínez-Pastor	Optoelectronic properties of Two-Dimensional Metal Halide Perovskites	Instituto de Ciencia de los Materiales, Universidad de Valencia (Spain)
	OE42	Beatriz S. Cugnasca	BODIPY/Eu3+-Tetrakis luminescent PMMA films aiming for smart window applications	University of Sao Paulo - Institute of Chemistry
	OE43	Stefano Giancola	Unlocking affordable and sustainable CO2 capture and purification to enable downstream conversion	Orchestra Scientific
	OE44	Jung-Young-Son	Color shifting and dynamic visual effects introduced by color moires	Konyang University (South Korea)
	OE45	Pawel Karpinski	Optical tweezers, laser refrigeration, Raman thermometry and anti-Stokes luminescence of Yb-doped microcrystals	Wroclaw University of Science and Technology
	OE46	Vitezslav Jary	Scintillation and optical properties of advanced YAS:Ce glass system	Institute of Physics of the Czech Academy of Sciences
	OE47	Daan Methorst	Emission collimation for enhanced diffuse light concentration	AMOLF institute, Amsterdam (Netherlands)
	OE48	Elaina Galvin	Dynamic Plasmonic Photothermal CO2 Hydrogenation	AMOLF institute, Amsterdam (Netherlands)
	OE49	Paulina Rajchel-Mieldzioć	Controlling Emission of Tm-based Upconverting Nanoparticles via Multi-Wavelength Near-Infrared Co-Excitation	University of Warsaw
	OE50	Maja Szymczak	Ratiometric luminescence manometry based on broadband-emitting phosphors: a new class of highly sensitive pressure sensors	Institute of Low Temperature and Structure Research Polish Acad. Scie.
	OE51	Emmanuel Reyes-Francis	High-Efficiency CsPbBr3 Perovskite Quantum Dots Embedded in Polymer Matrices for Additive Manufacturing	Instituto de Ciencia de los Materiales, Universidad de Valencia (Spain)
	OE52	Adam Filipkowski	Single-to-donut-mode converter for coupling light into ring core fibre	Institute of Microelectronics and Photonics
	OE53	Marta Gordel-Wójcik	Tracking Excited State Processes in Plasmon Chromophore Hybrids via Femtosecond Transient Absorption	Wrocław University (Poland)

STUDENTS - POSTER

Biomedical applications	PB1	Jordi Jaenen	Development of SiO2@AuNRs-LiLuF4:Ho3+,Yb3+ Hybrid Nanostructure for Simultaneous Near-Infrared Induced Heating and Optical Nanothermometry	Ghent University
	PB2	Joshua Baggott	Yb3+/Er3+ Upconversion Luminescence in Lithium Aluminosilicates	Intelligent Materials Chemistry Research Group, University of Turku
	PB3	Natalia Ochoa Paipilla	Towards nanothermometers for inflammation detection in the NIR-III – Optimization of Er3+ emission in the near-infrared	Universidad Autonoma de Madrid
	PB4	Renan Caike Silva	Design of core-multi-shell NaGdF4:YbIII, TmIII upconversion nanoparticles decorated with luminescent iridiumIII complex: synthesis and photophysical insight	São Paulo State University
	PB5	Zofia Petryna	Downshifting Tm3+ -Yb3+ doped LiLuF4 nanoparticles for NIR thermometry. Examining the influence of core-shell structures and a 3rd Ln3+ ion on thermometry performance	NanoSensing Group; Department of Chemistry; Ghent University
	PB6	Ayse Alici	Developing Hybrid Materials Based on Multifunctional Ag_2S Nanoparticles for Photothermal Therapy and Real-Time Temperature Sensing	Ghent University, NanoSensing Research Group
	PB7	Francesca Loschi	Lanthanide doped nanofluorides as optical probes for biomedical applications	Nanomaterials Research Group
	PB8	Maria S. Batista	Red/NIR emission in zinc gallogermanate: Cr3+ and Cr4+ active centers	i3N, Department of Physics, University of Aveiro, Portugal
	PB9	Livia Didonè	Use of biorthogonal click chemistry for the detection of inflammation-induced overexpression of VCAM-1 in mouse endothelial cells	nanoBIG - Universidad Autonoma de Madrid

Energy/others applications	PE1	Samuel Sanchez	Photon Piling in Upconverting Lanthanide Clusters	University Of Strasbourg
	PE2	Luis Merchante Gallego	Transition metal oxides as a methane oxidation catalysts under Plasma conditions	Institute of Chemical Research of Catalonia (ICIQ)
	PE3	Lília Dias	Photonic Materials for Neuromorphic Architectures	Department of Physics and CICECO-Aveiro Institute of Materials
	PE4	Ayla Dekker	Direct insights into ligand exchange dynamics on NaYF4 nanocrystals using 1H-NMR	Utrecht university
	PE5	Zoé Languénou	Metal-organic frameworks (MOFs) based on lanthanides from molecular electronics	CICECO-Aveiro Institute of Materials
	PE6	Jana Floréal	Stable nano-YAG:Ce3+ phosphors for photonic applications	Seaborough Materials Research B.V.
	PE7	Agnieszka Siomra	Metal ions sensing with two-photon fluorescent probes based on cadmium-free colloidal quantum dots	Wroclaw University of Science and Technology
	PE8	Liliana Santamaría Acevedo	Electrocatalytic H_2O_2 Production via $2e^-$ Water Oxidation on Fluorine-Doped Tin Oxide Catalysts	Institute of Chemical Research of Catalonia (ICIQ)
	PE9	Margarita Galper	Modifying PTAA Wettability for Large Area Perovskite Solar Cells	AMOLF
	PE10	Julia Zanoni	Optical Properties of Eu-Implanted Ga2O3 Thin Films: From α to β Polymorphs	i3N, Departamento de Física, Universidade de Aveiro
	PE11	Kiril Ivanov-Kurtev	Stitching-Based Resolution Enhancement in Wavefront Phase Measurement of Silicon Wafer Surfaces	Universidad de La Laguna / Wooptix SL.
	PE12	Alice Mirone	Compact photocapacitors and photobatteries for direct light energy storage	Politecnico di Torino, Italy
	PE13	Jiangtao Li	Skin-inspired stretchable biogel enables high-performance moisture-electric generation and AI-enhanced closed-loop hydration regulation	FUNSOM, Soochow University, Suzhou, China
	PE14	Fady Elhady	Superior Photodetection in Inverted Perovskite Architectures: Enhanced Responsivity and High Stability in p-i-n Triple-Cation Devices	Instituto de Ciencia de los Materiales, Univ. de Valencia (Spain)
	PE15	Álvaro de Armas Viera	Micropositioning NIR colloidal nanocrystals and measurement of their microluminiscence	Instituto de Ciencia de los Materiales, Univ. de Valencia (Spain)
	PE16	José Moreno-Tanco	Photoconductivity in ultrathin Indium Selenide nanosheets	Instituto de Ciencia de los Materiales, Univ. de Valencia (Spain)
	PE17	Miguel Medina-Alayón	Red/Green tunable emission from $NaTbF_4$ nanoparticles under dual-mode UV/NIR excitation for anticounterfeiting applications	Universidad de La Laguna, Spain

REGULAR (Dr./Prof.) - POSTER

Biomedical applications	PB10	Angela Staicu	Advanced Photodynamic Therapy Using Laser-Generated X-Rays	National Institute for Lasers, Romania
	PB11	Dinache Andra Cristina	Scintillating Nanocomplexes for X-Ray Induced Photodynamic Therapy	National Institute for Lasers, Romania
	PB12	Aleksandra Pilch-Wróbel	Engineering Core@Shell Upconverting Nanoparticles for High-Efficiency FRET-Based pH Sensing	Institute of Low Temperature and Struct. Res. Polish Acad.
	PB13	Magdalena Dudek	Evaluating the laser cooling potential of Yb3+ - doped CaF2 microcrystals	Wroclaw University of Science and Technology
	PB14	Łukasz Bujak	Adaptive Phase Engineering in Interferometric Scattering Microscopy	Institute of Photonics and Electronics of the CAS
	PB15	Vitalijus Karabanovas	Highly Photostable UCNPs–Chlorin e6 Nanocomplex for Dual NIR-Activated Photodynamic Therapy	National Cancer Institute
	PB16	Sílvia Silva	Before Going Intracellular: Exploring the Temperature-Dependent Emission Behaviour and Stability of a Genetically Encoded Probe in Intracellular-Mimicking Buffers	Universidade de Aveiro
	PB17	Dongmei Qiu	Infrared emitting lanthanide doped nanoparticles provide sensing capabilities to coronary implants	UAM nanoBig
	PB18	Tatiana Tozar	Development of a multimodal laser-based system for intraoperative differentiation of head and neck cancer	National Institute for Laser, Plasma, and Radiation Physics
	PB19	Tatiana Tozar	Modeling proton-induced DNA damage in human fibroblasts using GEANT4-DNA simulations	National Institute for Laser, Plasma, and Radiation Physics
	PB20	Felipe S. M. Canisares	Upconversion nanoparticles coated with Ir3+-Ln3+ bimetallic complex aiming for singlet oxygen (1O2) generation	University of São Paulo - Institute of Chemistry
	PB21	Alessandra Mara Garbosa Mutt	Investigation of a nanoconstructed curcumin-loaded Eu(III)-silica system as nitric oxide photoreleasing for theranostic application	UNESP
	PB22	Maryam Saketosgouei	Study on optical properties of K and Cs-doped g-C3N4 and their photoelectrochemical activity for reduction of CO2	Institute of Chemical Research of Catalonia (ICIQ-CERCA)
	PB23	Vilius Poderys	Photodynamic Performance of Upconverting Nanoparticle–Protein Stabilized Gold Nanocluster–Chlorin e6 Hybrid Systems	National Cancer Institute
	PB24	Laura García-Expósito	Label-free imaging of human cell models of neurodegenerative disorders using Quantitative Phase Imaging (QPI)	Dpto Ciencias Médicas ULL
	PB25	Mohammad Ali Nasiri	ZnO Layer Optimization for Enhanced Performance of InAs Quantum Dot Photodetectors in Bioimaging	Instituto de Ciencia de los Materiales, Univ. de Valencia (Spain)

Energy/others applications	PE18	Nayara De Melo Costa Serge	Bifunctional Eu3+-doped layered double hydroxide on membrane support for luminescent sensing and adsorptive removal of tetracycline	University of São Paulo (USP)
	PE19	Simon Spelthann	Making the Calibration of Power Dependence in Ratiometric Luminescent Nanothermometry superfluous	Leibniz University Hannover
	PE20	Leonnam Gotardo Merizio	Exploring the Glass–Particle Interface in PersL Composites	University of Sao Paulo (USP)
	PE21	Georgios Arvanitakis	Photoluminescence Spectroscopy of Upconversion Nanoparticles Using a Compact Spectrofluorometer	Edinburgh Instruments
	PE22	Luca Cartabia	Green Synthesis of P-doped Carbon Nitride for Effective Light-driven Oxidation Reactions in Hypoxic Environments	Justus Liebig University Giessen
	PE23	Christian Hernández Álvarez	A New Approach to Remote Optical Current Sensing Using $NaYF_4$:Yb^{3+},Er^{3+}	Adam Mickiewicz University / Universidad de La Laguna
	PE24	Michael Steinke	Fiber-based Plasmonic Microreactor for Flow Chemistry	Leibniz University Hannover
	PE25	Ghazaleh Abdolhossein	Iron Prussian Blue as a water oxidation catalyst in (photo)electrochemical CO2 reduction devices	Institute of Chemical Research of Catalonia (ICIQ)
	PE26	Boris de Jong	When photons snowball: Studying the photon-avalanching nanocrystals	Utrecht University

SHIFT'25 TENERIFE

Plenary Talks

Light for Motion

Ben L. Feringa*

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PLENARY SPEAKER

In the art of building small we explore the fascinating field of light powered molecular machines. The creative power of synthetic chemistry provides amazing opportunities on our route from molecules to dynamic functions along length scales. Among the major challenges ahead in the design of molecular switches, adaptive molecular systems and molecular motors is the control over dynamic functions and responsive behaviour.
The focus in this lecture is on my journey in the world of photochemical triggered molecular switches and light-driven rotary motors. The design of smart drugs and control of biomolecular functions will be illustrated in the context of recent advances in photopharmacology. Towards responsive materials, adaptive supramolecular assemblies in water and actuating soft materials are shown and prospects for the control of dynamic functions along length scales using light will be discussed.

Information on http://www.benferinga.com

**Nobel Laureate in Chemistry 2016: https://www.nobelprize.org/prizes/chemistry/2016/feringa/facts/*

SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Facing the Energy Challenge: Perovskite Solar Cells

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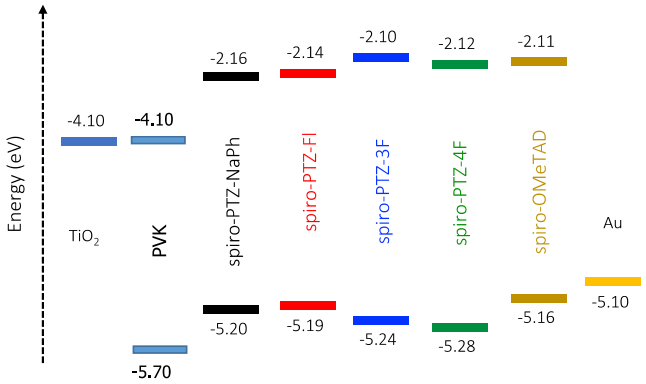
Energy and other Applications

Perovskites solar cells (PSCs) have emerged as a promising technology to face the urgent energy challenge.[1] Although the PCE values obtained so far must be considered outstanding, currently around 27 %, still other issues need further consideration for achieving competitive devices not only in terms of effciency but also of stability and technology.

A continuous improvement of the efficiency in PSCs has mainly been achieved using commercially available spiro OMeTAD as a reference and efficient hole-transporting material (HTM). However, spiro-OMeTAD is well-known to be an expensive material stemming from a multi-step synthetic protocol (under harsh conditions) and its difficult purification process, thus limiting its future use in large-scale applications.

Considering the power of modern organic synthesis, a wide variety of alternative organic low-cost molecules for its application as HTMs have been reported in the recent years.[2] In our group, we reported two doped-HTMs based on electron rich spiranic scaffolds, namely, 9H-quinolinophenoxazine (spiro-POZ) and 9H quinolinophenothiazine (spiro-PTZ) which exhibited a PCE value of 18.4%, and an excellent long-term stability in planar devices.[3] Based on these promising results, we have designed a variety of new derivatives based on spiro-PTZ and spiro-POZ which have been incorporated in PSCs, drastically improving the PCE of the devices and exhibiting outstanding stability properties.[4] In this presentation, a general overview on perovskites as well as our collaborative approach to new HTMs and preparation of devices will be discuss.



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SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Ultrasensitive, Multiplexed Nanophotonic Biosensors for Next-Generation Point-of-Care Applications

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Specify Technical Area: Biomedical

There is a critical demand for portable diagnostic tools that enable rapid, accurate testing with sensitivity and specificity comparable to laboratory-based methods. Among emerging technologies, biosensors—particularly photonic sensors—are well positioned to meet this challenge, offering fast, user-friendly point-of-need diagnostics. Nanophotonic sensors, which leverage evanescent wave-based light phenomena, enable sensitive, reliable, and selective detection while minimizing sample volume, eliminating the need for transport, and significantly reducing turnaround times.

Our work focuses on developing ultrasensitive, label-free point-of-care (POC) platforms using nanophotonic sensing technologies combined with custom-designed biofunctionalization protocols. These systems meet the critical requirements of disposability and portability for clinical diagnostics and environmental monitoring. We have demonstrated advanced nanophotonic sensors based on both nanoplasmonic and silicon photonics platforms, achieving highly sensitive analysis within minutes.

A central challenge in clinical biosensing is biofouling—non-specific adsorption of proteins and cells—which can impair sensor performance in complex biological fluids. To address this, we develop tailored antifouling strategies using hydrophilic and zwitterionic polymers, enabling robust biochip surface chemistry adapted to each application. This allows our POC platforms to detect proteins, genetic biomarkers, and pathogens directly in human samples in under 15 minutes, with high sensitivity and specificity. Applications validated to date include anticoagulant drug monitoring, plasma-based antibiotic allergy diagnosis, early detection of colorectal and lung cancers, and identification of viral and bacterial infections, including antimicrobial susceptibility profiling.

Beyond clinical diagnostics, we have integrated crystalline porous metal–organic frameworks (MOFs) and molecular metal–organic polyhedra (MOPs) into our sensor platforms. These materials offer versatile functionalization capabilities, enabling the selective and real-time detection of small pollutant molecules (<500 Da) in water. This advancement broadens the scope of our technology to include rapid, field-deployable environmental sensing.

SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Nanocrystals at Work: Unlocking the Power of Lanthanide Doping

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Abstract: Lanthanide-doped nanocrystals have emerged as a powerful class of optical materials for biological applications due to their unique photon management capabilities, including upconversion, downconversion, and persistent luminescence. These nanocrystals harness the ladder-like energy levels of lanthanide ions to achieve multi-wavelength emission with high photostability, deep tissue penetration, and minimal background autofluorescence, key attributes for advanced bioimaging and biosensing. Recent progress in the synthetic control, surface functionalization, and multiplexed encoding of lanthanide-doped nanocrystals has unlocked their potential for single-particle tracking, *in vivo* imaging, optogenetics, and theranostics. Moreover, their ability to transduce low-energy near-infrared excitation into visible or ultraviolet light enables spatiotemporally precise stimulation of biological processes, offering new avenues in neural modulation and controlled drug release. This talk highlights the latest breakthroughs in lanthanide nanocrystal-based biophotonics, emphasizing the mechanistic insights, design principles, and biomedical integration strategies that underpin their performance. I also discuss the emerging convergence of lanthanide nanocrystals with artificial intelligence, nanomedicine, and wearable technologies, envisioning a future where light-driven diagnostics and interventions are embedded into healthcare systems.

SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Coordination Control, Light Sensitization, and Radiation Targeted Delivery in Actinide Molecular Systems

Rebecca J. Abergel[1, 2]

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Actinides play a major role in many human-driven activities, such as in nuclear power generation, energy technologies, catalysis, and medicine. However, from potential contamination of individuals with radioactive fission products after a nuclear accident to the environmental impact of rare earth mine tailings or the therapeutic use of radioisotopes for cancer diagnostics and treatment, the nuclear, coordination and biological chemistry of 5*f*-elements have become increasingly relevant to a number of applied problems. Understanding the fundamental bonding interactions of selective metal assemblies presents a rich set of scientific challenges and is critical to the characterization of 5*f*-element coordination chemistry, and to the development of highly efficient separation reagents or new therapeutic agents. Using high-affinity, chelating ligands is one pathway for directing *f*-element's local coordination geometry, and currently the highest affinity *f*-block binding is achieved by organic, bio-inspired ligands. We will discuss some innovative molecular recognition and luminescence sensitization approaches, which, combined with advanced characterization techniques are used to achieve unprecedented 5*f*-element coordination control under a wide range of conditions. These studies will be discussed with a focus on resolving the fundamental electronic structure of 5*f*-elements and on emerging targeted radionuclide therapeutic applications.

SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Exploring light and life: Nanophotonics for scalable molecular sensing and sequencing

Jennifer Dionne
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Plenary Talk

The earth's biosphere is incredibly information-rich, with estimated information transmission rates exceeding those of the technosphere by 9 orders of magnitude (*Lingam et al, Life 13, 1850, 2023*). Yet, current methods to extract this information are slow and laborious, hindering our ability to understand the genesis and evolution of biochemical systems, and to optimize their performance. Here, we present nanophotonic methods that may enable unprecedented data about biochemical systems, at rates previously unattainable. First, we describe our lab's Si-photonic "Very-large-scale Integrated high-Q Nanophotonic Pixels" (VINPix). These photonic resonators achieve high-Q factors, subwavelength mode volumes, and controlled dipole-like radiation, simultaneously, with Q-factors from the thousands to millions, and resonator densities exceeding 100M/cm2. By combining VINPix arrays with acoustic bioprinting for local chemical functionalization, we develop Si chips and the associated AI framework that detect multi-omic signatures on the same platform. We discuss integration of these sensors with workflows in Stanford's Clinical Laboratories for label-free interrogation of the tumor-immune microenvironment, as well as with autonomous underwater robots from Monterey Bay Aquarium Research Institute (MBARI) for ocean biodiversity monitoring. Then, we describe how these chips can be used for peptide sequencing. By tailoring each resonator for strong Raman enhancement, we demonstrate high-resolution identification and de-novo sequencing of wildtype and mutated human leukocyte antigens. We also show how VINPix can be converted into reaction sites for DNA molecular synthesis by integrating optically absorbing heating elements. Reactions at each of the nanoantennas can be activated by a unique combination of optical wavelength and polarization, eliminating errors seen in other solid-state synthesis platforms. Further, the high-Q of each VINPix prevents spectral and spatial crosstalk between the nanoantennas, enabling maximum molecular sequence diversity with minimal error. Finally, we present our work uniting nanophotonics and mechanobiology to develop a new class of in vivo force probes, "microgauges". Our design is based on inorganic nanoparticles that, when excited in the near-infrared, emit light of a different color in response to compressive strain. We feed these nanoparticles to freely crawling worms, who readily ingest and excrete these sensors without measurable toxicity. We dynamically measure force changes during digestion, and show that the temporal pattern of force generation is consistent with the timing of action potentials. Collectively, we anticipate that these nanophotonic platforms can shed completely new data on the biosphere – from improved understanding of molecular communication systems, to optimization of novel biochemical sensing and synthesis platforms for sustainability.

Bio: Jennifer (Jen) Dionne is a Professor of Materials Science and of Radiology at Stanford. She is also a Chan Zuckerberg Biohub Investigator, deputy director of Q-NEXT (a DOE-funded National Quantum Initiative), and co-founder of Pumpkinseed, a company developing improved immune-modulating medicines. From 2020-2023, Jen served as Stanford's Inaugural Vice Provost of Shared Facilities. Jen received her B.S. degrees from WashU in St. Louis, her Ph. D. at Caltech, and her postdoctoral training at Berkeley. As a pioneer of nanophotonics, she is passionate about developing methods to detect and direct biochemical transformations, emphasizing critical challenges in global health and sustainability. Her research has developed culture-free methods to detect pathogens and their antibiotic susceptibility; amplification-free methods to detect and sequence nucleic acids and peptides; and new methods to image light-driven chemical reactions with atomic-scale resolution. She is the recipient of the NSF Waterman Award, NIH New Innovator Award, and the Presidential Early Career Award for Scientists and Engineers, and was featured on Oprah's list of "50 Things that will make you say 'Wow'!". Dionne alum hold faculty positions spanning top academia (eg, professors at MIT, Berkeley, Northwestern, Rice, Chicago, and Stanford), industry, startups, policy, and communications, including a Pulitzer prize winner.

SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Seeing, understanding and detecting with light

Luisa De Cola

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Light is a form of energy that can be used to visualize or trigger a process or to understand a complex, dynamic behavior. We have used light to monitor molecular aggregation and have shown that it is possible to follow, using a confocal microscope, an unprecedented real-time visualization of the evolving self-assemblies[1]. The molecules we have employed are platinum complexes and upon aggregation their emisión color can be modulated by controlling the distance between the compounds.
Intermediate, out of equilibrium, species can be "frozen" upon their entrappment in organosilica structure and released on demand to follow their evolution in different media[2].
Interestingly, self-assembly of such metal complexes can occur not only in solution and in controlled solvent ratios but also in living organisms. The supramolecular process in transparent animals can be visualized by the bright emission of the assembly and we have studied the process in the small freshwater polyp *Hydra*. We found that using water soluble luminescent platinum complexes we can follow the assembly in the body of the animal and that the self-assembly trigger unexpected biological event such self-regeneration of tissues[3].
Finally I wish to show how light generated upon recombination of oxidized/reduced species generated at the electrode and reduced/oxidized species produced by a chemical reaction, called electrochemiluminescence (ECL), can be used for the detection of pathogens.
In particular a strategy to increase the sensitivity of bioassays by a signal amplification methods based on cleavable ECL emitters[4] will be illustrated to increase sensitivity and to construct portable devices.

Acknowledgement: This project as received funding from the European Union's Horizon Europe EIC Pathfinder Open programme under Grant Agreement N. 101046787 (ECLIPSE).

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SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Rare Earth Doped Crystals for Integrated Quantum Photonics

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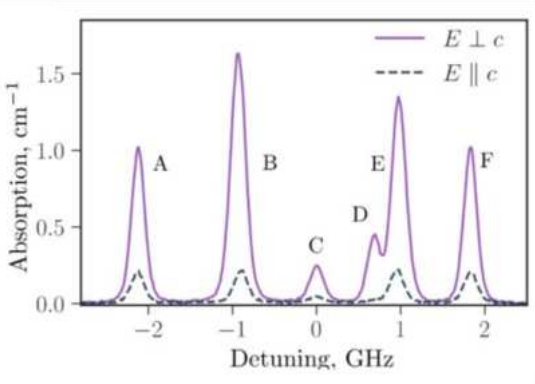
Systems with both spin and optical transitions offer a range of functionalities for quantum technologies. They allow storage and entanglement of photonic quantum states for quantum communications, interfacing processing nodes with optical networks for distributed quantum computing, or efficient detection for quantum sensing. Among various solid-state systems currently considered, rare-earth doped materials stand out as they combine, at cryogenic temperatures, long-lived optical and spin quantum states. In addition, they offer optical transition in a wide spectral range, including telecom wavelengths, high chemical stability, and easy doping in many hosts, thus enabling using large ensembles of centers with uniform properties.

Quantum-grade rare earth doped materials are developed in different forms. They include bulk crystals, as well as nanostructured materials such as nanoparticles, thin films, or molecular crystals, aiming at integration into nanophotonic devices. The latter offer small footprints, low energy consumption, high stability, scalability, and stronger interactions between light and rare earth ions. In this talk, we will present some of our recent results in the field [1-5], as well as the challenges to be addressed to bring rare-earth doped materials up to the highly demanding requirements of quantum technologies.



Narrow optical absorption lines in $^{171}Yb^{3+}$:$CaWO_4$ showing resolved hyperfine structures [1].

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[2] D. Serrano et al. , Ultra-Narrow Optical Linewidths in Rare-Earth Molecular Crystals, Nature 603, 241 (2022).
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This project has received funding from the European Research Council (ERC) under the European Union's Horizon 2020 research and innovation programme (grant agreement No 101019234, RareDiamond).

SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Colloidal Nanocrystal Materials and Optical Devices with Extraordinary Structures and Functions

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Please indicate preference: __Poster _x_ Oral
Specify Technical Area: __Biomedical _x_ Energy and other Applications

Colloidal nanocrystals (NCs) have inorganic cores and organic or inorganic ligand shells. They are prized for their size- and shape-dependent properties and serve as building blocks of artificial materials and unconventional devices. Here, we describe NC-based, optical metamaterials constructed using imprinting techniques from single- and multiple-types of metal, metal oxide, and semiconductor NCs. In one example, we exploit the chemical and thermal addressability of NCs, i.e., the ability to select, exchange, strip, or add atoms, ions, and molecules at the surface during or post-deposition, that is not accessible in bulk materials, and allows the control of metamaterial structure and properties. Through ligand engineering we tailor the dielectric function of metal NC assemblies through an insulator-to-metal transition.[1] By juxtaposing NC assemblies and bulk thin films to make bilayer heterostructures, we exploit ligand exchange to trigger folding of two- into three-dimensional structures,[2] which we use to achieve broadband[3,4] and reconfigurable[5] 3D chiral plasmonic optical metamaterials and 3D chiral luminescent materials. In a second example, we report a room temperature, single-step direct nanoimprint process into NC inks containing varying concentrations of adaptive polymer.[6] We pattern large-area, two-dimensional nanopillar gratings atop waveguides, forming tunable, highly reflective, high Q optical metasurfaces that are sensitive to targeted environmental stimuli. These metasurfaces are patterned on biodegradable and flexible substrates, serving as a platform for high figure of merit colorimetric sensors for environmental sensing in agricultural applications, and can be readily extended to the wider NC material library with a variety of adaptive polymer composites for the low-cost fabrication of optical devices, with potential applications in sensing, wearable devices, and flexible optics.

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SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

WATER'S HIDDEN DENSITY DANCE: FROM CHARGED INTERFACES TO PROTEIN DYNAMICS

Luís Dias Carlos

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Luminescence nanothermometry has emerged as a transformative technique, enabling precise sub-micrometer thermal flow measurement beyond conventional electrical methods. While diverse phosphors (e.g., polymers, quantum dots, and lanthanide-doped nanomaterials) have been explored, the field now focuses on robust theoretical foundations and standardized methodologies, including improved data acquisition and reproducibility.[1]

In this seminar, we demonstrate how luminescence nanothermometry can be applied to investigate both liquid water density fluctuations and protein dynamics. We first examine the intricate interplay between temperature, pH, and Brownian motion in differently sized upconversion nanoparticles.[2,3] Acting as nanorulers, these particles reveal the relative abundance of high-density (HDL) and low-density (LDL) water in their hydration shells, supporting the two-state model of liquid water and highlighting the critical role of nanoparticle surfaces in probing density fluctuations at charged interfaces.

We then discuss how protein unfolding is related to temperature-dependent density fluctuations in both light and heavy water. Although water's dynamic behavior at protein interfaces is fundamental to biomolecular function, it remains difficult to observe directly. By analyzing the Brownian velocity of enhanced green fluorescent protein (EGFP) colloidal suspensions,[4] we link the LDL–HDL crossover temperature to the onset of protein unfolding. This strategy enables the decoupling of water density dynamics from protein denaturation, providing insights into hydration-mediated protein stability and offering a versatile platform for bio-thermometry and the development of thermally robust protein-based technologies.

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Shift'25 TENERIFE

Keynote Talks

SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Exploring the rational design of upconverting nanocrystals through experimental and theoretical synergies

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Rare-earth doped upconverting nanocrystals (UCNCs) are among the most promising materials to overcome drawbacks associated with conventional fluorescent materials. Their ability to convert NIR light into UV-Vis-NIR light via a sequential absorption of two or more photons, narrow emission bands, long luminescence, good photo-stability, limited toxicity, make them suitable for many biomedical purposes.[1-3] However, the ultimate transfer of UCNCs into robust luminescent probes for daily use in biological and medical laboratories requires small and monodispersed colloidal nanocrystals, comprehensive knowledge of the many possible deactivation pathways that cause upconversion luminescence (UCL) quenching and a proper surface coating that provides physiological dispersion and biocompatibility while preserving optical properties.

In this contribution, I will illustrate how the integration of experiments and modeling allows us to: i) gain more insight into the mechanism of nucleation and formation of colloidal UCNCs; ii) understand the complex upconversion dynamics;[4] iii) identify the best protective surface ligands to transfer the nanocrystals in aqueous medium as well as conjugate them with biomolecules; vi) and, last but not least, develop optimal configuration for nucleic acid FRET biosensing and bioimaging.[3]

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SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Upconversion nanoparticles for chemical, physical and biological sensing: from functionalization to point-of-care devices.

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Among several applications, versatile upconversion nanoparticles (UCNPs) which can convert lower-energy infrared radiation into higher-energy visible or ultraviolet light, have emerged as one of the most powerful tools in the field of chemical, physical and biological sensing. The use of UCNPs in fluorescent sensors allows non-invasive, highly sensitive, and selective detection methods, which are particularly beneficial in environments requiring minimal interference and high precision for analytes that can range from metal ions to biomolecules. In this lecture, an overview and the state of the art will be given, accompanied by examples of our recent contributions to key areas such as chronic disease diagnostics, bacterial sensing, and multifunctionally responsive nanoplatforms: (1) An Enhanced Luminescence Lateral-Flow Assay (ELLA) designed for rapid (< 15 min) and early detection of acute kidney injury biomarkers in urine samples, using a commercial cell phone camera, will be presented. The platform is based on Er^{3+}- and Tm^{3+}-doped UCNPs whose emissions intensities are 40-fold enhanced by an Au-coated mesoporous silica shell, enabling the accurate detection of KIM-1 and NGAL biomarkers with detection limits as low as 0.23 ng/mL; (2) Also, a multifunctional nanoplatform that combines Tm^{3+}-doped UCNPs with a Cu(I) complex for applications in oxygen sensing, optical thermometry, and emission colour tuning will be presented. The platform utilizes Luminescent Resonance Energy Transfer (LRET) to achieve efficient energy transfer, enabling red emission from the Cu(I) complex while allowing the use of the UCNP's original emissions for thermometry. The dual functionality allows sensitive O_2 detection and temperature measurements, with relative sensitivities of up to 1% K^{-1}; (3) The critical challenge of rapid bacterial detection and differentiation was addressed by the development of a novel UCNP-based sensor. By functionalizing UCNPs with the antibiotics - vancomycin for Gram-(+) and polymyxin-B for Gram-(-), and using Au nanoparticles as intensity quenchers, the sensor leverages a ratiometric "turn-on" mechanism for selective detection of the bacteria, through changes in the green/red (G/R) ratio for Er-UCNP@PEG4-Van, and blue/red (B/R) ratio for Tm-UCNP@PEG4-Poly. By this approach, differentiation was possible over a wide concentration range of bacteria (0.05 to 5 x 10^5 CFU/mL) with high correlation with actual bacterial counts (r = 0.99 for *S. aureus*, r = 0.91 for *E. coli*); (4) Recently, we have demonstrated a water dispersable ratiometric pH-nanosensor based on host-guest interaction of Tm^{3+}/Yb^{3+} co-doped UCNPs functionalized with b-cyclodextrin (b-CD) and a pH-responsive nitrobenzoxadiazol dye modified with adamantane (NBD-Ad). The sensor shows a ratiometric emission response (blue/red) over a pH range of 8.0 – 11.0 with high reproducibility, excellent reusability and selectivity, even in the presence of interferents. Together, the presented examples highlight the versatility and potential of UCNPs to develop novel sensors, offering measurable advances in diagnostics, environmental monitoring, and beyond.

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SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Theranostic agents achieving PET-MRI fusion and photodynamic therapy

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Please indicate preference: __Poster ✓Oral
Specify Technical Area: ✓Biomedical __ Energy and other Applications

There is continued interest in combining the well-known imaging modalities of positron emission tomography (PET) and magnetic resonance imaging (MRI). However, there are no reports on a single-molecule probe offering dual-modal imaging without performance degradation. We present a potential solution where the compound incorporates radioactive Ga(III) for PET imaging whilst simultaneously being able to exhibit MRI contrast through a coordinated Gd(III) ion but at low concentrations/doses. Our compound has proven to be a successful dual-imaging agent for both PET and MRI in mice. Additionally, we conducted comprehensive in vitro and in vivo studies, assessing biosafety and photodynamic therapeutic potential across various cell lines and organoids. Moreover, we developed a solid-phase material, NOTA-Gel, to remove the excess radiometal ions from the post-labelling mixture actively and efficiently without the use of organic solvent. The time spent for purification can be shortened to 10 minutes in room temperature with more than 95% clearance rate, providing a novel strategy for post-radio labelling treatment.

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SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

So far, so good: NIR imaging and sensing

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Please indicate preference: __ Oral
Specify Technical Area: Biomedical

Nanoparticles emitting in the second and third near-infrared windows (NIR-II and NIR-III, 1000–1700 nm) are reshaping the landscape of preclinical bioimaging and biosensing. Their exceptional ability to penetrate deep into biological tissues with minimal scattering positions them as powerful tools for non-invasive, high-resolution imaging. However, the path to clinical translation is far from straightforward. Persistent challenges—such as non-uniform signal attenuation across heterogeneous tissues and the inability to fully suppress autofluorescence—continue to limit their broader adoption. In this talk, I will offer a critical overview of recent advances in NIR-emitting nanoparticles, examining both the breakthroughs and the bottlenecks. More importantly, I will discuss how some of these limitations, when approached creatively, can be transformed into unique opportunities. By leveraging the inherent complexity of biological environments, we can turn challenges into functional features—paving the way toward innovative solutions such as the development of smart, image-guided diagnostic implants. This perspective not only reframes current obstacles but also highlights a promising and dynamic future for nanotechnology in medicine.

SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Enabling large-scale genomics for precision medicine

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Please indicate preference: __Poster _X_ Oral
Specify Technical Area: _X_Biomedical __ Energy and other Applications

Next generation sequencing has drastically transformed our understanding of the fundamentals of life and for positioning genomics in the center of translation of innovation for health care purposes and beyond. In particular, DNA sequencing-by-synthesis, leveraging controlled sequential addition and imaging of fluorescently labeled nucleotides with reversible terminators, delivers accurate per base sequence of genomes. At the Genomics Division of ITER, born at the dawn of 2016, we aim for the improvement of scientific capabilities and the establishment of the basis for transforming our experience and infrastructure in R&D&I in the archipelago into applications for personalized health care. For that, ITER has cutting-edge infrastructure both at the level of ultra-sequencing and high-performance computing, necessary to bring the standards pursued by the Precision Medicine paradigm closer to the health care system. So far, we have been leading the development of tools and resources to adapt and deploy this technology to the specificities of the population and the community. Some of the most salient applications and developments so far include: a) Support of the genomic surveillance of respiratory pathogens, which was central during the COVID-19 pandemic and to rapidly characterize re-emerging threads like Mpox during 2022; b) Contribution to create international standards and leading regional catalogs of genetic variation; c) Lead the identification of genetic risks across many diseases, including idiopathic pulmonary fibrosis, inborn errors of immunity, and severe infectious diseases; d) Assistance in diverse genomic applications by third-parties, including: epigenetics as early biomarkers of mental health, genome sequencing to identify genetic risks and novel druggable targets in amyotrophic lateral sclerosis, genome sequencing in adverse drug responses, genome sequencing to identify causes of rare diseases, among others. Our resources and expertise, the geographical position of the Canary Islands, at the crossroads of Africa, Europe and the Americas, and the critical HPC infrastructures hosted at ITER, positions Tenerife in the right place for strategic developments for Precision Medicine applications that are adapted for the region.

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SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Persistent luminescence nanoparticles for biosensors and bioimaging

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Please indicate preference: Oral , Technical Area: Biomedical

Persistent luminescence is controlled by a slow liberation of trapped charge carriers by a simple thermal de-excitation process. It can last for few minutes to hours after the removal of the excitation source. The persistent luminescence mechanisms can be envisioned either from physics or chemistry points of view, playing with the intrinsic defects and the optimization of the trapping by stoichiometric variation and thermal annealing. Several applications were envisioned with these materials such as emergency signing, luminous painting, etc. More recently this concept was also proposed for the development of new optical imaging modalities. At nanoscale, deep red and near-infrared persistent luminescence nanoparticles enable highly sensitive *in vivo* optical detection and complete avoidance of tissue autofluorescence. Development of nanosize persistent luminescent materials was initiated by our research team in Cr^{3+} doped zinc-gallate nanomaterials and requires perfect materials with high fluorescence intensity and careful control of the defects [1]. Lot of parameters of these nanoprobes can be adjusted, such as surface functionalization, composition by using Sn^{4+} as dopant to improve the intensity *(Fig.1 left),* or wavelength of the optical stimulation/emission to favor multiple challenging biomedical applications. Bioimaging applications can be tuned when using probes emitting in BW-I and BW-II *(Fig.1 center),* since this could allow better imaging of deeper tissues but this is not that simple as in BW-II efficient SWIR camera are required [2].

New applications of the persistent luminescence nanophosphors include optical sensors in nanothermometry field or biological markers. A novel *in-vitro* strategy for biomolecule detection was introduced, leveraging the dose-dependent enhancement of persistent luminescence signal upon exposure to hydrogen peroxide (H_2O_2) [3] *(Fig.1 right).* This approach enables both quantitative and qualitative detection of H_2O_2, a product of various enzymatic reactions and an essential biomarker in numerous diseases, including diabetes and cancers. The development of sensitive, rapid, and user-friendly H_2O_2 sensors is therefore of great biomedical significance. A comprehensive analysis of material structure, surface chemistry and spectroscopic and electrochemical properties is proposed.

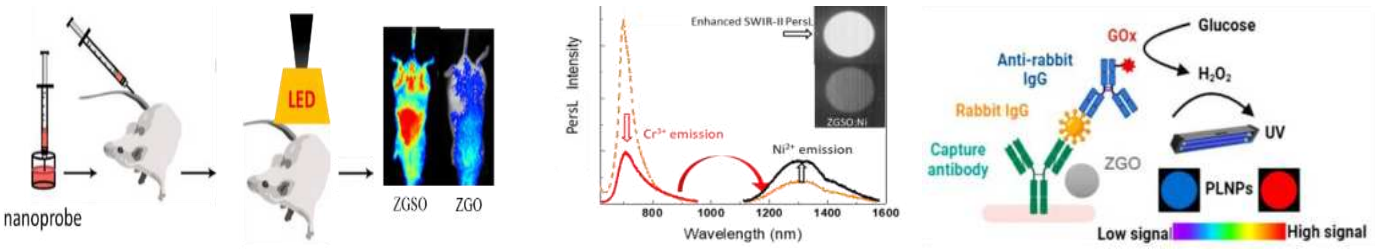

Fig.1. Persist. Lum. NPs with optimized: composition (left), dopant for SWIR bioimaging (center),and H_2O_2 nanosensors (right)

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SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Perovskite Solar Cells: Novel Nanomaterials for High Stability

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Please indicate preference: Keynote Speaker
Specify Technical Area: Energy Applications

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The power conversion efficiency of Perovskite Solar Cells for single junction devices has exceeded the astonishing 27% efficiency. The Perovskite/Silicon Tandem version have already surpassed the theoretical single-junction Shockley–Queisser limit of 33.7%. In addition, the commercialization of the technology is now a reality with the PV industry demonstrating its first commercial products. Many companies have shown excellent module reliability with most of them passing the IEC standardization (required for commercial Silicon Solar Cells). Thus, in this talk, we want to bring some light on the most intriguing question regarding the stability and reliability of the PSC technology: are we there yet? Issues on stability are still under strong investigation and research on the topic has increased exponentially in the last 10 years. Some companies have already promised excellent reliability of their modules, with 80 % retention of the initial power conversion efficiency (PCE) after 25 years. The next two or three years will be crucial to demonstrate these pledges. In this talk, I will present an outline of the most stable PSC devices reported up to date and discuss the most important nanomaterials and strategies leading to highly stable devices.

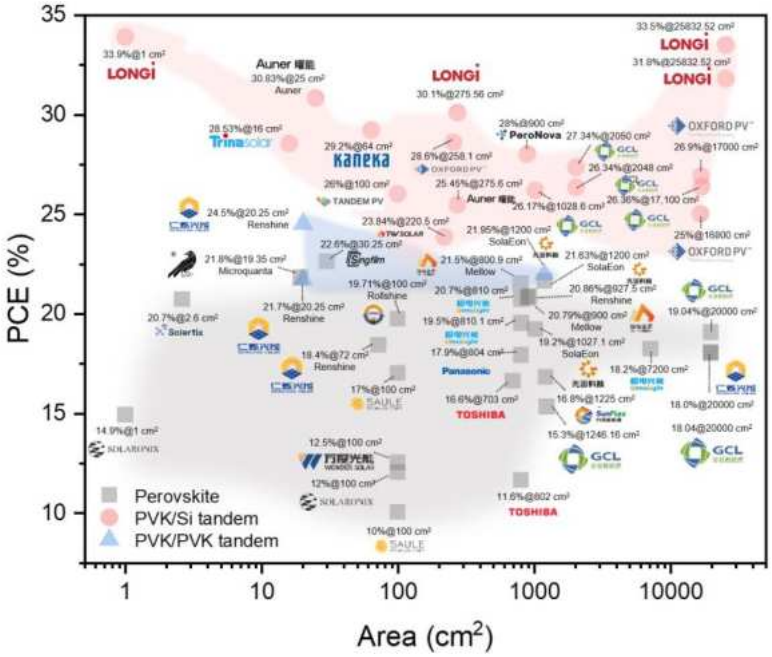

Figure 1. Power conversion efficiency (PCE) for Halide Perovskite Solar Cell PSMs developed by industries: single junction (■), Perovskite/Silicon Tandem (●) and Perovskite/Perovskite Tandem (▲) solar cells.

SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
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The Chemistry of Small Molecules for Energy Applications

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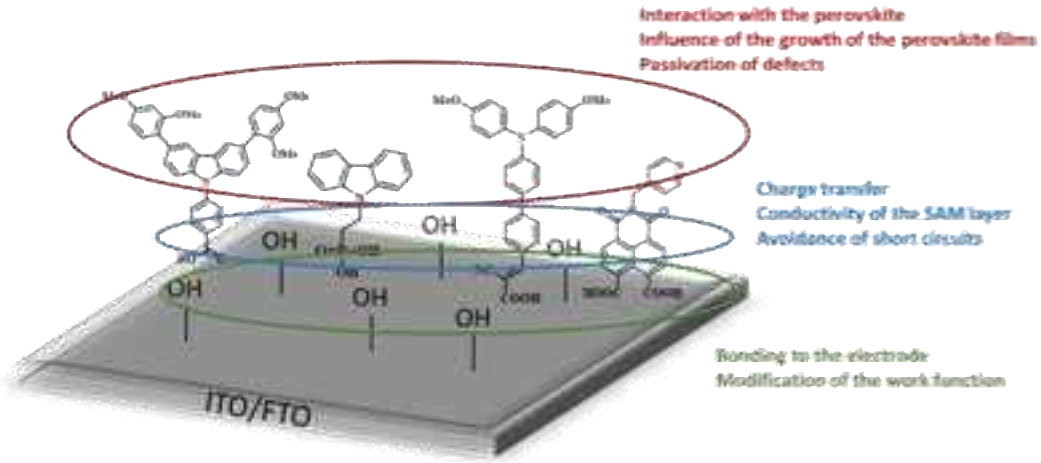
Please indicate preference: Oral
Specify Technical Area: Energy and other Applications

The charge-selective contacts play a crucial role in the charge dynamics of solar cells. In the fast race to achieve higher power conversion efficiencies in perovskite-based devices, avoiding the detrimental effects stemming from interfacial charge recombination and/or poor charge extraction is key to attaining high-performance devices. The unique molecular structure of self-assembled molecules (SAMs) provides the potential to fine-tune different parts of the molecule through precise design of its components, allowing for desirable energy levels and molecular dipoles that facilitate charge transfer. Hence, the application of SAMs as selective contacts emerges as a promising approach to achieving high-performance perovskite solar cells, offering advantages such as low material consumption, longer lifetimes, and reduced interfacial non-radiative recombination. In this review, we summarise the recent literature regarding SAMs applied as selective hole or electron contacts. The objective of this review is to unravel open questions related to these molecules and propose our perspective on the development of SAMs for the creation of cost-efficient and stable perovskite solar cells.



SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Photonic Effects in Luminescence Spectroscopy

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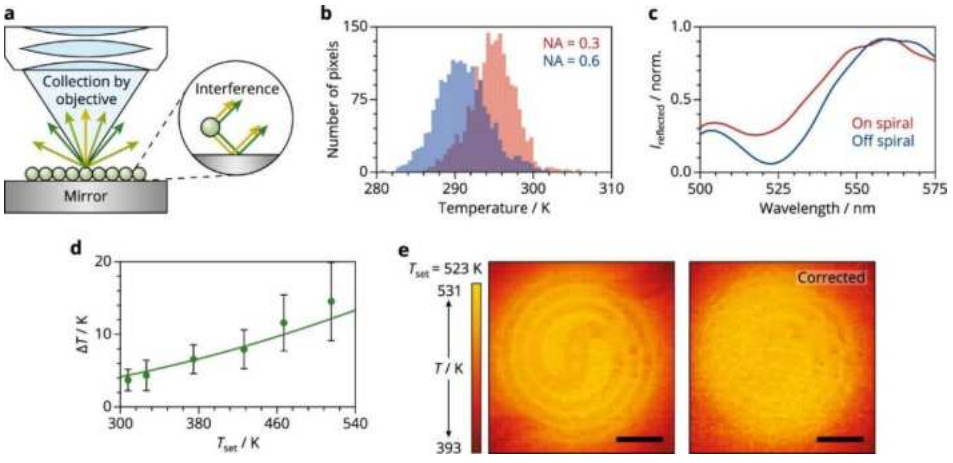
Specify Technical Area: __Biomedical _x_ Energy and other Applications

Photonic effects affect the optical properties of luminescent ions. This has been known for over a century but with luminescent nanocrystals a new and versatile probe emerged for quantifying photonic effects. In this lecture an introduction to the field will be followed by an overview of recent findings on the role of photonic effects in radiative, non-radiative and energy transfer processes and implications for applications. Pioneering work on photonic effects showing how nanocrystals are uniquely suited to probe these was done on Eu^{3+} in Y_2O_3 nanocrystals.[1] Later, the role of photonic effects on radiative decay and energy transfer rates was done using 4 nm $LaPO_4$ NCs doped with Ce^{3+} and/or Tb^{3+} ions in different refractive index solvents.[2-4] The measured influence of the refractive index on the radiative decay rate is in excellent agreement with the theoretical nanocrystal-cavity model. No influence was measured on energy transfer rates. Luminescence quenching of lanthanide luminescence in nanocrystals was modelled with a new ligand-quenching model for multi-phonon quenching in $NaYF_4$:Er,Yb upconversion nanocrystals and allowed to identify the most important loss mechanisms: solvent quenching, cross-relaxation, and coupling to OH defects.[5] Finally, the impact of photonic effects on applications of luminescent (nano)probes will be discussed showing how quantum efficiency can be optimized and how the local photonic environment lead to systematic errors in probing temperatures using luminescence thermometry (see figure below [6]).



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SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Charge carriers dynamics in quantum dots: from modeling to applications

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Please indicate preference: __Poster _X_ Oral
Specify Technical Area: __ Biomedical _X_ Energy and other Applications

Modeling the light-matter interactions in nanomaterials has been an indispensable tool for understanding the complexity of charge carrier dynamics, allowing their exploitation. Machine-learning algorithms have been proven to be particularly useful in optimizing nanomaterial synthesis with respect to their optical properties.[1] Such algorithms do not often include a detailed mathematical model of charge carriers' dynamics, as the implementation of such models would be impractical in terms of processing times. Consequently, less information about the mechanism itself can be derived.
Modeling luminescent dynamics through rate equations is widely used and offers the possibility to consider even the ionic distribution of an active species within a crystal lattice and its symmetry.[2,3] Predicting the effect of even the smallest change in ionic distribution in the population of the involved energy levels requires a higher level of sophistication,[4,5] covered by coupling rate equation models that take into account the crystal lattice occupancy and machine-learning algorithms. However, as underlined earlier, the models must be substantially simplified to attempt any resolution.
A possible solution to this problem would be to find an approximate resolution of the rate equation models that would lead to a known error, to account for it in the final analysis of the mechanism. Ideally, an algebraic expression would be preferable to avoid the excessive computational load. Searching for such a resolution, a possible compromise between accuracy and computational load will be presented. The prospective application of such a model to nanomaterials investigated in our group will be clarified, to finally showcase the possible implications of the use of quantum dots and their charge carriers' dynamics in biological, environmental and radiation safety applications.

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SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Revisiting the mechanisms of non-radiative energy transfer in lanthanide materials

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Specify Technical Area: __Biomedical _X_ Energy and other Applications

In this lecture three main points will be highlighted: 1) to call attention for shielding effects, produced by the 5s and 5p filled sub-shells, in the multipolar mechanisms (dipole-dipole, dipole-quadrupole and quadrupole-quadrupole) of energy transfer rates between lanthanide ions and ligand-ion [1]. As for the very short-range exchange mechanism, no shielding factors are explicitly necessary, once they are implicitly taken into account in the ion-ion (4f-4f) overlap integrals between their valence shells. 2) to use a new model for treating the Judd-Ofelt Ω_λ intensity parameters by using a thermal root mean squared displacement around each ligating atom (ion) in the analysis of the intensity parameters [2]. This might have an important role for the rationalization of 4f-4f transition intensities and ion-ion energy transfer processes, mainly when the lanthanide ions occupy a center of inversion. 3) to call attention to the fact that the quadrupole-quadrupole mechanism imy be dominant for ion-ion distances as far as 20 Å, provided shielding effects are taken into account. Spectral overlap integrals are evaluated analytically [3]. The mechanisms of intramolecular energy transfer in lanthanide complexes will be discussed.

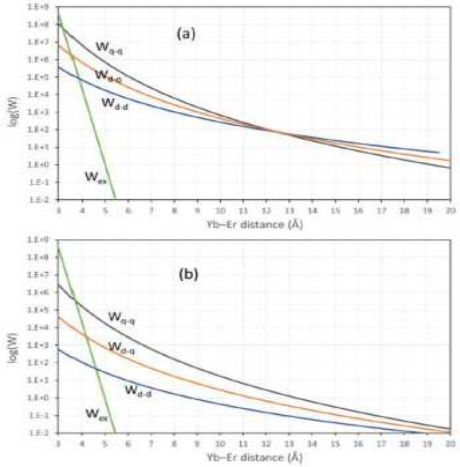

Figure 1. Energy transfer rates for the Step 1: (a) without shielding and (b) with shielding effects.

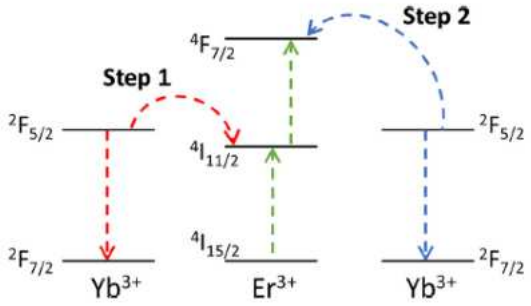

Figure 2. Schematic energy transfer from Yb^{3+} to Er^{3+} ions in the up-conversion process. **Step 1** is considered when the states $^2F_{5/2}$ from Yb^{3+} and $^4I_{11/2}$ of Er^{3+} are involved. **Step 2** involves the higher acceptor (Er^{3+}) level $^4F_{7/2}$.

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SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

The size effects on luminescence of lanthanide upconversion nanoparticles

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Specify Technical Area: _x_Biomedical __ Energy and other Applications

Optical upconversion from lanthanide-doped nanoparticles is promising for a variety of applications ranging from bioimaging, optogenetics, nanothermometry, super-resolution nanoscopy and volumetric displays to solar cells. Despite remarkable progress made in enhancing upconversion to fuel these applications, achieving luminescence of upconversion nanoparticles (UCNPs) that is comparable to or higher than the bulk counterparts has been challenging due to nanoscale-induced quenching effects. Here we present a size-dependent lanthanide energy transfer effect in a conceptual design of hexagonal sodium yttrium fluoride core–shell–shell $NaYF_4$@$NaYF_4$:Yb/Tm@$NaYF_4$ UCNPs with depleted surface quenching. We show that precise control over the domain size (from 1.2 to 13 nm) increases the lanthanide energy transfer efficiency (from 30.2 to 50.4%) and amplifies the upconversion quantum yield to a high value of 13.0 ± 1.3% in sub-50 nm UCNPs (excitation: 980 nm, 100 W cm^{-2}), which is around fourfold higher than the micrometre-scale hexagonal NaYF4:Yb/Tm bulk counterparts. Spectroscopic studies and theoretical microscopic modelling reveal that long-range lanthanide energy transfer (>9.5 nm) takes place and underlies the observed size-dependent phenomena. Demonstration of size-dependent lanthanide energy transfer and upconversion quantum yields at the nanoscale transforms our long-existing conceptual understanding of lanthanide energy transfer (size independence)[1-2], thereby having important implications for applications of lanthanide nanophotonics and biophotonics.

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SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Advanced nanostructures for solar energy harvesting

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Please indicate preference: Oral (keynote)
Specify Technical Area: Energy and other Applications

Composite nanostructures can be efficiently applied for Sunlight conversion and, in general, for energy harvesting and generation of solar fuels. In most of the applied systems, like excitonic solar cells, (photo)-electrochemical cells for solar fuel production, and evaporation systems for water desalination, nanomaterials can play a critical role in boosting conversion efficiency and energy use by ameliorating the processes of light management, charge photogeneration, exciton dissociation, and charge transport. A crucial role in such processes is played by the structure and quality of the interface, which needs to be properly assembled to obtain the desired functionality. Specifically, the structure of the interface determines the electronic configuration of the conduction and valence band in semiconducting composites, altering the electronic and optoelectronic properties of composite nanostructures and quantum systems. In addition, conformal interfaces inhibiting the presence of pin-holes in sub-nanometer thin films of multilayered devices are very challenging to obtain, but are critical to avoid undesired electrical short circuits. Several strategies can be pursued to modify the interface of composite systems, aiming to maximize energy harvesting and storage, including broadening light absorbance to reduce solar light losses, fastening exciton dissociation and charge injection from the photoactive medium to the charge transporting materials, reducing charge recombination during charge transport and collection at the electrodes, creation of continuous nanometer thick conformal layers to overcome issues related to the presence of pin-holes. In this lecture, a few examples of the application of nanocomposites will be discussed, including thin film solar cells [1], quantum dot and carbon dot fluorophores for high-efficiency luminescent solar concentrators [2,3], selective solar absorbers for solar water desalination [4] and composite sulfides for hydrogen generation [5,6]. Emphasis will be given to the role of interface engineering in improving the efficiency of energy conversion in different systems, spanning from electric power generation from Sunlight to chemical fuel production.

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SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Synthetic Methodologies for Developing Lanthanide-Based Molecular Magnetic and Optical Materials

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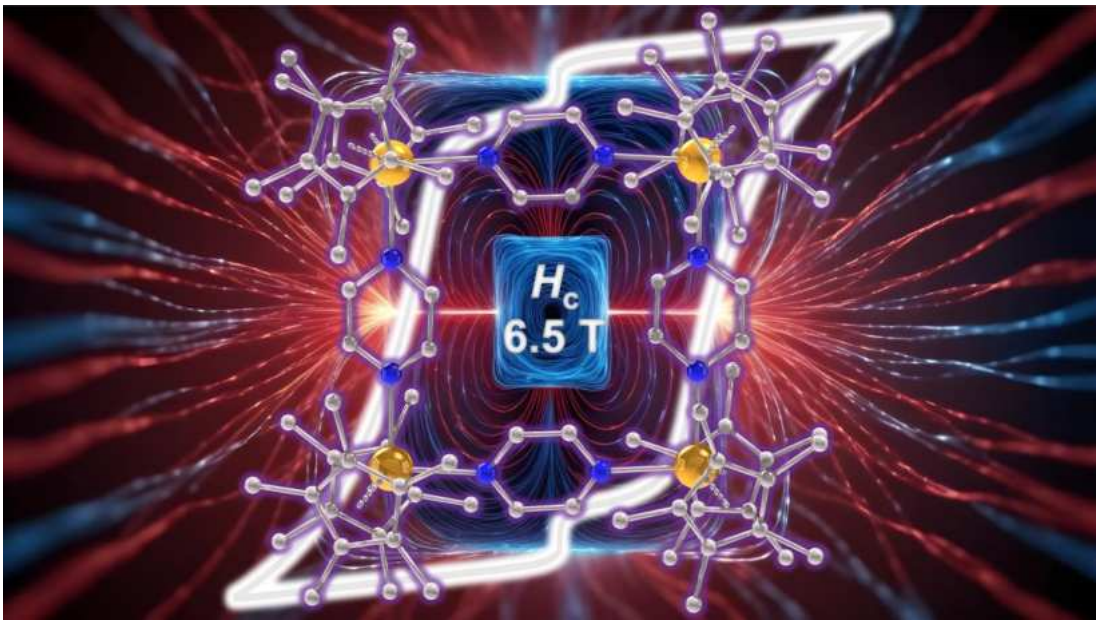
Oral

Specify Technical Area: Energy and other Applications

Molecules that exhibit the super-paramagnet-like property of slow magnetization relaxation and thus behave as magnets below their magnetic blocking temperature. Single-Molecule Magnets (SMMs) are promising candidates for molecular electronics such as high-density memory storage and quantum computers. Yet, the design of high-performance SMMs has been an ongoing challenge for the last three decades. This issue is particularly pronounced in multinuclear lanthanide systems, where the unpaired electrons are confined to the core 4f orbitals, limiting the possibility of strong magnetic interactions between metal centers. To address this, we have focused on incorporating small radical bridges that can enhance magnetic interactions, thereby enabling the formation of lanthanide clusters with behavior resembling the giant spin vector model typically observed in transition metal ions. Clusters based on tetrazine and pyrazine radicals exhibit strong intramolecular magnetic interactions and a large coercive fields, indicative of hard magnet behavior. These findings mark a significant advancement towards SMMs with record-high blocking temperaturas



SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Broadband Spectral Conversion and Light Management for Next Generation Greenhouses

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Specify Technical Area: Energy

Greenhouses play a key role in realizing global food security in modern agriculture – it controlled environment allows for year-round crop production, even in extreme climatic conditions. Greenhouses are an important part of the food-energy-water nexus with advanced technologies optimizing the use of resources, e.g. up to 90% less water consumption than in open field farming. Greenhouses are important to feeding the world's growing population, expected to exceed 9.7 billion by 2050. It is estimated that greenhouses currently occupy approximately 1.2 million hectares of agricultural land in 130 countries worldwide, demonstrating the technology's widespread adoption and role in modern food systems.

Traditional greenhouses are made of either i) metal frames with glass walls and ceilings; or ii) simpler plastic materials formed into a so-called polytunnel. More advanced greenhouses are now incorporating climate control systems, which are very energy intensive, and indeed their environmental footprint is heavily influenced by this. To further improve their performance, recent advances in greenhouse technology have been made. For example, the use of agri-photovoltaic systems can allow for the generation of electricity and the cultivation of crops at the same time - ideally while optimizing the efficiency of land use. In addition, spectral conversion (luminescent) materials can increase the rate of photosynthesis - and thus plant growth - by converting the underutilized wavelengths of the solar spectrum - primarily in the ultraviolet and green - into wavelengths more useful to plants, i.e., better matching the photosynthetically active radiation (PAR) spectrum.

Improved thermal management to passively dissipate heat, minimizing reliance on electrical cooling/ventilation systems, is enabled by recent advances in passive radiative cooling during the day. Finally, novel water harvesting systems based on advanced materials and designs can capture moisture directly from the atmosphere, helping to address water scarcity. Taken together, these advances demonstrate significant potential for next generation greenhouse technologies that can help overcome traditional limitations while enabling food to grow in a more sustainable and resource-efficient manner.

Plant growth is influenced by four key factors: i) light spectrum, intensity and diffusion, ii) water availability (including air and soil moisture), iii) temperature, both air and soil, and iv) the level of carbon dioxide (CO2) concentration inside the greenhouse. These factors are all highly interrelated and together affect plant growth and productivity. One of the key goals for the next generation of greenhouses is to achieve net zero energy (NZE) consumption. This currently represents a major challenge due to the energy required to regulate the microclimate of the greenhouse. There is also a need to avoid competition for the same resource, e.g. photosynthesis and photovoltaics both require space and access to sunlight. This is where compromises need to be avoided and where synergies need to be found. A transdisciplinary effort is necessary to pave the way for the development next-generation NZE greenhouses. In this paper, the opportunities and challenges for next-generation greenhouses will be the subject of discussion.

SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Taking Luminescence Thermometry to Extremes for Device, Energy, and Catalysis Applications

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Please indicate preference: __Poster _X_ Oral
Specify Technical Area: __Biomedical _X_ Energy and other Applications

From next-generation electronics to emerging catalytic processes, broad swaths of modern technology combine a need for micro to nanoscale thermal metrology with challenging operating conditions. However, existing thermometry techniques often fall short of providing the requisite spatial resolution and operando capabilities. Here, two prime examples of pushing the boundaries of luminescence thermometry to address such challenges will be presented. First, a super-resolution nanothermometry technique based on stimulated emission depletion (STED) imaging of highly doped upconverting nanoparticles (UCNPs) will be introduced, which enables far-field optical thermometry with spatial resolution below the diffraction limit. The results showcase the ability of STED nanothermometry to reveal a temperature gradient across a Joule-heated microstructure that is undetectable with diffraction limited thermometry [1]. Ongoing efforts to explore other lanthanide-doped nanoparticle compositions and further reduce the required laser intensities for super-resolution nanothermometry will also be addressed. Second, a dual-mode technique that enables simultaneous yet separate operando UCNP thermometry and Raman-based chemical reaction monitoring during plasmonic photocatalysis will be discussed. Temperature rises exceeding 40 K are recorded during 4-nitrothiophenol dimerization on plasmonic silver-coated silicon nanopillar structures, yet complementary measurements rule out a purely thermal mechanism [2]. Additional measurements on plasmonic silver nanotriangle and nanoisland samples in which thermal conductivity of the underlying substrate material is varied by orders of magnitude further reveal the complex interplay between thermal and non-thermal contributions to the observed reaction enhancement.

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SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

SUPERVAL:
A European project towards solar-powered waste to added value chemicals

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Please indicate preference: Invited Speaker

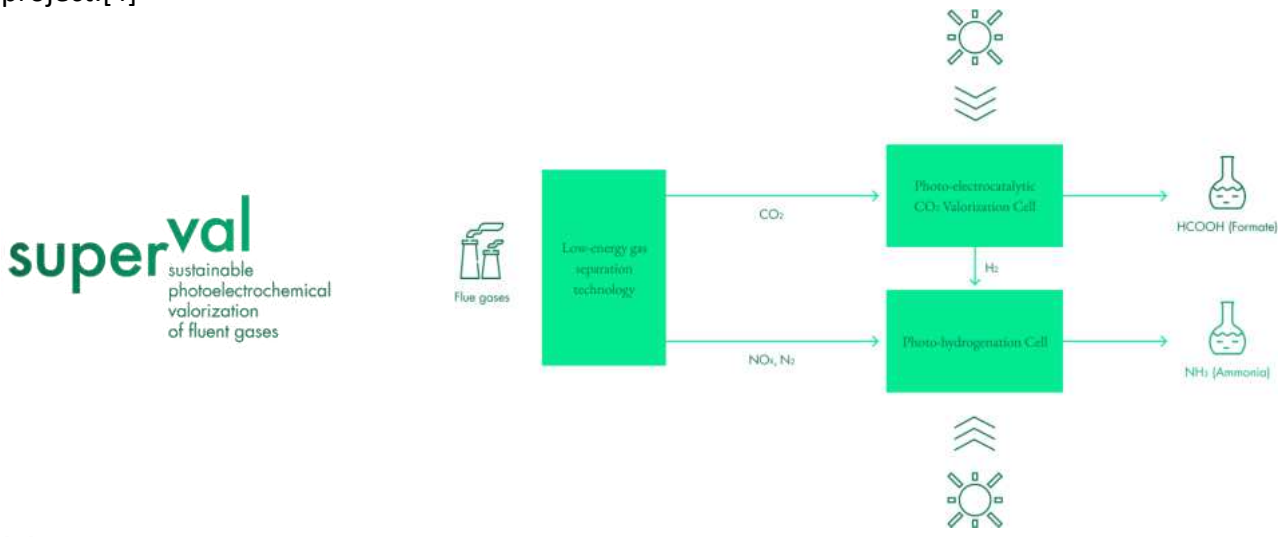
Specify Technical Area: Energy and other Applications

In the road to sustainability, the treatment of post-combustion emissions is still far from being techno-economically viable. On one end, the low concentration of CO_2 in these streams precludes the use of current carbon capture (CC) technologies.[1] On the other end, even if CC were successfully implemented, there are not plausible final uses, maybe except geological long-term storage.[2]

Our ambitious SUPERVAL project aims to investigate the viability of a technology able to tackle all these challenges at once, contributing to the carbon and nitrogen cycles for emission management and valorization, while using solar power as major energy input.

SUPERVAL modular approach envisions the capture and transformation of CO_2 into an organic, energy-rich molecule (formate) through a photo-electrolytic process. The N_2/NO_x will be also captured from the flue gas and transformed into ammonia using the green hydrogen obtained in the CO_2 co-electrolysis process. This integrated effort will offer the comprehensive capture and valorization of carbon and nitrogen components in post-combustion emissions, thus limiting pollutants and resulting in added-value chemicals. With the additional limitation of using exclusively non-critical raw materials, as defined by the European Union.[3]

In this presentation we will summarize the major strategies behind the different SUPERVAL challenges, highlighting the different complementary expertise required in the consortium realizing this European project.[4]



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SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

A Simplified Architecture for Air-Processed Perovskite Solar Cells: Carbon-Paste Back Contacts and Pathways to Improved Efficiency

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Please indicate preference: Oral
Specify Technical Area: Energy and other Applications

This study introduces a novel carbon-based composite and simplified device architecture for fabricating Hole Transport Material-Free (HTM-free) perovskite solar cells (PSCs) under ambient conditions. The back contact is deposited using a thick, conductive paste composed of graphite, black carbon, and polyvinylidene fluoride (PVDF) dispersed in chlorobenzene, offering a low-cost alternative to traditional vacuum-deposited electrodes. Initial results demonstrate stabilized power conversion efficiencies (PCE) around 1%, with a champion device reaching 1.65%. Electrical characterization reveals a high series resistance (2 kΩ) and low shunt resistance (200 Ω), highlighting challenges in charge transport and recombination losses. Furthermore, pronounced hysteresis in current-voltage (IV) measurements and visible perovskite degradation (yellowing) under prolonged illumination suggest ion migration and lattice instability. To address these limitations, ongoing optimization strategies include: (1) refining electrode composition and thickness to minimize series resistance, (2) incorporating mesoporous TiO_2 layers to enhance interfacial contact, and (3) introducing multi-cation perovskites (e.g., formamidinium, cesium) to improve structural stability and device performance. This work represents a critical step toward scalable, ambient-processed PSCs with simplified architectures, combining cost-effective materials with streamlined fabrication. Preliminary findings and future directions will be presented at the Conference, emphasizing the potential of carbon-based electrodes in sustainable photovoltaic technologies.

shift'25 TENERIFE

Invited Talks

SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Cross-sensitivity in Luminescence Sensing: From Foe to Friend

Nikita Panov[1], Liyan Ming[1], Emily Andreato[1], José Lifante[1], Leyre Aldaz-Caballero[1], Anna Romelli[2], Ginés Lifante-Pedrola[1], Antonio Benayas[1], Patrizia Canton[2], Daniel Jaque[1], Erving Ximendes[1], Riccardo Marin[1,2]*

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Please indicate preference: __Poster X Oral
Specify Technical Area: X Biomedical __ Energy and other Applications

Luminescence sensing continues to attract the attention of several scientific communities: Materials scientists, optical spectroscopists, biologists, environmental scientists, and signal processing experts are just some of the researchers involved in this fast-paced field. A holistic approach to the development of a luminescence sensing approach entails the design and preparation of the most appropriate luminescent sensor, followed by careful calibration and attentive analysis of the luminescence signal. Properly performed, this process yields a sensor capable of providing reliable and precise readouts of a measurand of interest. In many cases, this is easier said than done. One of the most pervasive obstacles in this process is *cross-sensitivity*: The simultaneous and often similar response of the sensor to multiple external stimuli.

In this talk, we will touch upon our latest research achievements and challenges we encountered in the development of luminescence sensing approaches, focusing on temperature and pressure sensing as case studies. Novel nanoparticles and staple luminescent materials will be discussed in the context of luminescence sensing, introducing the concept of cross-sensitivity and its quantitative description. This discussion will segue into a somewhat unexpected eulogy of this phenomenon, which provides fertile ground to augment the functionalities of a luminescence sensing approach.

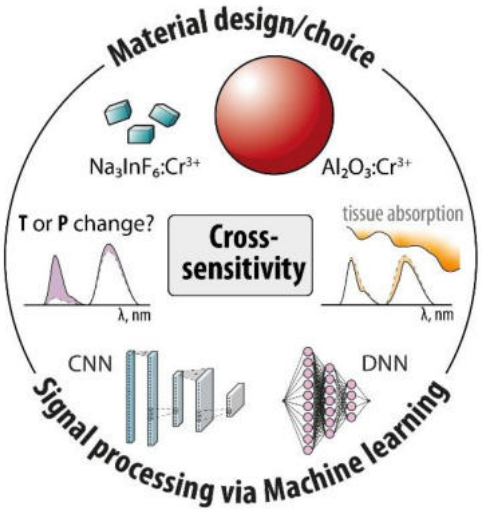

Fig. 1. Some elements at the basis of our recent contributions to luminescence sensing "on the verge" of cross-sensitivity.

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SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Label free sub-diffraction imaging

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Please indicate preference: invited
Specify Technical Area: Biomedical

The ability to image nanoscale objects below limit of light diffraction offer an unprecedented opportunity to study the outlook, organization, interactions or *in-situ* functioning of sub-micrometer objects such as subcellular structures or nano-engineered materials, thin layers or devices. However, most of the current methodologies exploit specially designed luminescent labels, which are often invasive, may modify the properties and behavior of the sample, as well as often undergo photobleaching, offer limited color combinations or specificity of labeling, are toxic and often remain cumbersome to apply. Moreover, the dedicated existing super-resolution imaging (SRI) optical setups, such as stimulated emission depletion microscopy (STED), Stochastic optical reconstruction microscopy (STORM), photo activated localization microscopy (PALM) or super-resolution optical fluctuation imaging (SOFI) microscopes are relatively complex, costly or/and require heavy computations, precise spatial alignment or temporal synchronization of laser beams and detectors. From the other hand, the existing non-destructive, non-invasive and label-free SRI methods like scanning near-field microscopy (SNOM) or atomic force microscopy (AFM), are also challenging and not trivial in use, as issues related to the imaging speed and contamination of the scanning tip are ubiquitous.

To address these issues, we propose, simulate and experimentally demonstrate a novel, unprecedented concept of sub-diffraction imaging, which, according to simulations should offer improved optical contrast and resolution while imaging highly transparent and non-labeled samples. We demonstrate the concept, modelling and first experimental evidences confirming this extraordinary and unprecedented possibilities, which may become pivotal for label-free, remote studies in biology, physics, materials science, nano-photonics and nano-engineering.

SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Tailored Nanostructured Anodic Alumina Platforms for Biomedical Applications

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Please indicate preference: ORAL
Specify Technical Area: Biomedical

Nanoporous anodic alumina (NAA) has emerged as a highly versatile and biocompatible nanomaterial platform for biomedical applications, particularly in biosensing, diagnostics, and therapeutic monitoring. Its unique structural features—including tunable pore size, periodic architecture, large surface area, and high chemical stability—enable the fabrication of advanced photonic structures capable of precise light manipulation and enhanced light–matter interactions[1-4].

By tailoring key nanostructural parameters such as pore diameter, interpore distance, porosity, film thickness, and surface chemistry, NAA can be engineered into one-dimensional photonic crystals (1D PCs) like Fabry–Pérot interferometers, distributed Bragg reflectors (DBRs), rugate filters, and optical microcavities. These architectures exhibit finely tunable optical responses, including wavelength-selective reflection and resonant signal amplification—critical for high-sensitivity biosensing and label-free optical detection.

In biomedical contexts, these photonic structures enable real-time, non-invasive monitoring of biomolecular interactions, early pathogen detection, and identification of disease biomarkers via techniques such as reflectometric interference spectroscopy (RIfS), photoluminescence (PL), and surface-enhanced Raman spectroscopy (SERS)[5-9]. Their label-free nature and ability to function in aqueous environments make them particularly suited for clinical diagnostics and point-of-care applications.

Moreover, the incorporation of metallic films or plasmonic nanoparticles (Ag, Au, Cu) into the NAA matrix allows the creation of hybrid photonic–plasmonic platforms, further enhancing sensitivity through localized field amplification and improved energy transfer dynamics.

In summary, NAA-based photonic architectures present a scalable, cost-effective, and multifunctional solution for the development of next-generation biomedical devices, offering promising capabilities in biosensing, diagnostic imaging, and targeted therapeutic monitoring.

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SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Functionalized Nanoparticles and Spectroscopy for High-Sensitivity Biomarker Quantification: Progress in Decentralized Diagnosis and Food Safety Control

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Please indicate preference: Invited conference
Specify Technical Area: _X_Biomedical __ Energy and other Applications

This presentation highlights recent developments in the synthesis, functionalization, and use of gold nanoparticles, carbon-based nanomaterials, and quantum dots for decentralized bioanalytical applications. Emphasis is placed on the tailored surface modification of these nanostructures to achieve selective and high-affinity interactions with relevant targets, including protein biomarkers, mRNA, and biogenic amines—key indicators of disease states and food quality.

A diverse set of analytical methodologies has been developed with detection strategies leverage both photoluminescence-based transduction and naked-eye colorimetric readouts, offering high sensitivity with minimal instrumentation. These approaches support rapid, in-field analysis, aligning with the growing demand for point-of-need testing. The talk will also address the design and implementation of low-cost, portable detection systems capable of translating lab-scale precision to real-world environments.

Critically, the evaluation and control of nanoparticle functionalization efficiency have been tackled using advanced separation techniques (e.g., field-flow field fractionation) coupled with elemental mass spectrometry and multiangle light scattering detection. These hyphenated systems provide detailed characterization of nanoparticle bioconjugates, ensuring functional integrity and analytical robustness.

SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
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Material Cues Regulating Stem Cell Fate for Cell Therapy of Neurological Diseases

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Please indicate preference: Invited Oral presentation
Specify Technical Area: Biomedical Applications

Stem cell therapy represents a promising approach for treating neurodegenerative diseases. However, precisely regulating the rate of neuronal differentiation and lineage specification of stem cells remains a major obstacle in stem cell therapy.
Conventional methods to accelerate directed differentiation involve using biomolecules such as growth factors to construct a bioactive microenvironment. Unfortunately, biomolecules (including proteins, enzymes, and RNAs) are costly, prone to rapid degradation *in vivo*, and may diffuse uncontrollably – posing significant challenges for clinical translation.
Fortunately, stem cells' responsiveness to small molecules and inorganic ions, combined with physical signal receptors on their extracellular matrix, enables the regulation of stem cell fate through material-derived cues. Compared to biological signals, material-based signals allow quantitative and temporally controlled modulation of intracellular chemical microenvironments or surface physical microenvironments by tuning the physical/chemical properties of materials. However, conventional ion modulation is hindered by cell membrane shielding, while macroscopic physical fields cannot target transplanted stem cells *in vivo*.
Recently, our group pioneered an interdisciplinary biology-materials-physics approach to regulate stem cell differentiation: 1. Solid-state nanoengineering of small molecules/ions for cellular internalization and intracellular release ion/small molecule storm; 2. Nanostructure-mediated physical signal regulation under external fields for rapid directed differentiation.
This talk will introduce the principles, advances, and prospects of material-guided stem cell fate regulation. We focus specifically on: Phytochemical-ion hybrid nanomaterials for neuronal differentiation, and nanostructure mediated ultrasound/alternating magnetic field-driven wireless signals from functional nanomaterials.
We will further demonstrate their therapeutic efficacy for neurodegenerative diseases through *in vivo* animal studies.
Keywords: Stem cell neuronal differentiation, Nanoparticle endocytosis, Wireless electric stimulation, Neurodegenerative disease therapy

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SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Exploring overlooked variables in upconversion nanoparticle synthesis: getting the basics in place for future biomedical applications

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Please indicate preference: Oral. Technical Area: Biomedical

Despite impressive advances in the past 25 years, most upconversion nanoparticle (UCNP) synthesis methods require specialist equipment or highly-skilled air-free techniques, presenting a high barrier to entry to early career researchers and non-chemists. As a new interdisciplinary research group in the UK – where upconversion research is still sparse – we have been exploring various methods of producing upconversion nanoparticles with an emphasis on the ease and reliability of synthesis, which is paramount for ongoing development of challenging biomedical applications.

We have found that high safety autoclave reactors enable opportunities UCNP synthesis with good experimental control and safe operation by relatively inexperienced personnel. However, whilst attempting to reproduce various UCNP formulations by others, we have noted that the literature reporting autoclave synthesis parameters has been lacking. We provide a number of key parameters that should be noted and reported to aid inter-operator and inter-lab reproducibility of nanomaterial synthesis.[1]

We have arrived at a one-pot solvothermal autoclave synthesis approach yielding water-dispersible, red-emitting NaYF4:Yb,Er UCNPs, incorporating polyethyleneimine (PEI) in the synthesis and as the aqueous dispersing agent. This synthesis is highl\y repeatable but is not well explored or understood. We will detail a number of key advances in this area, including initial developments toward multi-wavelength excitation (808 nm and 976 nm), and sensor functionalization, highlighting the importance of overlooked parameters such as average polymer molecular weight. We will also report progress towards drug loading and specific cell targeting with these reliable, but not yet well understood, PEI-UCNPs.

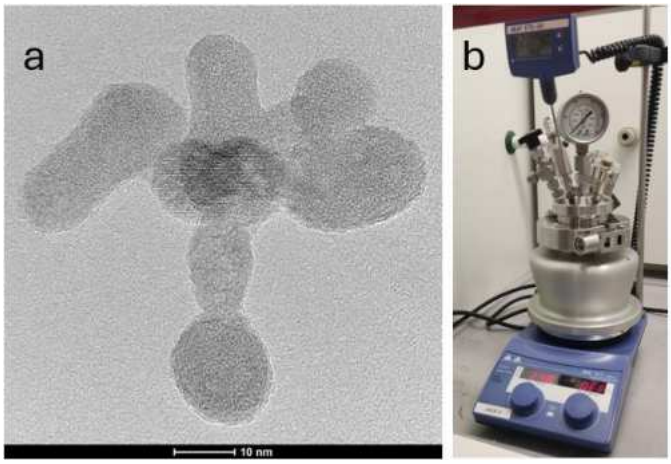

Figure 1. (a) TEM of PEI-UCNPs**. (b)** A high-safety autoclave synthesis reactor currently in operation in our laboratory. Featuring internal temperature probe and various pressure control/safety features.

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SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Luminescence thermometry 4.0: the probe testing heat transport within itself

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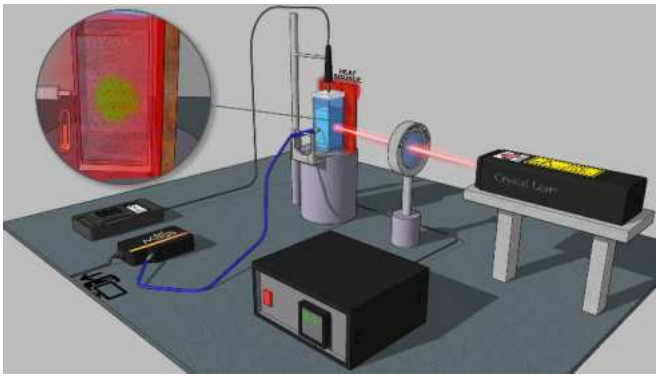
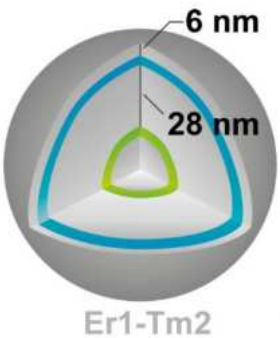
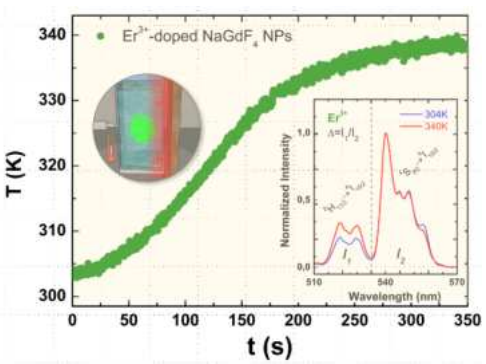
Please indicate preference: __Poster X Oral
Specify Technical Area: X Biomedical __ Energy and other Applications

In the last couple of decades, luminescence thermometry (hereafter LT)- i.e. *how the optical emission features -from an emitting probe- change as a function of its temperature* (T)- experienced enormous development, provoking widespread interest, in particular for biomedical applications. LT has been remotely monitoring temperature throughout a highly varied gamut of systems [1]. When the LT was born, research focused on developing new (nano) phosphors while also expanding the palette of luminescence fingerprints (band shape, peak energy or intensity, and excited state lifetimes and risetimes). Later, relevant LT breakthroughs on more complex and challenging systems were reached, either determining absolute temperatures or monitoring ongoing T-changes minimizing the readout delay [2]. A third stage of LT advancements has more recently brought a self-critical assessment of LT procedural limitations, together with the promising advent of machine learning to increase precision and reliability for T-readouts [3].

In this work, we are surfing through the dawn of a fourth wave in LT development, already anticipated by early work- using it for physics´ fundamental studies. We used *in situ* luminescence nanothermometry to probe the heat propagation in colloidal lanthanide-doped upconverting nanoparticles (UCNPs) at sub-wavelength length scales, by thermometric layers strategically positioned at various locations within the nanoparticle architecture. We measured an exceptionally slow heat propagation speed within these UCNPs, approximately 1.3 $nm \cdot s^{-1}$, which Fourier numerical model fails to explain adequately. These experimental results -plus few recently added theoretical ones- pave the way to extract phenomenological heat propagation parameters at the nanoscale through a generalized use of LT.







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SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Ag_2S-based nanoparticles for luminescence nanothermometry

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Nanothermometry, *i.e*, the capability to measure temperature and thermal variations at the nanoscale, has emerged as a powerful tool for applications ranging from optoelectronics to nanomedicine. Among the available approaches, luminescence nanothermometry, which relies on temperature-dependent changes in the optical response of nanoscale emitters, has gained particular attention in recent years, especially in biomedical contexts. Research on the synthesis of photoluminescent probes is central to this strategy, as significant effort is required to obtain optimized emitters with properties that maximize thermal sensitivity while minimizing measurement uncertainty. In this talk, I will present the performance of Ag_2S-based semiconductor nanoparticles as bright luminescent probes for imaging and potential diagnostic probes in the eye, and I will discuss how colloidal synthesis strategies can be exploited to enhance and tune their photoluminescent response, thereby pushing the limits of luminescence nanothermometry with semiconductor nanoparticles.

SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

NanoLDHs for biomedical applications

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Please indicate preference: __Poster _X_ Oral
Specify Technical Area: _X_Biomedical __ Energy and other Applications

Layered Double Hydroxides (LDHs) are an exciting class of materials that are interesting not only for the highly versatile layered structure but also for the capability of loading ionic groups within the charged layers and forming supramolecular structures that can be adequately functionalized. LDHs have been considered for biomedical applications due to their very good biocompatibility, also in some in-vivo studies. Moreover, LDHs have been considered as optical probes, as scaffolds for loading fluorescent dyes.

In this communication, hydrotalcite-like nanostructured LDHs (nanoLDHs), constituted by Mg^{2+}, Al^{3+}, and Gd^{3+} metal ions, will be presented. They have been prepared with a facile co-precipitation method followed by microwave-assisted solvothermal treatment using mild temperatures. NanoLDHs have also been loaded with ICG fluorescent dye through a facile adsorption procedure, thus developing a multifunctional (fluorescent and paramagnetic) hybrid nanocomposite. Moreover, the embedding of the nanoLDH-ICG in Pluronic F-127 has been considered to prepare a thermoresponsive nanocomposite that gels at the usual body temperature. The detailed preparation and the luminescent properties of the nanocomposite, doped with lanthanide ions, will be presented and analyzed.

SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

From Multicolor Reporters and Sensors and Surface Functionalization to Multi-Method Nanoscale Reference Materials

Elina Andresen[1], Philipp Kossatz[1], Anna Matiushkina[1], Christian Würth[1], Robin Schürmann[2], Jerome Deumer[2], Christian Gollwitzer[2], Ute Resch-Genger[1]*

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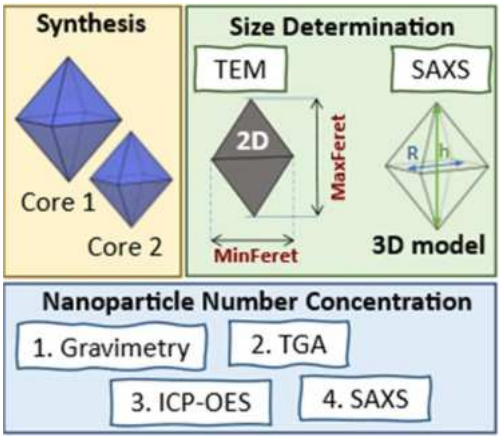
Please indicate preference: __Poster __ Oral x (invited lecture)
Specify Technical Area: x_ Biomedical __ Energy and other Applications _

Lanthanide-based, spectrally shifting, and multi-color luminescent upconverting nanoparticles (UCNPs) have received much attention in the last decades because of their applicability as reporter for bioimaging, super-resolution microscopy, and sensing as well as barcoding and anti-counterfeiting tags. $NaYF_4$ or $LiYF_4$ doped with, e.g., with Yb^{3+} and Er^{3+} or Tm^{3+}. In addition to their meanwhile broadly explored and utilized luminescence properties, UCNPs as well as other lanthanide nanomaterials present ideal candidates for a platform of multi-method nanoscale reference materials (nanoRMs). This is related to the fact that UCNPs i.) consist of multiple elements measurable with different analytical methods, ii.) can be reproducibly prepared in different sizes, shapes, and chemical compositions in relatively large quantities with various surface coatings, and iii.) are chemically inert and long-term stable. This renders them very attractive for elemental analytical techniques such as ICP-OES, ICP-MS, LA-ICP-MS, and LIBS, X-ray fluorescence methods like XRF and X-ray fluorescence computed tomography (XFCT) used, e.g., for quantitative bioimaging as well as XPS.[1] In addition, the broadly variable parameters size and shape can be utilized for size standards, e.g., for SAXS and the provision of reference data for setting up and validating the simulation of SAXS data.



Here, we provide an overview of our emerging platform of UCNP nanoRMs for different methods and measurands and methods or applications including the development of such nanoRMs and their multi-method characterization. A first example for making UCNP-based nanoRMs for size, shape and particle number concentration and their traceable characterization by absolutely calibrated SAXS and a chemical approach involving gravimetry, TGA, and ICP-OES is shown in Figure 1.[2]

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The Role of Molecular Symmetry in Modulating Downshifting and Upconversion Circularly Polarized Luminescence of Lanthanide(III) Systems

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Circularly Polarized Luminescence (CPL) is a sophisticated photophysical phenomenon that has attracted substantial scientific interest due to its wide-ranging potential applications, including, but not limited to, CPL-based sensors, photoelectric devices, circularly polarized organic light-emitting diodes (CP-OLEDs), and molecular fingerprinting technologies. CPL is fundamentally defined by the differential emission of left- and right-handed circularly polarized light from chiral systems [1]. Lanthanide(III) complexes, with their extensive and well-established legacy, represent a cornerstone in the advancement of next-generation CPL-active materials. The exploration of CPL in lanthanide(III) systems is both deliberate and strategic. Trivalent lanthanide ions possess 4f electrons that are effectively shielded by the filled outer $5s^2$ and $5p^6$ subshells, thereby giving rise to spectrally narrow intraconfigurational 4f–4f transitions, high emission color purity, prolonged excited-state lifetimes. These intrinsic properties markedly enhance their applicability in luminescent materials. Moreover, certain magnetic dipole-allowed transitions in lanthanide(III) ions can yield pronounced luminescence dissymmetry factors (g_{lum}), one of the critical parameters in the realization of efficient CPL. In chiral lanthanide(III) complexes, elevated g_{lum} values are commonly associated with transitions that are primarily magnetic dipole-allowed and partially electric dipole-allowed. Nevertheless, it is important to recognize that transitions characterized by high g_{lum} values often exhibit low emission quantum yields, thereby presenting a fundamental trade-off between maximizing the dissymmetry factor and enhancing CPL brightness. This work offers a comprehensive and systematic examination of the current state of CPL in advanced lanthanide(III) complexes. We will discuss recent results concerning the synthesis and application of novel chiral molecules employed as ligands in lanthanide(III) complexes. Recognizing the significant potential of this research, we propose the synthesis, comprehensive characterization, and detailed photophysical investigation of new chiral complexes containing Eu(III) ions. These chiral complexes are strategically designed with two types of ligands: sensitizing ligands, which efficiently transfer energy to the lanthanide(III) ion via the well-known antenna effect, and chiral ligands, which impart molecular chirality to the complex and, by extension, to the lanthanide center itself. Emphasis will also be placed on our recent developments focusing on lanthanide(III)-doped upconverting nanoparticles (UCNPs). These nanoparticles have emerged as promising candidates for generating upconversion CPL (UC-CPL) signals in solid-state materials. Despite significant progress, numerous open questions remain concerning the role of symmetry around lanthanide ions, particularly in nanoparticles, where surface complexity introduces additional challenges. In this context, we will present our recent findings on the upconversion CPL properties of core@shell UCNPs, functionalized in various ways: with oleate ligands, with (+)-3-heptafluorobutyryl camphorate ($hfbc^-$) ligands, and with oleate-functionalized nanoparticles interacting with the chiral $hfbc^-$ ligand. Our investigations have been conducted on nanoparticles exhibiting either cubic (α-phase) or hexagonal (β-phase) crystalline structures. The results obtained demonstrate the potential to achieve high upconversion g_{lum} values from unfunctionalized UCNP. Moreover, these findings open new avenues for the design and development of chiral solid-state systems, which hold considerable promise for future applications in optoelectronic devices and related technologies.

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SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Lanthanide Compounds for Biological Imaging: Dual-mode Near-infrared Optical and Photoacoustic Imaging Agents with Low Energy Excitation Wavelengths

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Please indicate preference: __Poster X Oral (Invited)
Specify Technical Area: X Biomedical __ Energy and other Applications

Medical and biological diagnostics are in great needs of non-invasive imaging approaches with responses in real-time using small footprints instruments. Photoacoustic (PA) and near-infrared (NIR) luminescence are imaging techniques that can uniquely address these requirements. They take advantage of the NIR light operating in the biological transparency window as excitation source. The creation of dual-mode imaging agents allows to combine the advantages of the two techniques: high sensitivity and high resolution of the NIR luminescence imaging with high signal detection depth of the PA imaging.

Lanthanide complexes formed with NIR-absorbing chromophores are promising candidates for the creation of such dual-mode agents. Lanthanide ions possess unique luminescence properties which makes them excellent candidates for the luminescence imaging. However, they have small values of molar extinction coefficients that will directly limit the number of photons they can emit. To achieve our goal, we have used organic chromophores to absorb a large amount of excitation light and sensitize the luminescent lanthanide ions with the collected energy. In complement, organic chromophores can generate photoacoustic signals by dissipating the part of the excitation energy that results in non-radiative processes. The presence of both the NIR-emitting lanthanide ion and the organic chromophore in the complex allows using the same molecule for the creation of new dual-mode imaging agents.

In this work, we present new dual-mode photoacoustic and NIR luminescence imaging agents that are based on lanthanide complexes bearing NIR-absorbing chromophores. We will also present the results of the evaluations of the performances of these new PA and NIR imaging agents for non-invasive detection in biological systems using phantom models.

Acknowledgements

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SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Luminescent Lanthanide(III)-Based Metallacrowns as Modular Scaffolds to Design the Next Generation of NIR-II Imaging Agents

Svetlana V. Eliseeva[1*], Codruţa C. Bădescu-Singureanu[1], Timothée Lathion[1], Julie Bourseguin[1], Ismail Alahyen[2], Paul Demay-Drouhard[2], Marie-Aude Hiebel[2], Soroush Naseri[3], Vincent L. Pecoraro[3], Franck Suzenet[2], Stéphane Petoud[1]

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Please indicate preference: __Poster X Oral (Invited)
Specify Technical Area: X Biomedical __ Energy and other Applications

Optical imaging in the second near-infrared (NIR-II, 1000–1700 nm) enables non-invasive, real-time acquisition of biological images with improved contrast and spatial resolution from deeper tissues due to reduced light scattering, absorption and autofluorescence.[1]
We have shown that lanthanide(III)-based metallacrowns (MCs) are a unique class of metal complexes exhibiting advanced luminescence properties and perspectives to be used as NIR-II imaging agents.[2-5] In this presentation, we will describe different synthetic strategies to create lanthanide(III)-based MCs with appended chromophoric moieties that allow the tuning of their luminescent properties, more specifically their absorption/excitation wavelengths, quantum yields and lifetimes. Detailed studies of the photophysical properties of obtained functionalized lanthanide(III)-based MCs as well as NIR-II imaging experiments using biological tissue-mimicking phantoms and living cells will also be presented.

Acknowledgments
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SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Hole-Transporting Materials for Perovskite Solar Cells: Chemical Design and Charge Transport

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Hole-transporting materials (HTMs) are a crucial component in obtaining high photoelectric conversion efficiencies (PCEs) in perovskite-based solar cells (PSCs). They play the important roles of extracting the photogenerated holes, formed within the perovskite film, and transporting them to the electrodes. Among the wide number of chemical structures proposed as HTMs for PSCs, small organic molecules have received special attention with spiro-OMeTAD as a reference.[1,2] In this communication, we mainly focus on the theoretical evaluation of the charge transport properties of reference HTMs, taking into account the effect of molecular ordering, material morphology and dynamic fluctuations. First, we discuss how the donor ability and hole reorganization energy change with the chemical structure of the HTM. Second, we investigate a series of HTMs based on fused polyheteroaromatic molecules incorporating 7-azaindole terminal moieties that induce the hydrogen-bond self-assembly of the conjugated molecules thus increasing the supramolecular ordering in the HTM layer (Figure 1a). The effects of this ordering on the charrier transport are theoretically discussed.[3] Third, a multi-level theoretical approach based on DFT calculations and molecular dynamics and Kinect Monte Carlo simulations is used to estimate carrier mobilities in both crystalline and amorphous phases (Figure 1b).[4]

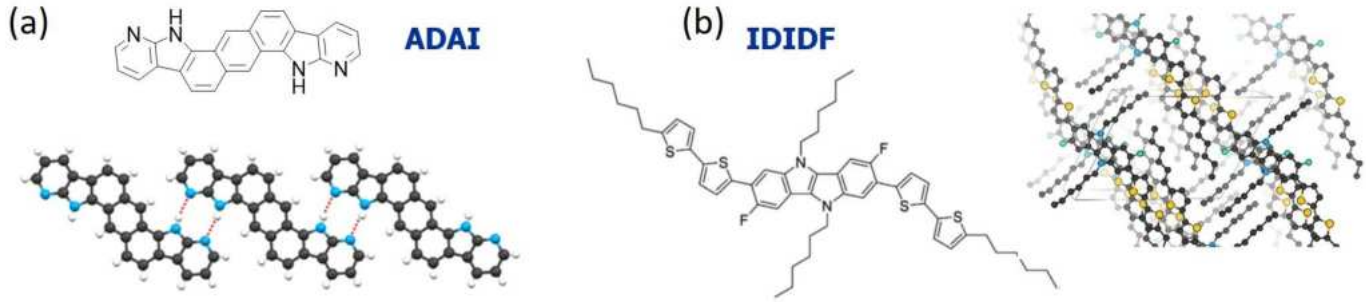

Figure 1. Chemical structure and supramolecular ordering of **ADAI** (a) and **IDIDF** (b) HTMs.

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Acknowledgments

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SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Nanocomposites and Nanoscale Structural-Properties for More Stable Perovskite Solar Cells

Dongjiu Zhang,[1] Smail Mostefaoui,[2] José Alvarez,[3] Jiazhuo Nie,[1] Lionel Aigouy,[1] Jérôme Aleon,[2] and Zhuoying Chen[1]

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Please indicate preference: X Oral. Specify Technical Area: X Energy and other Applications

The achievement of both efficiency and stability in perovskite solar cells (PSCs) remains a challenging and actively researched topic. Under this context, our research team at LPEM strives to understand the degradation mechanisms and propose engineering methods to mitigate such effects. In this presentation, I will present recent works from our research team, applying nanoscale structural-property investigations, to reveal the underlying physical and chemical processes involved in the passivation and degradation of functional PSCs.

On the aspect of engineering methods to fight against PSCs' instability, fluorinated molecules have shown good promise in the literature by enabling moisture barriers to some extent. Most of previous reported fluorinated molecules involve relatively short-chain molecules, enabling only a limited impact on the water-contact-angle of the perovskite surface. Here, our group investigated a series of fluorosilane molecules with different chain lengths and their effect perovskite surfaces to achieve superhydrophobic surfaces. In particular, by coupling a series of spectroscopic techniques, I will discuss the underlying structural-property relationship of how these fluorosilane molecules interact with perovskite absorber.

On the degradation mechanisms of PSCs, I will present our recent work applying novel local electro-optical scanning technique to monitor the *in-situ* evolutions in terms of device interfacial temperature, photoluminescence (PL), and photovoltaic characteristics during device accelerated degradation.

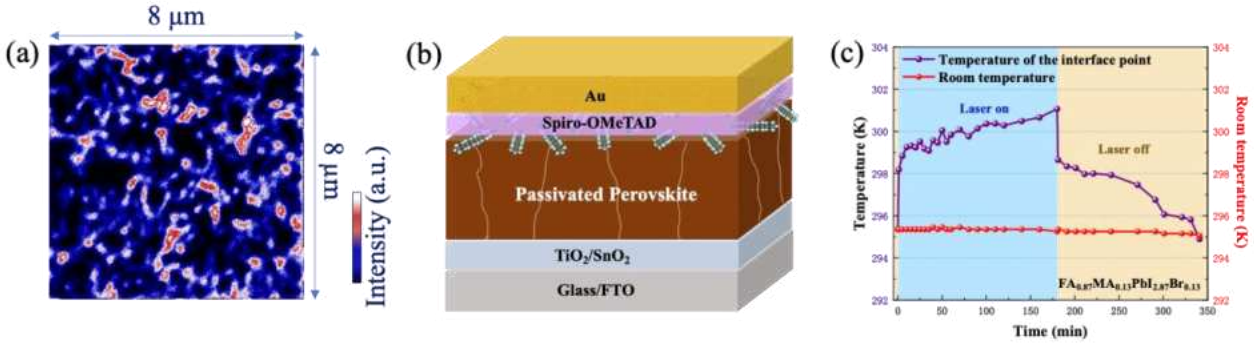

***Figure caption**: (a) NanoSIMS mapping of the F-element from the top surface of a fluorosilane-passivated $FA_{0.9}MA_{0.1}PbI_3$ perovskite layer; (b) Schematic of the fluorosilane-passivated perovskite solar cell structure under investigation; (c) In-situ monitoring of the perovskite/HTL interfacial temperature during accelerated solar cell degradation triggered by the illumination of a blue laser (λ = 447 nm, 50 mW cm^{-2}) in ambient air.*

SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

SHIFTing Paradigms: Molecular Logic Meets Lanthanide Photonics

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Please indicate preference: __Poster _X_ Oral
Specify Technical Area: __Biomedical _X_ Energy and other Applications

As silicon-based technologies approach their physical limits, the search for alternative computing paradigms becomes imperative. Molecular logic has emerged as a promising approach, particularly systems based on trivalent lanthanide ions that exploit the unique photophysical properties of these ions to implement Boolean logic operations [1]. This presentation will delve into the principles, methodologies, and recent advancements in luminescence-driven molecular computing, as detailed in our recent publication [2].

Designed for newcomers, the discussion will outline fundamental concepts, essential experimental techniques, and standardized protocols for characterizing luminescent molecular logic devices. We will critically examine the advantages of these devices, such as energy efficiency, multiplexing capabilities, and adaptability to complex environments.

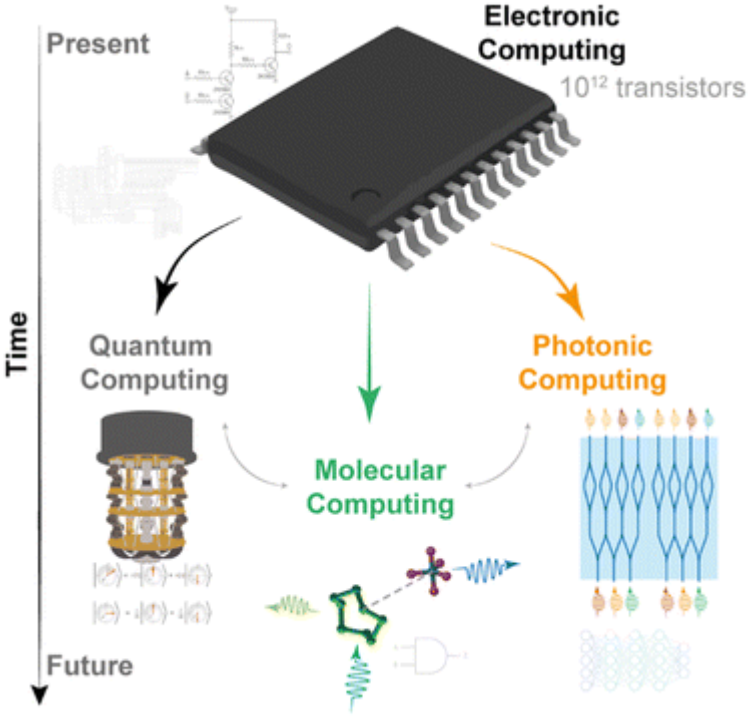

Figure 1. Limitations of current silicon technology based on top-down lithography techniques are fostering the development of novel computing strategies such as quantum computing, photonic (or optical) computing and molecular computing.

Furthermore, recent developments in integrating magnetic inputs into molecular logic gates—leveraging the magnetic properties of lanthanide ions to introduce an additional layer of control [3]—will also be discussed. This synergy between luminescence and magnetic responsiveness represents a significant step toward multifunctional and adaptable molecular computing platforms.

By addressing some limitations of traditional electronics, molecular logic paves the way for innovative applications in diagnostics, sensing, and novel computational architectures, offering a transformative and sustainable pathway for next-generation information processing.

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SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Single-particle structure-property correlation for optical fiber-based photocatalytic reactors

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Please indicate preference: Oral
Specify Technical Area: Energy and other Applications

The drive toward sustainable chemical production has spurred the development of advanced photocatalytic systems that rely on controlled light excitation with high spatial precision and efficiency. One promising approach involves optical fiber-based photocatalytic reactors, which offer an elegant solution for light management and delivery deep within catalytic environments. Their ability to channel and distribute light precisely to reaction zones is pivotal for scalable and efficient photoreactor design. In this context, localized surface plasmon resonances (LSPRs) of noble metal nanostructures can dramatically enhance the local light intensity at the fiber–catalyst interface. Within the EU reaCtor project (www.fibre-reactor.eu), we explore how plasmonic nanoantennas—integrated onto or near optical fiber surfaces—can be tailored to guide and amplify light at the nanoscale (Figure 1).

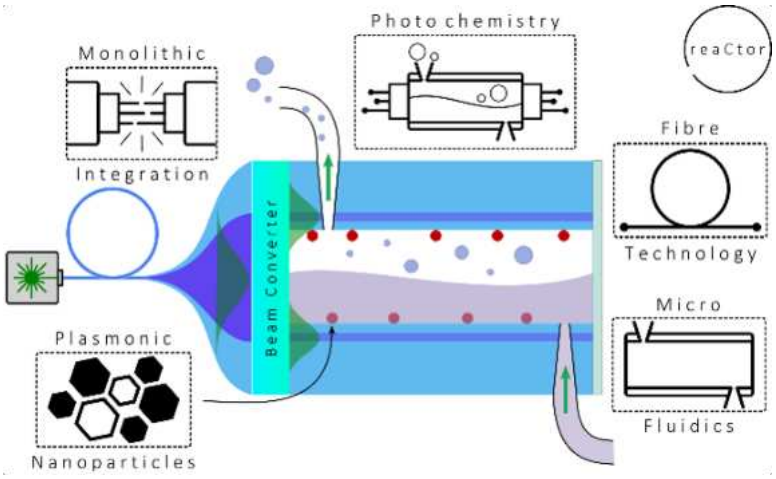

Figure 1: Schematic of the envisioned integration of the different components of a fibre-based photocatalytic reactor.

Key challenges lie in designing plasmonic antennas that not only enhance local field intensities but also enable efficient light–matter interaction over extended fiber lengths. This requires balancing nanoparticle geometry and density to tune absorption without excessively attenuating the guided light, thereby allowing light to reach more catalytic sites downstream. At the same time, ensuring structural stability under sustained illumination and operational conditions remains essential. To address these challenges, we emphasize the power of single-particle structure–property correlation, which links nanoscopic geometry and composition with both optical and photocatalytic performance. Furthermore, we demonstrate how in situ transmission electron microscopy (TEM) under light excitation serves as a critical tool for probing the photothermal and structural stability of these plasmonic components. Such real-time observations under operational conditions are key to predicting long-term functionality and guiding the development of robust, high-efficiency plasmonic photocatalysts for next-generation fiber-integrated reactors.

SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Efficient ultrathin solar cells enabled by nanoscale architectures with correlated disorder

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Invited Talk
Energy and other Applications

For the successful large-scale deployment of solar energy conversion technologies—whether for generating electrical power or facilitating chemical processes—achieving effective broadband control of light-scattering is essential.[1] Managing how light interacts with materials is crucial for enhancing the efficiency and functionality of solar devices. One powerful approach to achieving this control is through the design of metasurfaces, which are engineered materials with tailored optical properties.

Light can be directed and distributed with remarkable precision by precisely structuring the spatial frequencies within these metasurfaces. This control over power spectral density allows light to be guided in specific directions, optimizing energy capture, reflection, or transmission according to the desired outcome.[2] Such flexibility opens new possibilities for improving the performance of solar energy systems. For instance, we can unlock new potential in solar energy systems, paving the way for more effective, adaptable, and visually appealing renewable energy solutions.

In this talk, we will explore the use of metasurfaces with correlated disorder to control light scattering and absorption in solar cell devices. Broad-band scattering with optimized matching to waveguide modes maximizes light absorption in thin slabs, enabling the development of ultrathin and lightweight solar cells.[3,4] Color-selective isotropic back-scattering can provide colorful appearances so that solar cells can be implemented in urban spaces.[5] Distinctive angular scattering for different colors is also a long-sought component to improve tandem solar cells, either vertically or horizontally stacked.

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SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Tailored Electrochemical Interfaces for Renewable Energy Conversion

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Preference: Oral (invited)
Technical Area: Energy

Tailoring and elucidating the structure of electrocatalytically active sites at the atomic and molecular levels is key to design advanced and functional nanomaterials for sustainable energy conversion. This talk will focus on recent strategies to understand and tune the structure-property relationships for different electrocatalytic reactions of interest to produce renewable fuels and chemicals. We are combining electrochemical methods, surface-science techniques, in-situ vibrational spectroscopy and electrochemical scanning probe microscopy [1] to understand the mechanism of emerging sustainable reactions. Some electrocatalytic reactions of interest include oxygen evolution for green hydrogen production, along with electrochemical carbon dioxide, nitrate and methane conversion into sustainable fuels and chemicals.

In this talk, I will present our studies on well-defined Cu-based surfaces to assess the interfacial properties for the electrochemical CO_2 reduction reactions along with new methods to evaluate and tailor the facet distribution on Cu-based catalysts [2,3]. I will discuss some strategies to investigate the molecular mechanisms of emerging electrosynthesis processes. These reactions include the electrochemical nitrate reduction to produce ammonia, electrochemical C-N coupling for urea production [4], and electrochemical methane conversion to produce liquid fuels such as methanol [5].

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SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Up-conversion in sol-gel derived 1-D microcavities for photonic crystal assisted white light generation

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Please indicate preference: __Poster _X_ Oral
Specify Technical Area: __Biomedical _X_ Energy and other Applications

This study uses the sol-gel (SG) method, a cost-effective and flexible liquid phase processing technique, for the fabrication of one-dimensional (1-D) photonic bandgap structures, namely Bragg mirrors (BMs) and Fabry-Perot microcavities (F-P MCs). The study begins with the formation of highly reflective quarter-wave multilayer stacks composed of alternating layers of high refractive index titania and low refractive index aluminosilicate glass thin films. In particular, 1-D MCs have been prepared by spin-coating suitable sols on Si and silica glass substrates; these included lanthanide-doped (Tm^{3+}, Er^{3+}, Yb^{3+}) aluminosilicate and neat titania sols, designed for MCs with pass band defects at 500, 625, 650 and 700 nm at normal incidence reflection. Several techniques were utilized to characterize such multilayered structures, including Spectroscopic Ellipsometry, FTIR, variable angle specular reflection and 980 nm laser-excited up-conversion (UC) photoluminescence (UCPL) spectroscopy [1-3]. Laser power dependence studies have been performed to assess the UC mechanisms and CIE chromaticity diagrams were used to characterize the visible light emitted by the MCs. The CIE color coordinates are affected by changing the UCPL detection angle. The present research clearly demonstrates the versatility and effectiveness of SG-derived 1-D photonic crystals in lanthanide-doped optoelectronic materials and devices, allowing the preparation of optimized optical structures with tunable properties for future photonic applications.

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SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Low-cost and sustainable smart window films for energy savings

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Please indicate preference: Oral
Specify Technical Area: Energy and other Applications

Buildings account for 40% of the energy consumption and 25-30% of CO_2 emissions, half of which comes from heating, ventilation and air conditioning systems, used to maintain the thermal comfort of the inhabitants. Besides global warming, indoor temperatures are seriously affected by the increasing use of transparent glazed surfaces of modern architecture, which promotes the entrance of natural sunlight, normally desired to reduce artificial lightening, but also causing solar heat gain that in certain period of the years must be compensated by excessive use of cooling devices.[1]
Smart window materials, which pass from a transparent to an opaque/light absorbing state under external stimulus, are capable to modulate and control the solar light transmittance and heat gain according to the external conditions, being thus a promising solution to reduce buildings energy consumption. However, they still suffer high costs (> 500 $/m^2), complex architectures, need of external power, low photostability and difficult tunability, drawbacks that prevent their mass adoption in buildings.
Herein we show a novel, sustainable and scalable strategy to obtain smart window films from readily available and low-cost materials. They are based on composites of paraffin particles embedded in a polymer matrix.[2] When the particles are in the solid state, their refractive index matches that of the polymer, producing a highly transparent state in both visible (%T_{lum} = 77.3%) and near infrared spectral regions (Figure 1). In contrast, upon heating, the melted particles significantly vary their refractive index, mismatching that of the matrix, which instead varies only negligibly, thus yielding an opaque and scattering state and a strong modulation of the transmitted solar light (ΔT_{solar} = 58.6%).

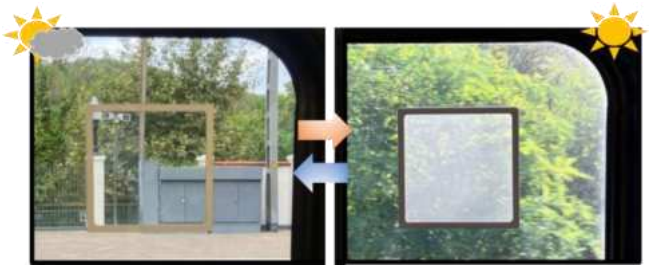

Figure 1: photo of paraffin particles-based smart window film in the transparent and opaque state

The same material can be activated by light (if photothermal agents are added), thus adapting to different ambient conditions, and voltage (via Joule´s heating), providing user control, if the film is deposited onto conductive substrate. Such materials proved to be very stable against light exposure, temperature and, upon lamination, to humidity. More importantly, the produced transmitted light modulation allowed reducing solar heat gain in a model house and favoring better plants growth inside coated greenhouses.

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SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

VO2-Au coupling: photothermal and modulation effects

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Please indicate preference: __Poster X Oral
Specify Technical Area: __Biomedical _X_ Energy and other Applications

Vanadium dioxide (VO2) undergoes a remarkable insulator-to-metal transition at 68°C, accompanied by a drastic, change in electrical resistivity spanning several orders of magnitude. This property has led to its proposed use in photodetectors and uncooled bolometers, exploiting its resistance sensitivity to temperature variations induced by absorbed photons.
In this talk we will consider two systems where interaction of VO2 and metallic elements play a key role. In the first, we use orderly arrays of Au nanodisks embedded within VO2 to demonstrate that the insulator-to-metal transition in VO2 thin films is facilitated by plasmon excitation. Direct optical visualization at the submicron scale, when the nanodisks are illuminated near their plasmon resonance with a $\lambda = 1.5$ µm laser beam, reveals that the laser power required to induce the transition is reduced by 30% in the presence of Au nanodisks. Using numerical simulations, we explore the underlying mechanisms, finding that the localized dipolar pattern of the electromagnetic field surrounding the nanodisks penetrates deeply into the VO_2, likely acting as the primary driver of the observed modifications in transition conditions [1]. In the second, we consider a perforated thin film placed onto a VO2 unpatterned thin film. We demonstrate that in this system it is possible to achieve reflectance modulations from nearly perfect reflection (90%) down to 10% using simple sub-micron slits patterned into the gold film. This optical-valve effect occurs at discrete wavelengths determined solely by the slit length. The tuning is achieved by temperature variation, acting as the required parameter for external control [2].

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SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Luminescence and Circularly Polarized Luminescence from Molecular Transuranic Complexes

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Please indicate preference: Oral
Specify Technical Area: Energy and other Applications

Circularly polarized luminescence (CPL) is the preferential emission of right- or left-handed circularly polarized light. In the lanthanide series, because of the core-like nature of 4f orbitals, the split between energy levels of 4f-elements is larger through spin-orbit coupling than through crystal field splitting. In 4f-elements, each luminescent transition between spin-orbit coupling term levels is associated with a specific transition type, resulting in different relative CPL strengths. More importantly, CPL spectroscopy allows for better distinction of the individual components resulting from crystal field splitting, though these transitions' selection rules are not well understood.

We are interested in investigating if the principles of CPL observed in 4f-elements are also applicable in 5f-elements and/or how they differ. We will show that by employing appropriate ligands, luminescent molecular complexes of americium, curium, berkelium, californium, and einsteinium can be obtained. Additionally, by utilizing chiral ligands, CPL spectra of transplutonium elements (Am and Cm) can be observed, and quantitative information about their crystal field splitting can be obtained.

Figure 1: Picture of a luminescent curium complex in solution.

SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Materials and Technology for Banknotes

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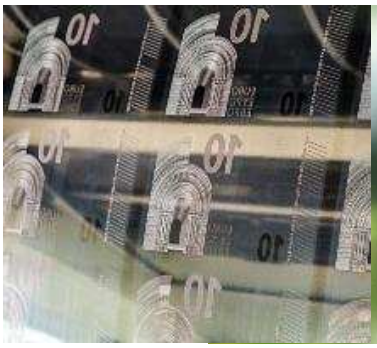
Please indicate preference: Invited
Specify Technical Area: Energy and other Applications

Banknotes—particularly euro banknotes—are a prime example of a high-tech product. Their production involves not only complex manufacturing processes but also the integration of advanced materials and technologies that ensure their security, authenticity, and durability.

Modern banknotes incorporate a wide range of security features, from visually striking elements that aid public recognition to machine-readable components that support automated processing and authentication. These features are the result of continuous research and development efforts led and funded by the Eurosystem to stay ahead of counterfeiting threats.

Beyond security, the Eurosystem is equally committed to sustainability and longevity. All materials used in euro banknote production must meet stringent health and safety standards while minimizing environmental impact throughout the banknote's lifecycle. This dual focus on innovation and responsibility drives ongoing updates to euro banknote design and composition.
This presentation will provide an overview of the current materials and technologies used in banknotes, as well as the categories and objectives of ongoing R&D projects. Stakeholders interested in contributing to the development of more secure, durable, and environmentally friendly banknotes are warmly invited to contact us.


SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

The Material Evolution Revolution

Prof. Erik C. Garnett

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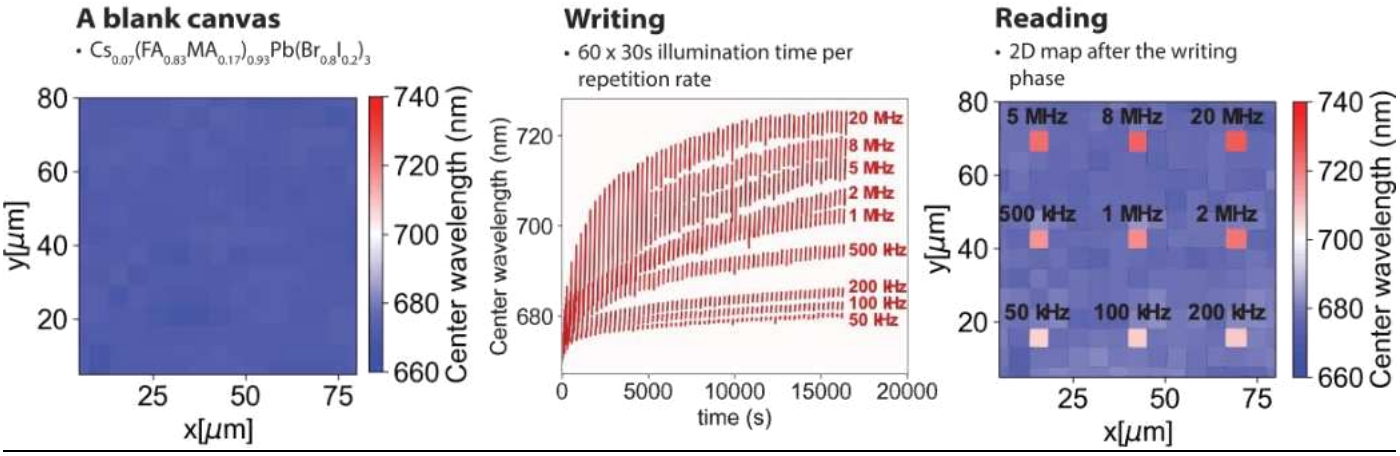
Please indicate preference: This is an invited speaker abstract from Jorge Mendez Ramos
Specify Technical Area: __Biomedical _X_ Energy and other Applications

Traditionally we design materials with exactly the properties we want and try to make them stable for decades – we intentionally avoid mutations. This means that we avoid degradation processes like rusting, cracking and warping, but we also exclude the possibility that materials improve over time or adapt to their environment. The idea of a bridge becoming more stable or a computer becoming faster with use may sound absurd, but such performance enhancements over time are a hallmark of biological evolution. We are not surprised now that AI models become better over time and even design them to evolve and improve, so why don't we take such an approach with materials and devices? This lecture outlines the requirements for such evolvable materials and proposes spatiotemporal patterning of light as a tool to direct the evolution. It begins by highlighting the ways that light can both control and measure the properties of materials in space and time. I will then show several examples of adaptable, self-optimizing and (re)programmable materials with applications in catalysis, photonics and energy conversion and our first results on materials that display memory and elements of learning (see Figure for one example). I will end with my vision for the material evolution revolution and the exciting possibilities it presents.



Hydrogen: present and Future

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Please indicate preference: __Poster X Oral
Specify Technical Area: __Biomedical X Energy and other Applications

Hydrogen is emerging as a key element in Spain's energy transition strategy, aligning with both European decarbonization goals and national efforts to achieve climate neutrality by 2050. As a clean and versatile energy carrier, hydrogen has gained attention as one of the feasible and potential solution to decarbonize hard-to-abate sectors such as heavy industry, transportation, and long-term energy storage. Spain's favorable geographic conditions, including abundant solar and wind resources, position the country as a competitive producer of green hydrogen, generated through electrolysis powered by renewable energy.

The Spanish government has taken decisive steps to promote hydrogen development, particularly through its "Hydrogen Roadmap: A Commitment to Renewable Hydrogen," approved in 2020 and reviewed in 2024. This roadmap sets ambitious targets for 2030, including the installation of 12 GW of electrolyzer capacity, the deployment of hydrogen refueling stations, and the integration of hydrogen within different industrial processes.

Challenges remain, particularly in scaling up infrastructure, reducing costs, and creating a regulatory framework that ensures market competitiveness and safety. However, with strong political support, technological advances, and growing key collaborations, Spain is well-positioned to become a leader in the European hydrogen economy.

This abstract provides a concise overview of the current state, policies, opportunities, and challenges of hydrogen development in Spain, emphasizing its strategic role in the broader context of energy transition and sustainability.

This keynote aims to review the National plans to develop and deploy the hydrogen economy, based on the objectives defined for 2030 and 2050 to reach net zero emissions. Current ongoing projects are explained, as well as the different funding schemes used to deploy the solution within different industries to be decarbonized, both as an energy vector and as an industrial raw material.

Finally, the future European and National challenges are mentioned, with the aim of being able to meet the fixed objectives to achieve the complete decarbonization of the economy to reach a net zero emissions by 2050.

Key words: Hydrogen, green hydrogen, renewable energies, decarbonization, Zero emissions, electrolysis, fuel cells, applications, strategy, roadmap, Europe, Spain, Challenges.

SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Sustainable Semimetal Nanostructures for Unconventional Plasmonics : Promising Energy and Sensing Photonic Platforms

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Please indicate preference: Invited Oral
Specify Technical Area: __Biomedical _X_ Energy and other Applications

Light shaping via plasmonic nanostructures plays a crucial role in enhancing energy-harvesting performance. In photovoltaics, light trapping and subwavelength field confinement translate directly into higher carrier generation and improved conversion efficiencies. In sensing, metal-based nanoparticles and metasurfaces have been engineered to produce sharp, spectrally tailored resonances that maximize sensitivity to very small refractive-index shifts or molecular absorption lines, enabling ultrasensitive biochemical detection. Traditional plasmonic materials (noble metals Au and Ag) lie at the core of these developments thanks to their strong resonances; however, they suffer from high cost, limited availability, and poor compatibility with large-scale, low-temperature processing.

Semimetal elements like bismuth (Bi) and antimony (Sb), along with their compounds, have recently emerged as sustainable alternatives. They combine earth-abundant availability, low-temperature processability, and low toxicity with unconventional plasmonic behavior spanning the ultraviolet, visible, and near-infrared. Although traditionally overlooked due to their lower carrier densities and higher losses, these materials exhibit unique optical properties. We have demonstrated that Bi nanostructures support pronounced interband plasmon resonances in the UV–visible range, that are driven not by free carriers but by interband transitions, and that also enable an exceptionally high refractive index in the infrared [1-2]. These complementary dielectric features have facilitated the design of both narrowband, spectrally selective components and broadband light-trapping architectures [3-5]. Moreover, a final advantage of Bi nanostructures in the ability of modulation of its optical response through phase change thanks to its low melting temperature, opening routes to dynamically reconfigurable devices [6-7].

In this presentation, I will review the fundamental principles of semimetal plasmonic, outline design and fabrication strategies for Bi- and Sb-based nanostructures, and chart the path toward integrating these unconventional materials into eco-friendly energy-harvesting and sensing devices.

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SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Magnetic Circularly Polarized Luminescence with Lanthanides(III)

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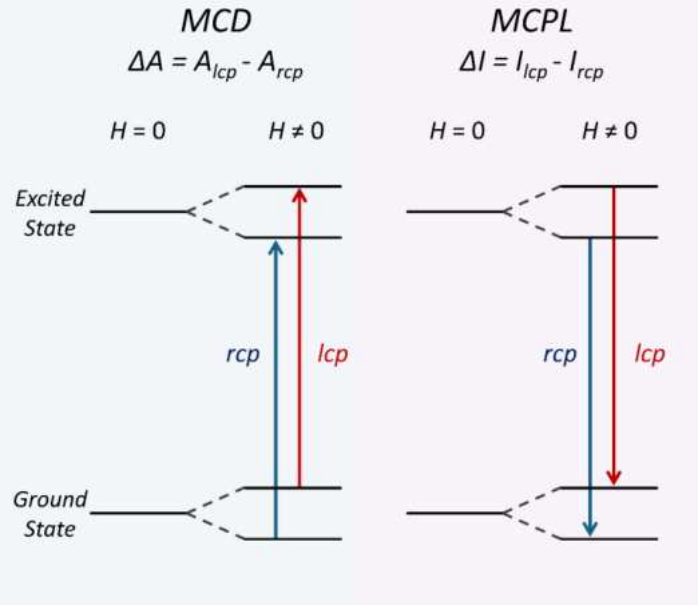
Please indicate preference: __Poster _X_ Oral
Specify Technical Area: __Biomedical _X_ Energy and other Applications

Lanthanide(III) materials display remarkable optical properties, making them valuable for advancing remote luminescent sensors. The narrow emission bands and energy-transfer processes can be tailored to respond to external stimuli, such as temperature changes and magnetic fields. The application of magnetic fields lifts the Zeeman degeneracy, creating electronic spin polarization, and giving rise to magneto-optical phenomena. Magnetic circularly polarized luminescence (MCPL) is a magneto-optical technique in which the differential emission of left and right circularly polarized light is induced by a magnetic field oriented parallel or antiparallel to the light propagation axis.[1,2] In the context of lanthanide(III) materials, this technique has only been explored in a few studies as a characterization tool. In this talk, I will discuss about the MCPL technique applied to lanthanide(III) materials. A historical background about the technique will be presented, with a discussion about potential applications and future perspectives.



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SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Towards all-inside-crystal 3D nanophotonics for extreme-environment sensing

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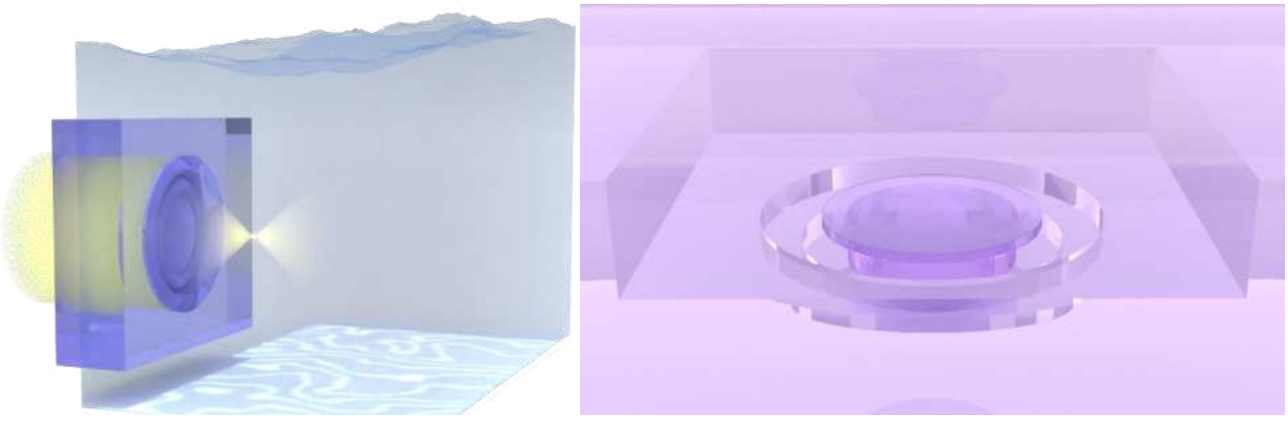
Please indicate preference: __Poster _**X Oral**
Specify Technical Area: __Biomedical _**X**_ **Energy and other Applications**

We will show that three-dimensional nanofabrication of monolithic fully embedded micro-photonic components such as hollow nanostructured diffractive microlenses and resonant micro-discs is for the first time to our knowledge feasible inside yttrium aluminum garnet (YAG) crystals, either doped or undoped with optically active ions. Since the seminal demonstration of subtractive three-dimensional laser nanolithography in YAG and sapphire crystals in 2019 [1], based on direct femtosecond-pulse laser writing and wet-chemical etching, interest has grown for the development of functional micro-photonic components inside these industrially critical materials, with 3D spatial resolution down to 100 nm and below [2, 3]. We will first show that the high-fidelity (>95% simulation-to-experiment) fabrication of nanostructured diffractive hollow lenses (NDHL) inside optical crystals is readily feasible, showcasing a standard NA (0.49) NDH lens inside undoped YAG crystals. This new type of hollow metalens, being monolithic and deeply embedded inside the crystal, is an obvious candidate for the highest resistance lens to extreme environments ever fabricated (biofouling, ionizing radiation, extreme temperatures and gradients, vibrations, etc). Secondly, we will show that the same technique can be used for the fabrication of embedded resonant micro-discs inside rare earth doped RE^{3+}:YAG.



Nanostructured Diffractive Hollow Lens (NDHL) concept (left), and monolithic µ-disc inside a rare-earth doped crystal (right).

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SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Guidelines on the design of wide-range luminescent thermometers

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Specify Technical Area: Energy and other Applications

Luminescence thermometry has emerged as a method for non-invasive, remote temperature sensing with spatial resolution at the micrometer scale [1]. It becomes increasingly relevant for e.g., *in situ* monitoring of temperature changes in chemical reactions [2], over *in vivo* bioimaging [3] to investigation of fundamental thermodynamic phenomena at the nanoscale [4]. A particularly simple way of luminescence thermometry employs an ensemble of non-interacting luminescent centers with two thermally coupled and radiatively emitting states, usually from the same electron configuration. The luminescence intensity ratio then follows Boltzmann's law. Trivalent lanthanoids with their narrow-line $4f^n \leftrightarrow 4f^n$ transitions have become particularly interesting in that regard.
Among the different possible emitters, Er^{3+} has become a primary working horse example in that area and seems to manage every application question in mind for that technique. Throughout this talk, we will discuss why that is [5–7] and what are ways to even improve the performance of such a luminescent thermometer on purpose. This will be demonstrated on the examples of Gd^{3+} [8] and Cr^{3+} [9], which shows a dynamic Boltzmann-type working range from below 77 K to over 800 K within one and the same compound. By that targeted approach, it is possible to design luminescent thermometers for various spectral emission ranges with constantly high dynamic working ranges.

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SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Photon avalanching in Nd^{3+}-doped heavy-halides

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Please indicate preference: ~~__Poster~~ _x_Oral
Specify Technical Area: ~~__Biomedical~~ _x_ Energy and other Applications

Lanthanide-doped upconverting nanoparticles can efficiently transform long-wavelength photons into short-wavelength ones through their nonlinear response to incoming light, and as such, offer significant advancements in biomedical, sensing, and photonic applications. When targeting specific applications, the luminescence characteristics of these nanocrystals are manipulated by the host matrix and the selection of dopants. Properties of the host, like phonon-cutoff frequency, affect the multiphonon relaxation rates and complex photophysical interactions between Ln^{3+} dopants. Subsequently, low-phonon-energy hosts are prioritized to boost light emission and reduce non-radiative losses.

Here, we discuss lanthanide-doped KPb_2Cl_5 nanocrystals, which have phonon energies that are twice as low as those of the state-of-the-art $NaYF_4$ host.[1] These low-phonon-energy nanocrystals deliver unique lanthanide upconversion, including the steeply nonlinear photon avalanche response by Nd^{3+} dopants when excited with a 1064 nm pump laser.[2] We found that the emission of Nd^{3+}-doped KPb_2Cl_5 nanocrystals scales with the pump intensity with a nonlinearity of more than 200. Increasing the pump intensity by around 1% results in an emission intensity gain of more than two orders of magnitude. Furthermore, these nanocrystals also exhibit optical bistability, wherein two stable luminescence states may be observed under identical excitation conditions, contingent on excitation history. Through rate equation modeling, we show that this extreme nonlinearity and the resulting bistability arise solely from the electronic properties of Nd^{3+} ions when doped in a low-phonon-energy material. The highly nonlinear and history-dependent response of Nd^{3+}-doped KPb_2Cl_5 nanocrystals enables their use as optical labels for sub-wavelength imaging and optical data handling. In fact, by employing a two-wavelength excitation scheme, we could demonstrate transistor-like photoswitching of these nanocrystals. We believe these results will inspire further development of low-phonon-energy hosts, fostering innovation in architectures of nonlinear emitters and their applications.

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SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Lanthanide Upconversion Luminescence: From Molecule-Nano-Micro Scale

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Please indicate preference: Invited speaker
Specify Technical Area: wavelength conversion processes (upconversion, down shifting)

Lanthanide upconversion luminescence in nanoparticles has prompted continuous breakthroughs in information storage, temperature sensing, and biomedical applications, among others.[1] However, currently, research on the upconversion luminescence phenomenon of rare earths is mostly focused on lanthanide-doped nanoscale or bulk material systems, lacking research on molecular and other micro-scale systems. Here I mainly introduce our recent progress in achieving upconversion luminescence from multiple scales, including molecular, nanoscale, and micro scale, which improves the lanthanide luminescence mechanism.

(1) **Nanoscale:** We have demonstrated a dumbbell shaped nanocrystals composition in which the energy migration pathways can be modulated by controlling energy migration pathway and cerium-assisted energy transfer processes. The multimode emissions of dumbbell-like nanocrystals are cooperated with deep learning, where the advantages of narrow emission peak of visible fluorescence and deep tissue penetration of NIR-II fluorescence are combined to offer a unique deep learning fluorescence bioimaging.[2,3] (2) **Molecular scale:** We explored the potential for achieving upconversion using a mononuclear Yb^{3+} complex as a sensitizer and a mononuclear Eu^{3+} complex as an activator for designing new upconverting co-crystal dispersions in non deuterated solution, with high UCQY.[4] Then, we developed the upconversion luminescence in co-crystal assemblies consisting of discrete mononuclear Yb and Sm complexes. The characteristic visible emissions of Sm^{3+} were observed under the excitation of absorption band of Yb^{3+} at 980 nm. This is the first example of Sm^{3+}-based upconverting luminescence in discrete lanthanide complexes which present as co-crystal assemblies at room temperature.[5] (3) **Micron-scale:** Lanthanide-doped metal-organic frameworks (Ln-MOFs) have versatile luminescence properties, however it is challenging to achieve lanthanide-based upconversion luminescence in these materials.[6] Here, 1,3,5-benzenetricarboxylic acid (BTC) and Yb^{3+} ions were used to generate Yb-BTC MOF microrods with upconversion luminescence under NIR excitation via cooperative luminescence. Subsequently, the Yb-BTC MOFs were doped with a variety of lanthanides (Y, Tb, Eu, Ho, Tm, Pr, Sm, Dy, and Er) to evaluate the potential for Yb^{3+}-based upconversion and energy transfer. The effects of different dopants on the efficiency of cooperative luminescence were established and will provide guidance for the exploitation of Ln-MOFs exhibiting upconversion.[7]

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SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Luminescent Materials for Autonomous Energy Harvesting and Thermal Sensing in Photonic Devices

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Please indicate preference: __Poster x_ Oral
Specify Technical Area: __Biomedical x Energy and other Applications

The growing demand for autonomous energy systems in smart infrastructure emphasizes the role of luminescent solar concentrators (LSCs) as multifunctional photonic platforms. Recent advances highlight the potential of styrene-ethylene-butylene-styrene (SEBS) matrices doped with lanthanide complexes for autonomous sensing and energy harvesting in next-generation IoT devices (1). These stretchable, adhesive systems exhibit stable thermometric response and allow continuous operation under variable light conditions. Complementarily, nature-derived bacteriochlorophyll integrated into SEBS enables near-infrared emission and dual-mode thermal readout in large-area transparent LSCs, merging biological functionality with scalable photonic design (2). Building on circular material strategies, we also address LSC devices fabricated from recycled polystyrene, enabling simultaneous light harvesting and thermometric response while maintaining color tunability and structural compatibility with building facades. These sustainable architectures not only reduce dependence on virgin polymers but also introduce nature-derived chromophores for low-impact fabrication. Machine learning-assisted design further supports material selection by correlating photoluminescent properties with device performance, establishing a predictive pathway for scalable, low-footprint energy solutions (3).

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SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Bismuth-based semiconductors for sustainable light-energy conversion

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Invited Oral
Specify Technical Area: Energy and other Applications

Bismuth-based semiconductors, including the double perovskite $Cs_2AgBiBr_6$ but also perovskite-inspired materials such as bismuth oxyhalides, show great promise for sustainable light-energy conversion due to their low toxicity, abundance, and tunable electronic properties. This presentation will explore strategies to enhance the efficiency, stability, and scalability of these materials in photoelectrocatalytic and photovoltaic applications. Methods like automated film production, surface modifications, and heterojunction formation have been employed to improve the performance of BiOI and BiOBr in water splitting and hydrogen evolution reactions. A continuous automated film production method for BiOI photoelectrodes was introduced, significantly improving the reproducibility and efficiency of large-scale production. Surface modifications and heterojunction formation have been explored to optimize PEC performance, with enhanced water oxidation and hydrogen evolution reactions observed. Additionally, the lead-free double perovskite $Cs_2AgBiBr_6$ was optimized for use in solar cells with improved efficiency through interface engineering and low-cost carbon-based electrodes. These advancements position bismuth-based semiconductors as viable, eco-friendly alternatives for energy conversion technologies.

SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
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Designing NIR-Responsive Nanohybrids: Conjugated Polymer Shells on Upconversion Nanoparticles

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Please indicate preference: __Poster _x_ Oral
Specify Technical Area: __Biomedical _x_ Energy and other Applications

Upconverting nanoparticles (UCNPs) are stable, tunable photoactive materials that convert low-energy near-infrared (NIR) light into higher-energy light through multiphoton processes. They serve as robust platforms for creating upconversion nanohybrids (UCNHs) by surface functionalization with photoactive molecules, macromolecules, or nanoparticles with complementary functions.[1]

In photocatalysis, optimizing the synthesis of UCNHs, such as the number and aggregation state of anchored photoactive molecules, is key to enhancing performance under NIR irradiation.[2] However, some nanohybrids experience leaching [2], prompting the development of new methods like in situ cation exchange to strengthen interactions between UCNPs and their photoactive coatings.[3]

In this context, Conjugated Porous polymers (CPPs) are relevant due to their extended π-conjugated networks, hypercrosslinked molecular structure, and intrinsic porosity. BODIPY-based conjugated porous polymers have been used as heterogeneous photocatalysts in organic transformations.[4] Actually, we have reported the synthesis of hybrids based on BODIPY porous polymers and TiO_2 for solar fuel production[5,6] and the nanostructurating of BODIPY-based CPPs hybrid photocatalyst for hydrogen production.[7]

Here, BODIPY-based photoactive CPPs have been engineered to get novel nanohybrids with a polymeric shell able to absorb the upconverted emission of UCNPs upon NIR excitation.

Acknowledgements

This research was funded by MINECO, grant number PID2020-115710GB-I00, PID2022-141688OB-I00 and PID2023-152131NB-I00; Agencia Estatal de Investigación-AEI, grant number MMCIU Unit of Excellence "Maria de Maeztu" CEX2024-001467-M; and Generalitat Valenciana (GVA) grant numbers CIPROM/2022/57 and IDIFEDER/2018/064, partially co-financed with FEDER funds. This study forms part of the Advanced Materials Programme (MFA/2022/051) and was supported by MCIN with funding from European Union NextGenerationEU (PRTR-C17.I1) and by GVA. LFS thanks also MCIU, AEI and FSE+, for her Ramón y Cajal contract (RYC2023-043859-I).

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SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

On the complex nature of Eu-doped ZnO nano-sponges

Gunnar Westin*

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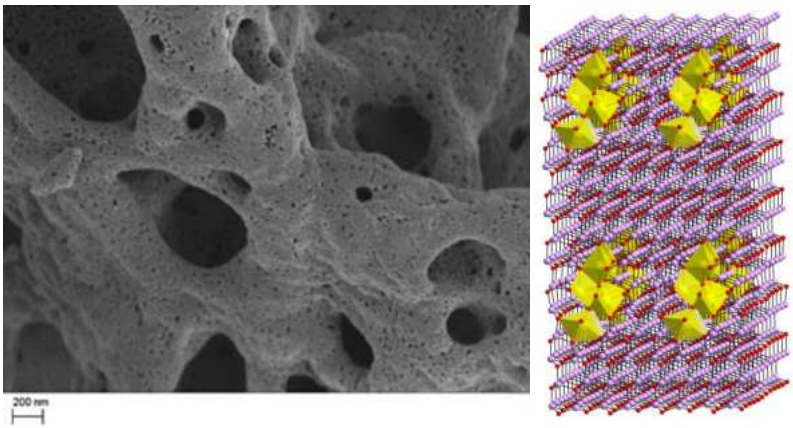
Invited speaker
Energy and other Applications

Abstract: Doped semiconductor oxides are highest importance for renewable energy conversion, optic, electronic and magnetic materials. Crystal quality, size, connectivity, and surface structure along with the dopants electronic state, coordination and distribution are all pivotal for the properties and crucially dependent on the synthesis parameters. Here, Eu-doped ZnO nano-crystalline sponges with up to 33% Eu in ZnO are presented and discussed. The high doping levels found in the rich literature has spurred debate as the comparatively very large and aliovalent Eu^{3+} dopant-ions should not fit in the *h*-ZnO lattice. A study using TG/DSC, XRD, XPS, IR- and Raman spectroscopy, EXAFS, SEM,(S)TEM/ED/DF/EELS/EDX/ePDF, and DFT proved that the Eu-ions were actually present in the 8-10 nm sized ZnO nano-crystals. Their presence did not change the *h*-ZnO unit cell-volume or show peaks of Eu-oxide. It was found that the ZnO:5% Eu crystals contained Eu-oxide clusters with 4-8 Eu-ions having an average coordination number of 5.2, without very little disturbance of the ZnO matrix. IR and Raman spectroscopy indicated that 10%Eu could be introduced in a similar way, while the 20%Eu sample revealed that besides the Eu-doped ZnO crystals, there was a 5-10 Å layer of an Eu-rich phase.



Left: SEM image of ZnO:5%Eu nano-sponge heated to 600 °C. Right: DFT model of ZnO doped with 4.26% Eu fitting the average very low CN of 5.2 obtained by EXAFS and virtually unchanged *h*-ZnO cell-volume change XRD and other experimental data quite well.

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SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Shifting our perspective on the electronic structure of lanthanide(III) ions

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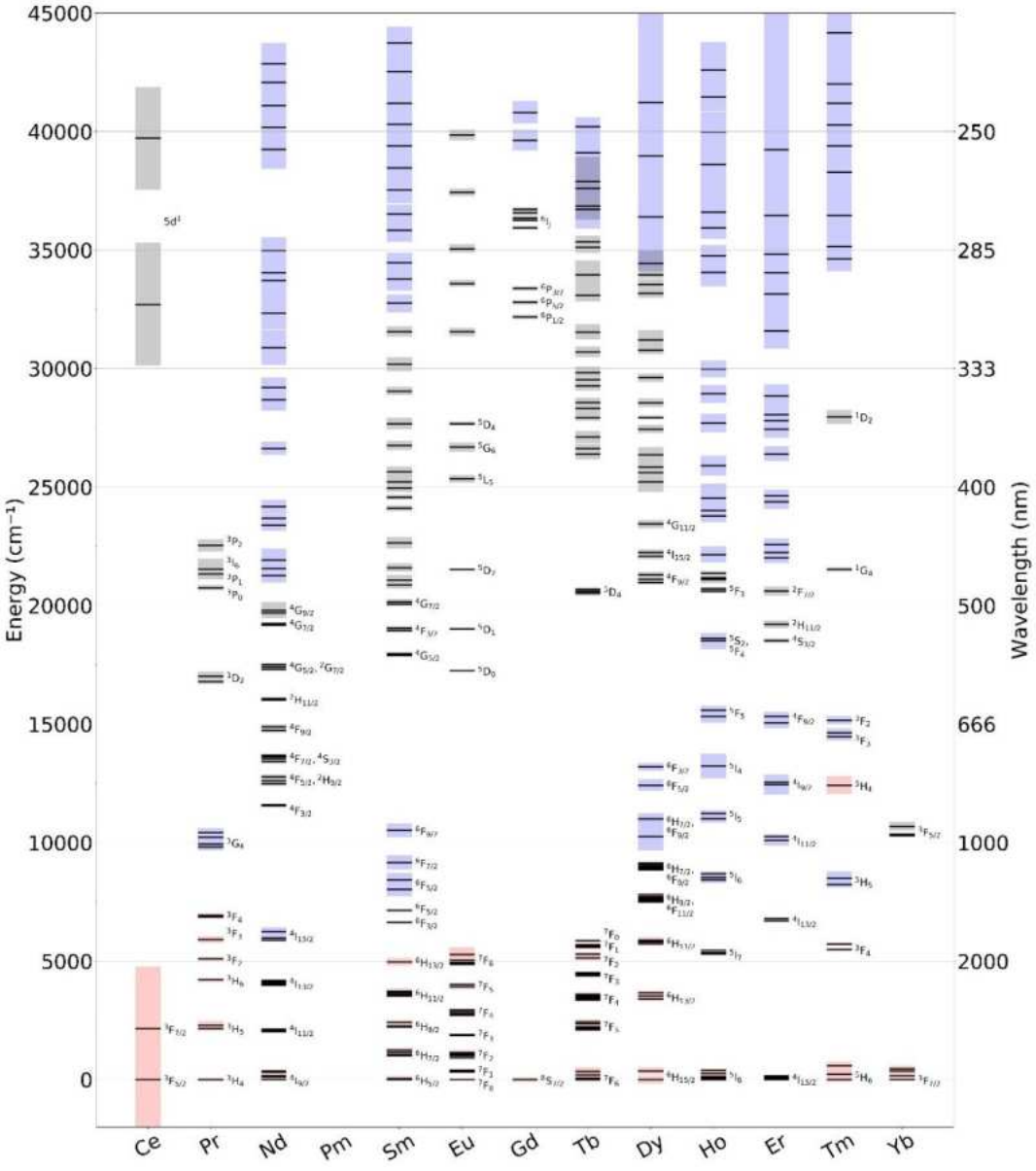
Please indicate preference: Invited
Specify Technical Area: X Energy and other Applications

Lanthanide(III) ions are central in shifting the energy of light. Up-conversion allows for up-shifting in solutions and materials, while lanthanide luminescence down-shifts with high efficiencies. Thus, shifters are often very familiar with the Dieke diagram. We have made an updated version, and looked closer at the electronic structure of lanthanide(III) ions and the mechanisms that are active when lanthanide(III) containing materials shift light.



SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Driving molecular upconversion with molecular wheels

Samuel Sanchez, Aline M. Nonat, and Loïc J. Charbonnière*
(Font : Calibri, 12 pt, Bold)

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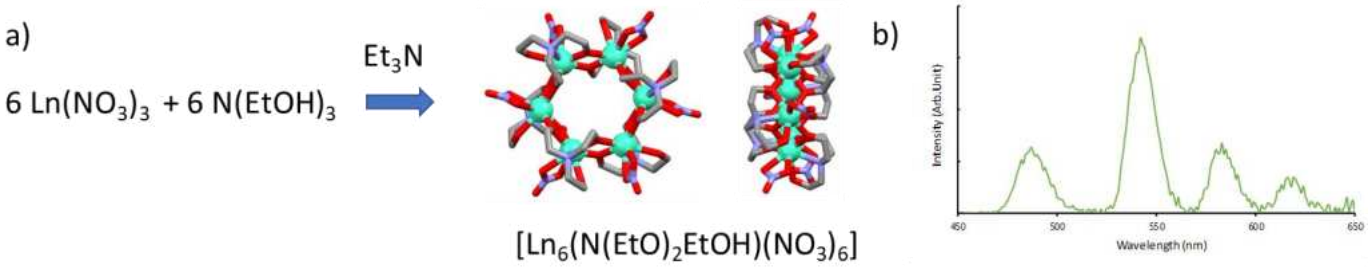
Please indicate preference: Oral
Specify Technical Area: Spectroscopy, molecular photonic upconversion

The phenomenon of upconversion (UC) consists of piling up the energy of two or more photons in a compound so that the total energy can be restored as a photon of higher energy than the excitation light.[1] While routinely documented for solid state compounds[2] or for nanoparticles,[3] examples of discrete molecules exhibiting UC are still scarce in the literature.[4,5]

Because of their ladder like energy level and their long-lived excited states, lanthanide (Ln) ions are prototypical elements for the construction of UC devices. However, at the molecular level, the vibrations of OH, CH and NH oscillators present in the framework of the ligands coordinated to the lanthanides or in the solvent molecules strongly quench the luminescence of lanthanide excited states, especially for intermediate excited states generally situated in the near infrared (NIR) spectral domain.[6]



a) Synthetic procedure for the synthesis of Ln6 wheels and b) UC spectra of a mixed Yb/Tb wheel in water (λ_{exc} = 980 nm).

We recently demonstrated[7] that Ln based clusters, also called molecular cluster aggregates,[8] allows to gather numerous Ln centers at very close distances, a prerequisite for efficient energy migration among the Ln, permitting the observation of UC at the molecular scale in organic solvents.[9] We now show that this strategy applied to the formation of hexanuclear Ln wheels is valid for molecular UC which can even be observed in pure water. The as obtained UC wheels can also be post-modified to vary both their spectroscopic and physico-chemical properties, opening large perspectives in spectroscopy and biolabeling applications.[10]

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SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Light-Switchable Plasmonic Catalysts: Smart Antenna-Reactor Nanomaterials for Energy and Environmental Applications

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Please indicate preference: __Poster X Oral
Specify Technical Area: __Biomedical X Energy and other Applications

The frontier of materials science is shifting toward systems that are not only efficient but adaptive: smart materials that respond to light to perform complex chemical tasks. In this talk, I present the design of functional plasmonic antenna-reactor nanomaterials that merge photonic and catalytic domains into a light-responsive interface. These nanostructures act as “on-demand” catalysts, converting visible light into chemical energy to address key challenges in solar fuels, pollutant remediation, and green chemical production, topics central to SHIFT Tenerife’s Materials for Energy & Environment focus.

By engineering the nanoscale interface within Au@AuPt core-shell systems containing ultralow Pt loadings, we achieve a six-fold boost in hydrogen evolution under light compared to commercial Pt/C catalysts. Similarly, these materials enable a 6.5-fold increase in nitrite reduction and a 2.5-fold enhancement in ammonia selectivity. In parallel, Au@AuPd nanoreactors yield full cinnamaldehyde conversion and a 7.7-fold enhancement in turnover frequency under visible light, offering a powerful strategy for light-driven biomass valorization.

Advanced characterization (electron microscopy, in situ spectroscopy) and density functional theory (DFT) modeling reveal how plasmonic-catalytic interfaces amplify hot carrier generation and activate unique, selective pathways inaccessible via dark thermocatalysis. These findings show that precise interface control can unlock tunable, light-activated behaviors with transformative potential.

Altogether, this work highlights how rationally designed, light-switchable materials can power cleaner reactions, smarter catalysis, and more sustainable technologies, illuminating a path forward in energy and environmental innovation.

Shift'25 TENERIFE

Oral Students

SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Vesicular-type nanocarriers co-loaded with photosensitizers and persistent luminescence $ZnGa_2O_4:Cr^{3+}$ nanomaterials for theranostics

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Please indicate preference: __ Poster X Oral
Specify Technical Area: X Biomedical __ Energy and other Applications

Nanomaterials presenting intriguing optical properties, such as persistent luminescence (persL), can be employed as nanomedicine agents, whereas their properties can be utilized for e.g. reactive oxygen species (ROS) generation, or bio-imaging [1]. Hence, through integrating these capabilities, it is possible to achieve a theranostic platform capable of simultaneous therapeutic action and diagnostic imaging, including real-time nanocarrier tracking [2]. Yet, proper surface modification stands as an equally important factor as the utilization of the nanoplatform optical properties, where it can greatly affect final effectiveness, by improving its biodistribution or active targeting [3].

We present the studies related to the vesicular-type nanocarriers based on novel L-α-phosphatidylocholine-based liposomes stabilized by an additional "mild" amphoteric surfactant, co-loaded with both persL $ZnGa_2O_4:Cr^{3+}$ nanomaterials and photosensitizers for effective ROS generation. The surface of the proposed nanoplatform has been specially modified by means of the subsequent absorption of various types of polyelectrolytes, commonly known as the layer-by-layer (LBL) technique [4].

The morphology of the obtained nanoplatforms has been defined via transmission electron microscopy (TEM), as well as by atomic force microscopy combined with infrared spectroscopy (AFM-IR). The process of ROS generation has been investigated using UV-Vis spectroscopy through changes in the absorption spectra of a ABMDA (9,10-Anthracenediyl-bis(methylene)dimalonic acid), a special trap for singlet oxygen quenching. Surface modification by the subsequent layer addition has been studied via dynamic light scattering (DLS) and electrophoretic light scattering (ELS) techniques.

The results of our studies indicate (i) an efficient process of obtaining vesicular-type nanoplatforms, and their further surface modification, together with (ii) a significant effect of increased ROS generation through the combination of persL nanomaterials along with photosensitizers.

Acknowledgments
This work was supported by the National Science Centre Poland under OPUS research grant (no. 2022/47/B/ST5/01138).

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SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Color Tunability and Optical Thermometry Study of Er^{3+} co-doped $SrMoO_4$: Dy^{3+} phosphor

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Preference: Oral

Technical Area: Energy and other Applications

1. Introduction

Rare-earth-doped phosphors like $SrMoO_4$ offer tunable emission colors due to the distinct energy levels arising from 4 f electron arrangements. Consequently, these phosphors are used extensively in diverse applications, leveraging their ability to emit different colors based on specific rare-earth dopants and optical thermometry applications.

2. Synthesis Process

Urea-assisted auto combustion method was used: strontium oxide and rare-earth (RE) nitrates were mixed with HNO_3, stirred for 1 hour, and combined with a molybdate precursor in water with urea, and the resulting solution was evaporated and then calcined at 1000 °C for 4 hours. Phosphors with different doping levels were produced.

3. Results and Discussion

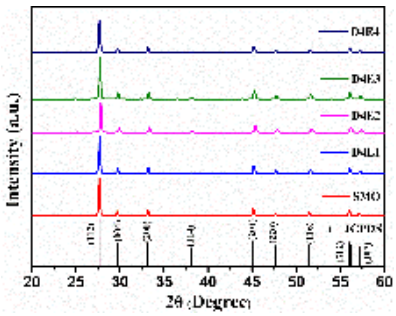


Figure 1 XRD plot for $SrMoO_4$ and $Sr_{0.96-y}Dy_{0.04}Er_yMoO_4$ (y= 0.01, 0.02, 0.03, and 0.04 at%) phosphor.

Figure 2 TDPL emission spectra of D4E3 phosphor, (b) Normalised intensity plot of TDPL spectra.

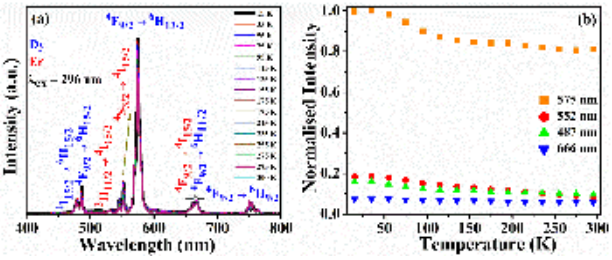


Figure 3 S_A and S_R values of thermally coupled levels of **(a)** $Er_{(552)}/Er_{(545)}$, **(b)**$Dy_{(667)}/Dy_{(661)}$ intensity ratios.

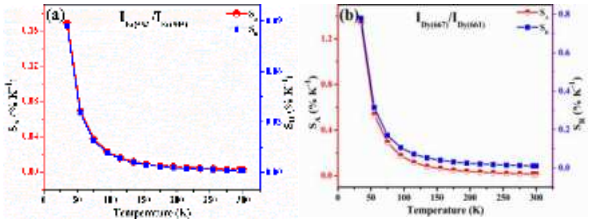
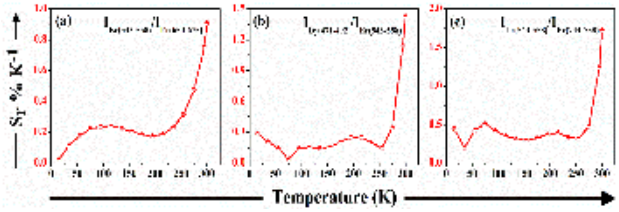


Figure 4 S_R values for non-thermally coupled levels of **(a)** $Er_{(543-558)}/Er_{(650-675)}$, **(b)** $Dy_{(471-492)}/Er_{(543-558)}$, and, (c) $Er_{(543-558)}/Er_{(744-758)}$.



4. Conclusions

The structural investigation confirms the tetragonal crystal structure. For thermally coupled levels, relative sensitivity (S_R) values are found to be 0.08% K^{-1} and 0.77% K^{-1} for $^4S_{3/2} \rightarrow {}^4I_{15/2}$ and $^4F_{9/2} \rightarrow {}^6H_{11/2}$ transitions, respectively. Similarly, for non-thermally coupled levels, S_R values are 0.90% K^{-1}, 1.42% K^{-1}, and 1.72% K^{-1}. FIR technique uses TDPL spectra for the calculations.

Acknowledgement: Satyam Chaturvedi is grateful to the INSPIRE program, sponsored and managed by the Department of Science and Technology, Government of India, for providing a JRF grant.

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SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Microwave-assisted method for rapid synthesis of high-quality iron-oxide nanocubes using benzaldehyde as a key molecule

Jugal Barman[1,2*], Wid Mekseriwattana[1], Niccolo Silvestri[1], Rosaria Brescia[1], Ecem Tiryaki[1], Farshad Gorji Mohammadzadeh[1], Nabila Jarmouni[1], Teresa Pellegrino[1*]

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[2] Dipartimento di Chimica e Chimica Industriale, Università di Genova, Via Dodecaneso, 31, Genova, 16146, Italy

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Preference: Oral
Technical Area: Biomedical Applications

Synthesis methods for the production of magnetic nanoparticles have been studied for a long time. However, finding the proper method for getting monodispersed iron-oxide nanocubes (IONCs) with high reproducibility and scale-up applicability is quite challenging. In this study, we have explored for the first time microwave (MW)-assisted method to produce high-quality IONCs in terms of shape and size distribution using benzaldehyde as a shape-changing agent [1]. We reported the MW-assisted method as a better method than conventional methods like the thermal decomposition method and solvothermal method in terms of reaction time duration, which took only a few minutes to get high-quality IONCs and has an iron conversion yield of up to 80%. The obtained size of IONCs ranged from 13 to 30 nm, depending on the amount of benzaldehyde, and fine-size tuning is acheved by adjusting the reaction time (within minutes) and reaction temperature. The obtained IONCs exhibit superparamagnetic behaviour at 298K with a saturation magnetization of 80 emu g^{-1}_{IONCs} and an excellent specific absorption rate (SAR) value of 400 W g^{-1}_{Fe}. Magnetic hyperthermia (MHT) on U87 glioblastoma tumor cells showed a significant reduction in cell viability up to 35-45% under an alternating magnetic field (AMF), and no toxicity of IONCs on tumor cells was observed even at a high dose of 2 gL^{-1}. These results represent a remarkable achievement in producing rapid high-quality IONCs with a significant iron conversion yield and high SAR values using a green method, which utilizes less energy and costs. Furthermore, we are investigating other shape-changing molecules to enable the synthesis of other anisotropic morphologies and magnetic properties that hold high potential for clinical use.

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Acknowledgements
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SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

How surface charge controls the onset temperature of LDL fluctuations in ambient liquid water

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Please indicate preference: Oral
Specify Technical Area: Biomedical

Several studies have now shown that the polymorphism of water also extends to ambient conditions, the stability and size of the liquid tetrahedrally domains (LDL) decrease upon heating, with significant implications for biological function and nanotechnology [1,2].

In our new work, we demonstrate that the onset temperature of LDL domain fluctuations in ambient liquid water at the surface of nanoparticles is highly sensitive to its surface charge density, providing a unifying framework to understand hydration water behavior in complex systems.

By combining temperature-dependent Brownian dynamics and zeta potential measurements on lanthanide-doped upconversion nanoparticles (UCNPs) with varied surface functionalizations, we establish a master curve relating crossover temperature to effective surface charge.

Our results reveal that increasing surface charge elevates the LDL onset temperature, converging toward the bulk water value ($\sim 330K$). This trend highlights how interfacial electrostatics modulate water structuring, offering predictive control of hydration water dynamics.

Together with recent reports of other water-suspended materials, such as QDs, plasmonic NPs, Ag2S NPs, organic molecules, and aqueous complexes. These findings will lead us to a fundamental understanding of the role played by water in the thermal stability of biomolecules and dielectric behavior in confined systems. Opening pathways for nanofluid engineering in biomedicine and energy systems.

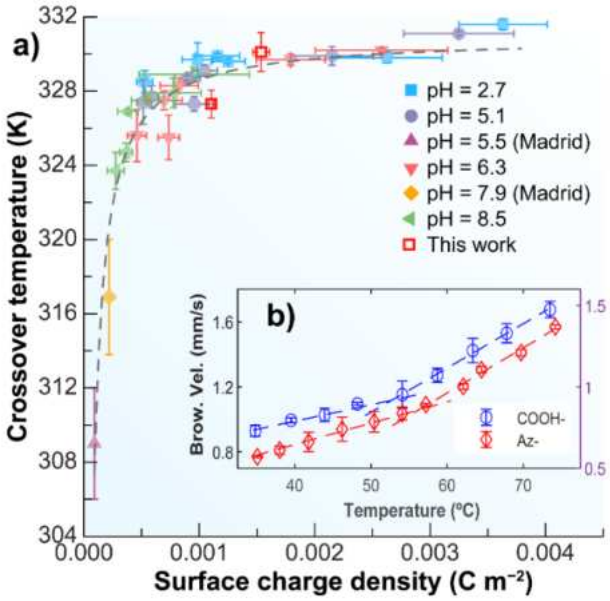

Figure 1. (a) Experimental data from previously reported studies from the Aveiro [1] and Madrid [3] research groups, superimposed with new data of two nanoparticles functionalized with azide and carboxylate groups, showing the crossover temperature (Tc) of different-sized UCNPs measured at distinct pH values as a function of their surface charge density. **(b)** Temperature-dependent Brownian velocity of the two UCNPs (COOH- and Az-functionalized).

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SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

What Can CaF_2:Nd,Y Nanothermometers Tell Us About Heating in U-87 Mg Multicellular Spheroids?

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Oral
Biomedical

Light-based technologies are essential in biomedical research, offering non-invasive strategies to study biological systems and enabling advances like super-resolution and live cell imaging. However, results from conventional 2D assays often diverge from those observed *in vivo*. To better mimic tissue environments, three-dimensional models such as multicellular spheroids have been developed, as they provide more realistic cell–cell and cell–matrix interactions. In this study, spheroids were produced using U-87 MG glioblastoma cells via the forced-floating method, resulting in structures approximately 200 µm in diameter. Their small scale requires at least micron-resolution for internal thermal evaluation during optical experiments.

To address this challenge, CaF_2:Nd,Y nanoparticles have been synthesized via hydrothermal method and used as luminescent nanothermometers.[1] These rare-earth-doped materials exhibit temperature-dependent emission governed by the Boltzmann distribution, enabling temperature determination through fluorescence intensity ratios (FIR). After optimizing parameters such as the excitation wavelength and the emission region for maximum FIR sensitivity, the nanoparticles were internalized into spheroids to enable calibration and real-time temperature monitoring.

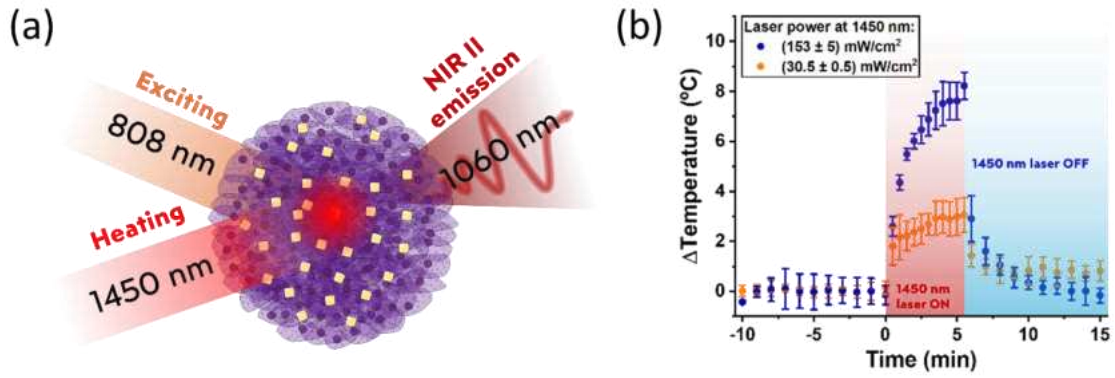

Figure 1. (a) Schematic of the nanoparticle irradiation and emission inside the spheroid, which is simultaneously heated using a 1450 nm laser. (b) Temporal evolution of the temperature measured from the emission of nanoparticles internalized within the spheroid during laser heating.

Building on previous work that defined safe illumination conditions,[2] this study quantifies internal temperature changes induced by a 1450 nm focalized laser Real-time measurement of these photothermal effects highlights the utility of nanothermometry for characterizing light–tissue interactions in complex 3D cell models.

[1] M. Pedroni et al., Menoscabe 3 (2011) 1456-1460.

[2] P. Camarero et al., Optical Materials 142 (2023) 114055.

SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Silica Shielding of Ag_2S Nanocrystals: Safeguarding Luminescence in Complex Biological Environments

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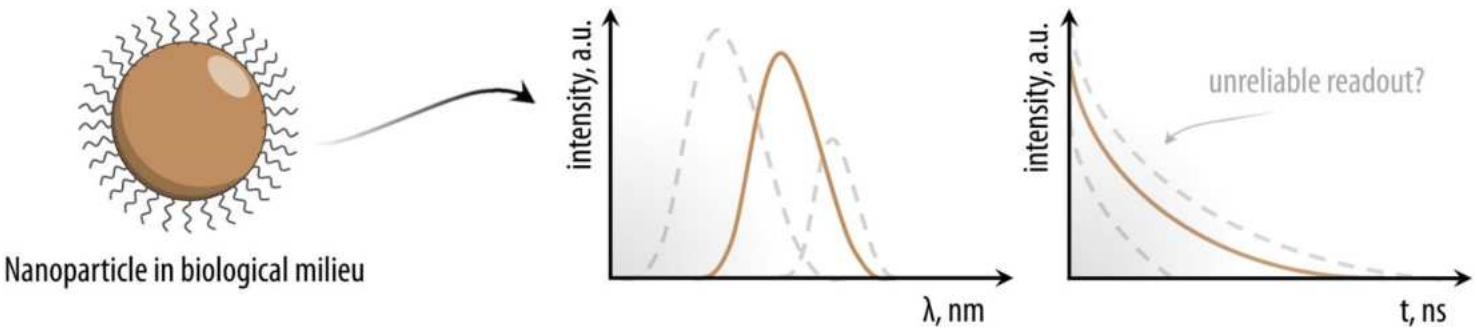
Please indicate preference: Oral
Specify Technical Area: Biomedical

Over the past decade, near-infrared (NIR) emitting Ag_2S nanocrystals (NCs) have garnered all the headlines in nanomedicine due to their outstanding optical properties [1]. Much has been done to improve their physicochemical and spectroscopic features, focusing on tuning their size, composition, surface chemistry, or core/shell architecture [2]. However, their physicochemical stability is often compromised when dispersed in biological media, leading to nonspecific interactions with biomolecules (particularly proteins) that strongly impact their photoluminescence properties, and hovers over doubts about their potential at the preclinical level.

In this study, we investigate the luminescence behavior of Ag_2S-based NCs in complex physiological environments (blood plasma and whole blood) and assess the impact on their surface modifications. To overcome these challenges, we propose a silica encapsulation strategy that effectively shields NCs from environmental disturbances while preserving their optical properties. Steady-state and time-resolved photoluminescence measurements reveal significant improvements in emission stability upon incorporation into silica, mitigating cross-sensitivity effects and enhancing performance in biological settings. The information collected was used to expand the applicability in small animal models.

[1] Y. Zhang, G. Hong, Y. Zhang, G. Chen, F. Li, H. Dai, Q. Wang, *ACS Nano* **2012**, 6, 5 3695.
[2] I. Z. Gutierrez, C. Gerke, Y. Shen, E. Ximendes, M. M. Silvan, R. Marin, D. Jaque, O. G. Calderón, S. Melle, J. Rubio-Retama, *ACS Applied Materials & Interfaces* **2022**, 14, 4 4871.



SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Dual-Mode NIR-III Fluorescent and OCT Contrast Agents Based on Zinc-Doped Silver Telluride Quantum Dots

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Please indicate preference: Oral
Specify Technical Area: Biomedical

The third biological window (NIR-III, approximately 1550–1870 nm) offers reduced light scattering and minimal tissue autofluorescence, making it highly promising for deep-tissue biomedical imaging. However, the development of suitable contrast agents that operate in this spectral region remains limited. Silver telluride (Ag_2Te) quantum dots are promising candidates due to their ultralow solubility, low-toxicity elemental composition, and narrow bandgap, which enables intrinsic fluorescence emission in the NIR-III range.

In this work, we synthesized Zinc-doped Ag_2Te quantum dots and explored their potential as dual-mode contrast agents for NIR-III fluorescence imaging and optical coherence tomography (OCT). The particles were thoroughly characterized in terms of morphology, size, optical properties, and colloidal stability. To render them compatible with biological environments, we investigated different approaches for transferring them into aqueous media, ultimately achieving stable and well-dispersed water suspensions.

Luminescence characterization confirmed emission within the NIR-III region, and visualization with an infrared camera further verified their optical activity. Moreover, OCT imaging experiments demonstrated a clear contrast enhancement, confirming their potential as scattering-based OCT agents.

These findings highlight Ag_2Te quantum dots as promising dual-function contrast agents combining deep-tissue fluorescence and structural imaging capabilities. Their optical performance, aqueous stability, and biocompatible composition position them as strong candidates for future applications in multimodal biomedical imaging.

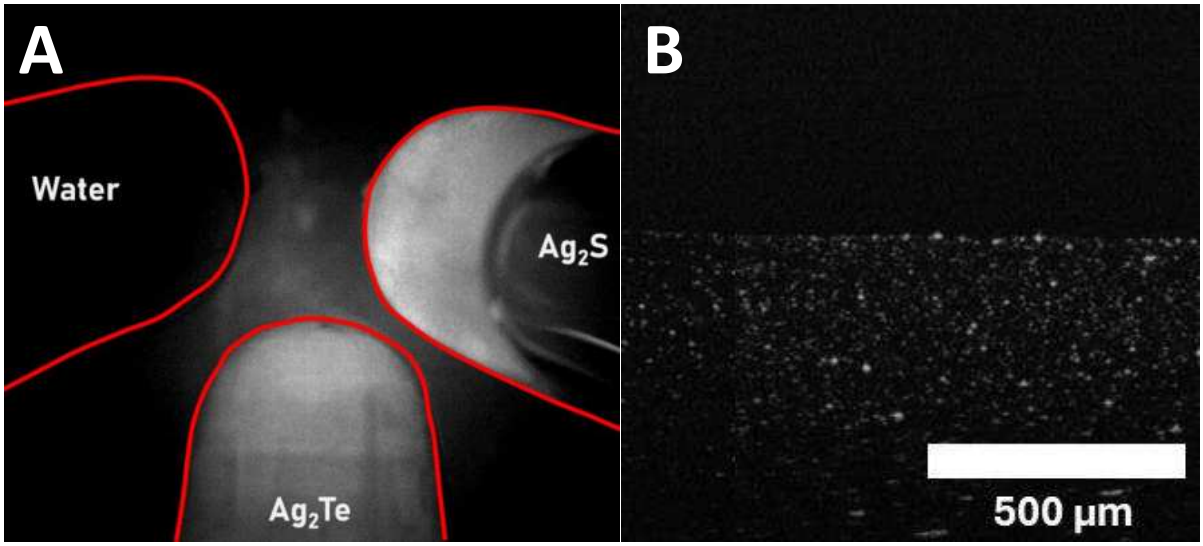

Fig. 1. (A) Fluorescence imaging of water (top-left), silver sulfide nanoparticles (top-right) and zinc-doped silver telluride quantum dots (bottom) under 808 nm laser excitation. (B) Optical Coherence Tomography imaging of zinc-doped silver telluride nanoparticles in water.

SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

The role of polyethyleneimine (PEI) molecular weight in tuning molecular binding, photophysical, and FRET properties of $NaYF_4$:Yb,Er upconversion nanoparticles.

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Please indicate preference: Oral
Specify Technical Area: Biomedical

Upconversion nanoparticles (UCNPs) are emerging as a promising tool in biomedical imaging due to their unique ability to convert near-infrared (NIR) excitation into higher-energy visible emission. This anti-Stokes emission enables deeper tissue penetration, minimal autofluorescence, and reduced photodamage compared to conventional fluorophores. However, UCNPs typically involve synthesis with hydrophobic ligands (i.e., oleic acid) and require ligand exchange routes to render them water dispersible, which can lead to losses in upconversion luminescence (UCL). Therefore, we investigated polyethyleneimine (PEI) capped UCNPs ($NaYF_4$: Yb, Er) as a water-dispersible alternative that avoids complex ligand exchange routes. PEI is a cationic polymer that renders red-emitting UCNPs water dispersible, from a 'one-pot', solvothermal, synthesis route, without requiring further ligand exchange. Our research focuses on exploring the influence of PEI molecular weight on UCNP properties, which is largely underreported in the literature.

Using three different molecular weights of PEI (1.2 kDa, 10 kDa, and 25 kDa), we evaluated effects on nanoparticle size, luminescence intensity, excited-state lifetime, molecular loading, and Forster Resonance Energy Transfer (FRET) interactions with Alexa Fluor 647 and an oxygen-sensitive molecule. We also explored their stability in various buffers and the formation of water-dispersible, core/shell UCNPs.

Our findings reveal that PEI chain length plays a critical and underappreciated role in dictating the photophysical and functional behaviour of UCNPs. This research highlights the importance of polymer selection when designing UCNPs for biological applications.

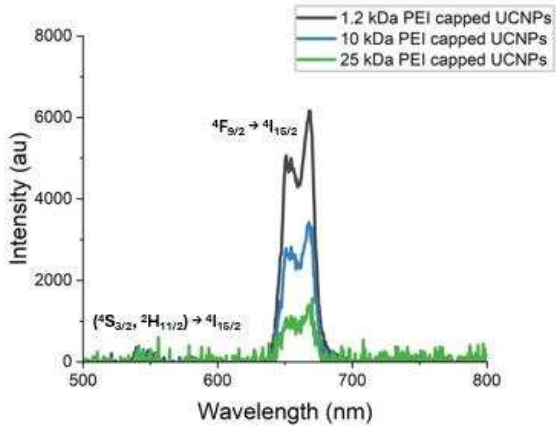

Figure 1: UCL spectra of the UCNPs in DI water under 980 nm excitation show that UCL increases upon decreasing PEI molecular weight.

SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Luminescence-enabled three-dimensional temperature mapping

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Please indicate preference: Oral
Specify Technical Area: Biomedical Applications

Luminescence nanothermometry analyzes the changes in the luminescent properties of nanoparticles to provide remote thermal readouts with high spatial resolution and in a minimally invasive way.[1] This technology has advanced our understanding of biological mechanisms and physical processes at the submicrometric scale. However, current luminescence-based techniques typically provide only two-dimensional (2D) thermal images. This is a limiting factor in biological applications, where precise localization of temperature variations is crucial. Yet, despite first attempts,[2] a credible method that allows extracting three-dimensional (3D) thermal maps via luminescence is missing.

Here, we design such a method combining Ag_2S nanothermometers and convolutional neural networks (CNN). The approach leverages the distortions in the emission spectra of luminescent nanothermometers caused by changes in temperature and tissue-induced photon extinction. The optimized, neural network-based algorithm can extract this information and provide 3D thermal maps of complex nanothermometer patterns (**Figure 1**). Although tested for luminescence thermometry in vivo, this method has far-reaching implications for luminescence-supported 3D sensing in biological systems in general. This is because it offers a means to simultaneously capture spatial distribution information of sensors and the magnitude of the parameter of interest.

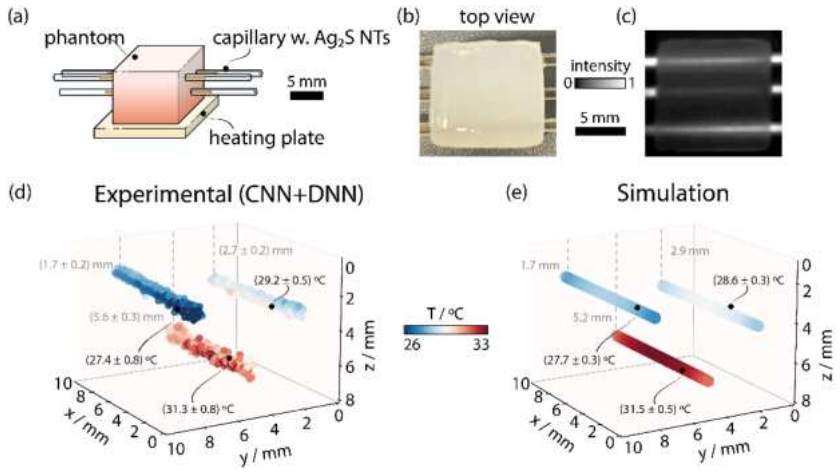

Figure 1. (a) Scheme of the phantom with inserted Ag_2S NTs-filled capillaries (outer diameter = 1 mm, inner diameter = 0.5 mm). (b) Top view of the phantom and (c) corresponding hyperspectral image used to obtain the 3D thermal maps shown in (d). (e) Thermal maps obtained considering the depth measured from a photo and the temperature resulting from simulations.

[1] *Adv. Mater.* 35 (2023) 2302749, DOI: 10.1002/adma.202302749
[2] *Adv. Mater.* 36 (2024) 2309452, DOI: 10.1002/adma.202309452

SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Biopolymer-Coated Lanthanide Nanoparticles for Enhanced Bioimaging

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Please indicate preference: Oral
Specify Technical Area: Nanobiomedical

Lanthanide-based nanoparticles (Ln-NPs) are sought-after for biomedical applications ranging from bioimaging to therapy. By carefully selecting the Ln^{3+} dopants, both near-infrared (NIR)-to-visible upconversion (UC) and NIR-to-NIR wavelength conversion can be achieved. Their ability to emit in the NIR region upon NIR excitation is particularly advantageous for bioimaging due to deeper tissue penetration and reduced phototoxicity compared to UV excitation. This allows for excitation and emission within the optical transparency windows (also known as biological windows). Despite recent progress, a better understanding of nano-bio interactions is needed for real-world applications. To address this, we present a straightforward strategy for surface-functionalizing Ln-NPs with naturally derived biopolymers, Gum Arabic, to create an effective bioimaging platform.

In this study, we explore a microwave-assisted synthesis approach to prepare Ln-NPs, followed by surface modification using Gum Arabic. This modification aims to enhance aqueous dispersibility, stability, and biocompatibility. Characterization techniques confirmed the phase purity, morphology, and luminescence properties of the nanoparticles.

Initial studies demonstrate strong chemical and colloidal stability in biological media and low cytotoxicity, suggesting their potential suitability for in vitro and in vivo applications. These findings form the basis for ongoing efforts to expand the functionality of these nanomaterials through additional surface engineering approaches aimed at improving their biological performance. These results help guide the next steps in improving lanthanide-based nanoparticles for use in biological systems and future medical applications.

SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Large Stokes Shift UV Emission from Fully Sensitized NaYbF4:Tm@NaYF4 Nanoparticles: Engineering Energy Migration and Shell Passivation for Bioactive Photochemistry

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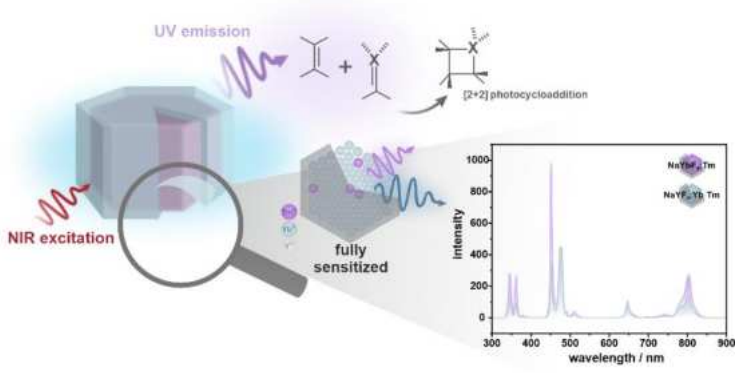
Please indicate preference: __Poster _X_ Oral
Specify Technical Area: _X_Biomedical __ Energy and other Applications

Achieving efficient ultraviolet (UV) emission from upconversion nanoparticles (UCNPs) under near-infrared (NIR) excitation remains a significant bottleneck for applying UCNPs in phototriggered bioactive systems, due to limited multiphoton conversion efficiency and surface-related quenching. We report a systematic engineering strategy for $NaYbF_4$:Tm@$NaYF_4$ core–shell UCNPs that enables five-photon upconversion at 345 nm with a large apparent Stokes shift of ~600 nm. By fully populating the core with Yb^{3+} as the sensitizer and maintaining low Tm^{3+} concentrations (0.4 mol%) to minimize cross-relaxation, we extend the Yb–Yb energy migration network and isolate the Tm^{3+} activators, maximizing stepwise energy transfer efficiency.

Spectroscopic characterization reveals a >200-fold increase in UV emission intensity relative to low-doped $NaYF_4$:Yb,Tm references, attributed to optimized interionic spacing and a 4–6 nm thick $NaYF_4$ shell that passivates surface defects and prevents back-energy transfer. Power-dependent measurements confirm a fifth-order nonlinear response at 345 nm, highlighting the successful suppression of nonradiative decay pathways.

As proof-of-concept, the UCNPs were employed as heterogeneous photocatalysts to initiate [2+2] photocycloadditions and Paternò–Büchi reactions under 980 nm excitation, achieving turnover numbers above 290,000. We now target the integration of photoresponsive protecting groups and UV-cleavable linkers to demonstrate UCNP-mediated, spatially resolved drug release. These results position fully sensitized Tm-doped UCNPs as powerful tools for deep-tissue, low-background photochemistry, and provide a mechanistic basis for their rational design in biomedicine.



SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Advancing CAR T Cell Therapy with Surface-enhanced Raman-based Live Immune Cell Monitoring

Ariel Stiber[1*], Boi Quach[2,3,4], Babatunde Ogunlade[1], Antony Georgiadis[1], Kai Chang[1], Patrick Quinn[4], Haoqing Wang[5], Yuanwei Li[1], Elena Sotillo[4], Zinaida Good[2,3,4], Crystal Mackall[4], Jennifer Dionne[1]

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Please indicate preference: __Poster _X_ Oral
Specify Technical Area: _X_Biomedical __ Energy and other Applications

Chimeric antigen receptor (CAR) T cell therapy is a transformative immunotherapy for cancer and autoimmune diseases. In this treatment, a patient's T cells are engineered to express a synthetic CAR that directs immune reactivity toward target cells. Monitoring patient CAR T cell quantity throughout treatment is critical for assessing therapeutic efficacy and predicting toxicities such as cytokine release syndrome and neurotoxicity. However, current quantification methods are costly and time-intensive, limiting point-of-care clinical decision support. There remains a critical need for real-time, low-cost CAR T cell monitoring. Here, we present a label-free, cost-effective approach using surface-enhanced Raman spectroscopy (SERS) and machine learning (ML) to monitor CAR T cells in patient blood. SERS enables rapid, label-free, non-destructive cell identification with single-cell resolution, avoiding complicated sample preparation. ML algorithms, trained on subtle spectral differences, facilitate precise cell phenotype differentiation. In combination, we achieve single-cell identification of engineered versus natural T cells.

We synthesize gold nanorods with a localized surface plasmon resonance around 660-700 nm for optimal Raman excitation at 785 nm. These nanorods reduce acquisition times for spectral collection of live immune cells in liquid. We collect and classify SERS spectra of human cells, training a lightweight ensemble Random Forest model that accounts for cell-to-cell, patient-to-patient, and nanorod-cell binding variability. We demonstrate ~85% accuracy in classifying single-cell live human blood components (T cells, B cells, and red blood cells). Focusing on engineered (CD19-targeted CAR) and non-engineered (Mock) T cells, we collected 1000 single-cell spectra per cell type across 5 donors, demonstrating an average 76% patient-level classification accuracy. We improve this to ~93% by co-culturing CAR T cells with JeKo1 B cells (generating an antigen-specific activating response) and Mock T cells with the B cells (no activation), using datasets of 2000 Raman spectra per donor, from 3 donors per condition. By acquiring continuous Raman spectra over a 2-hour activation period, we further capture the temporal dynamics of the CAR T cell activation process.

Finally, we use our trained Random Forest model to predict CAR T cell concentrations in complex, physiologically relevant CAR, Mock, and B cell mixtures at 10-60% CAR T cell levels. ML feature importance analysis identified specific vibrational modes distinguishing CAR from Mock cells and those arising during activation and killing. These findings enhance our understanding of the molecular underpinnings of CAR biology. Future work includes spiking low percentages of CAR T cells into Peripheral Blood Mononuclear Cells for a more clinically relevant assessment of detection sensitivity. In this talk, we demonstrate the promise of this platform for rapid, cost-effective, label-free, real-time CAR T cell monitoring during cancer therapy and shed light on the molecular underpinnings of this powerful treatment.

SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Integrated Photoluminescence-Based Volatile Organic Compounds Detection: Material Design and Miniaturized Sensor Development

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Please indicate preference: __Poster _x_ Oral
Specify Technical Area: _x_Biomedical __ Energy and other Applications

Exhaled breath, which contains gases, volatile organic compounds (VOCs), and aqueous microdroplets, has emerged as a promising matrix for the non -invasive detection of lung diseases, including Covid-19. During the onset or recovery phases of illness, various biochemical processes release gases and VOCs into the bloodstream, which can then diffuse into the lung alveoli and be detected in exhaled breath. A viable strategy for detecting these compounds involves using photoluminescent (PL) materials that respond to VOCs through measurable emission changes.

In this context, we synthesized a novel lanthanide complex, $3NH_4[Tb(HPMIDA)_2(H_2O)]$ (HPMIDA=desprotonated N-(Phosphonomethyl)iminodiacetic acid), and characterized it with a serie of techniques, among them single-crystal X-ray diffraction. TbHPMIDA exhibits a unique arrangement of phosphonate -OH groups, which could promote effective chemical on the substrate such as commercial SiO_2 glass.

Photoluminescence studies demonstrated the material's strong response to specific VOCs, particularly acetone and limonene, which are linked to hyperglycemia (e.g., diabetes) and chronic liver diseases, respectively. The PL intensity showed a linear correlation with VOC concentration, indicating potential for quantitative detection. The interaction between TbHPMIDA and acetone is presumed to occur via reversible hydrogen bonding, as supported by powder X-ray diffraction results.

Successful substrate functionalization was confirmed, and changes in the excitation profiles suggest new interactions between the complex and the substrate. Using a custom gas cell, we evaluated the PL response of the functionalized glass substrate (3 × 3 mm) under acetone exposure, confirming its sensitivity. To further reduce the quantification limits and enhance selectivity, a miniaturized gas cell is being developed. The integration of mid-infrared (MIR) detection in this system could significantly improve molecular discrimination and analytical performance.

Acknowledgements:
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SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Indium-Based Fluoride Nanoparticles Doped with Chromium for Near Infrared Luminescence

Emily Andreato[1,2*], Nikita Panov[1], Álvaro Artiga[1,3], Viktoriia Osipovad[4,5], Ute Resch-Genger[5], Erving Ximendes[1], Pablo Molina[2,6],Patrizia Canton[7], and Riccardo Marin[1,2,8*]

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Please indicate preference: Oral
Specify Technical Area: Biomedical applications

Transition metal (TM) and rare earth (RE) ion-doped nanoparticles (NPs) are emerging as key photoluminescent materials for applications in bioimaging, sensing, and light conversion.[1] Among these, fluoride-based NPs are particularly attractive due to their low phonon energy, high chemical stability, optical transparency, and tunable structural features.[1,2] However, most colloidal fluoride NPs–including widely studied systems such as $NaYF_4$ and $LiYF_4$–can be efficiently doped exclusively with trivalent rare earth (RE^{3+}) ions, while remaining largely incompatible with the incorporation of luminescent TM ions.[2]

Here, we address this limitation by proposing Na_3InF_6 NPs doped with Cr^{3+} as a model TM ion. We unveil the heat-driven formation mechanism of these NPs, characterized by a cubic-to-monoclinic phase transition–analogously to the well-known cubic-to-hexagonal transformation in $NaYF_4$. While reaction temperature and time above 225 °C have minimal effect on the morphology, the NP size can be effectively tuned by adjusting the fluoride precursor concentration and oleylamine content. Photoluminescence (PL) studies reveal that Cr^{3+} ions experience a weak crystal field environment within the host lattice, with a PL lifetime exhibiting a linear dependence on temperature in the 20–50 °C range: the temperature interval of biological relevance. The biocompatibility of Na_3InF_6 NPs with the U-87 cell line was confirmed by cytotoxicity assays. These results pave the way for further studies on photoluminescent TM-doped fluoride NPs, aimed at advancing their use in bioimaging, sensing, and light-conversion applications.

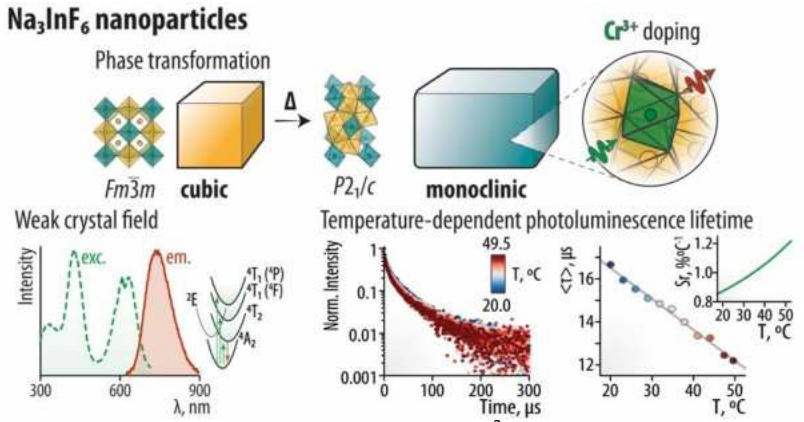

Figure 1. Heat-driven cubic-to-monoclinic phase transition of Na_3InF_6:Cr^{3+} NPs (on top); near-infrared PL of Cr^{3+}, arising from a $^4T_2 \rightarrow {}^4A_2$ indicating that Cr^{3+} ions lie on low crystal-field sites (bottom left); PL decay curves collected monitoring Cr^{3+} emission, average lifetimes at various temperatures, and the corresponding relative thermal sensitivity (bottom right).

[1] Gnach, A.; Bednarkiewicz, A. Lanthanide-Doped up-Converting Nanoparticles: Merits and Challenges. Nano Today 2012, 7 (6) , 532–563. DOI: 10.1016/j.nantod.2012.10.006.

SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Mechanosensitive polymer-upconverting nanoparticle composites with biologically-relevant compliances

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Please indicate preference: __Poster _x_ Oral
Specify Technical Area: _x_Biomedical __ Energy and other Applications

Upconverting nanoparticles (UCNPs) show promise as optical biomechanical force sensors due to their near-infrared excitation, low cytotoxicity, and photostability. Specifically, prior work using erbium-doped UCNPs embedded in polystyrene microgauges demonstrated linear, hysteresis-free colorimetric emission based on red to green emission ratio (%Δ I_R:I_G) in response to microNewtons of pressure in the lumen of a neuromuscular organ. However, polystyrene is comparatively stiff (elastic modulus ~740 MPa), preventing application to mechanically diverse types of biological tissues. To facilitate deployment of UCNPs macroscopically into biological tissues with a range of mechanical properties, we expand upon polymer-UCNP composite systems by embedding UCNPs in three polymer matrices with varying stiffnesses (epoxy resin, polydimethylsiloxane, and alginate hydrogels). These polymers have compliances that mimic those found in bone and cartilage, inner organs, and brain, respectively. We demonstrate their incorporation as a layer between the joint of a chicken wing bone, a pellet fed into a mouse colon, and a chunk embedded in an agarose phantom brain. To enhance these composites' mechanosensitivity, we methodically investigate polymer-UCNP combinations using two different core-shell architectures of SrLuF-based UCNPs doped with ytterbium, erbium, and varying manganese concentrations. We calibrate polymer-UCNP composite optical force sensitivity with simultaneous atomic force and confocal microscopy. We determine that SrLuF:Yb, Er, 0.013Mn @ SrYF dispersed in epoxy resin exhibits the greatest emission color change (12%Δ I_R:I_G per microNewton), as compared to 8.4%Δ I_R:I_G for the same UCNPs in PDMS and 1.0%Δ I_R:I_G for UCNPs without Mn-doping in epoxy resin. Finally, we spatially map forces in the epoxy-UCNP composite using confocal microscopy with weighted spherical beads, and demonstrate that the optical material faithfully measures a Hertz-model-predicted pressure distribution. We also map the forces in a more complex geometry in the joint of a chicken wing bone, demonstrating that this platform is able to probe forces in animal models *in situ*. These findings position polymer-UCNP composites as a richly customizable force-probing system for geometrically and mechanically diverse biological systems.

SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Conditional Diffusion Reconstruction for Scintillator-Based X-ray Imaging

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Please indicate preference: Oral
Specify Technical Area: Biomedical applications/ Scintillation imaging

Photon scattering within scintillators imposes a fundamental constraint on the spatial resolution of X-ray imaging, particularly under low-dose conditions. Conventional approaches such as structured scintillators or algorithmic deconvolution face limitations in fabrication scalability and physical model generalizability. To address these challenges, we propose a physically constrained image reconstruction framework grounded in Langevin-type diffusion dynamics and guided by experimentally captured scattering data. We developed an in situ light field imaging technique capable of depth-resolved optical sectioning within transparent scintillators under X-ray excitation. This method enables the direct acquisition of over 5000 datasets capturing true photon propagation trajectories, which serve as conditional priors for training a generative diffusion model. Complementary Monte Carlo simulations further reveal material-dependent variations in point spread functions, quantitatively linking resolution degradation to scintillator composition and thickness. Applied to a 500 μm thick BGO scintillator, our method achieves over two-fold enhancement in spatial resolution without any hardware modification. The trained model supports high-fidelity reconstruction at reduced radiation doses while maintaining rapid inference speed. These results demonstrate the feasibility and scalability of integrating physically grounded priors with stochastic generative modeling, offering a promising pathway toward high-resolution, low-dose X-ray imaging using conventional detection systems.

SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Upconverting colloidal nanocomposites for PDT

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Please indicate preference: __Poster _X_ Oral
Specify Technical Area: _X_Biomedical __ Energy and other Applications

Photodynamic therapy (PDT) is an emerging technique that uses a light-activated molecule (photosensitzer, PS) to produce Reactive Oxygen Species (ROS, e.g., $^1O_2$) useful to kill cancer cells. Nonetheless, one major challenge of this technique lies in finding a proper excitation radiation, as conventional visible or UV light has a low penetration depth in biological tissues, permitting only the treatment of surface tumors. It becomes therefore important to explore new PS systems able to work in the Biological Windows (750-900 nm, BW1; 1000-1700 nm, BW2). One interesting answer to this issue is the employment of nanosized materials absorbing photons in the BWs and re-emitting light at higher energies (upconversion, UC), in the visible or UV regions. Since many PS can be activated by UV or visible light, these kinds of nanomaterials permit activation of the PS by using NIR radiation. Moreover, since laser radiation is needed to generate UC, it is possible to activate a PS with a high spatial resolution, typically in micrometer-sized areas, with the big advantage of avoiding damage to the surrounding healthy tissues.

In this contribution, we describe the preparation, chemical-physical characterization, and *in-vitro* testing of a nanocomposite for PDT exploiting Yb^{3+}, Er^{3+}, and Nd^{3+} doped core@shell SrF_2-based UCNPs. The UCNPs were prepared by a fast, reproducible microwave-assisted hydrothermal method. These UCNPs have been conjugated with Rose Bengal (RB), which is a PS with a high $^1O_2$ quantum yield, in a subsequent step, via electrostatic interactions. Luminescence spectra and decays demonstrated an efficient energy transfer from the UCNPs to RB, while the production of $^1O_2$ has been evidenced by using a ROS scavenger. *In-vitro* tests on the SH-SY5Y tumoral cell line suggest that these UCNPs@RB nanocomposites can serve not only as optical imaging contrast agents, but also for PDT, upon laser irradiation in the BW1.

SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Exploring Water Beyond the Solvent: Insights into Density Fluctuations and Enhanced Green Fluorescent Protein (EGFP) Unfolding via Luminescence Thermometry

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Please indicate preference: __ Oral
Specify Technical Area: __Optical Application

Water is central to biological systems, modulating protein stability and dynamics through complex hydration interactions.[1] Recent studies propose a two-state model of liquid water — characterized by interconverting low-density (LDL) and high-density (HDL) motifs even at ambient conditions.[2] These fluctuations are hypothesized to directly influence protein folding and stability.[3] Despite advances in X-ray and neutron scattering, NMR, terahertz spectroscopy, and computational modeling, isolating the specific contributions of hydrated water from those of the protein itself remains challenging.[4] The fluorescence characteristics and Brownian motion of enhanced green fluorescent protein (EGFP) are highly sensitive to its local hydration environment, making it ideal for investigating this two-state model and its role in thermal unfolding processes. To this end, we employed temperature-dependent fluorescence quenching and Brownian velocity of EGFP at varying concentrations in H_2O and D_2O by luminescence thermometry. By measuring heating/cooling cycling experiments revealed that EGFP's thermal unfolding transition occurs at higher temperatures in D_2O (64°C) compared to H_2O (56°C), corroborating the stabilizing effect of isotope substitution on protein conformation. Additionally, analysis of temperature-dependent Brownian velocity uncovered a crossover temperature between LDL and HDL fluctuation transitions, which shifts from 55°C in H_2O to 65°C in D_2O. Our fully optical approach uniquely distinguishes hydration shell dynamics and conformational changes of protein, providing mechanistic insights into how water's polymorphism impacts protein stability.

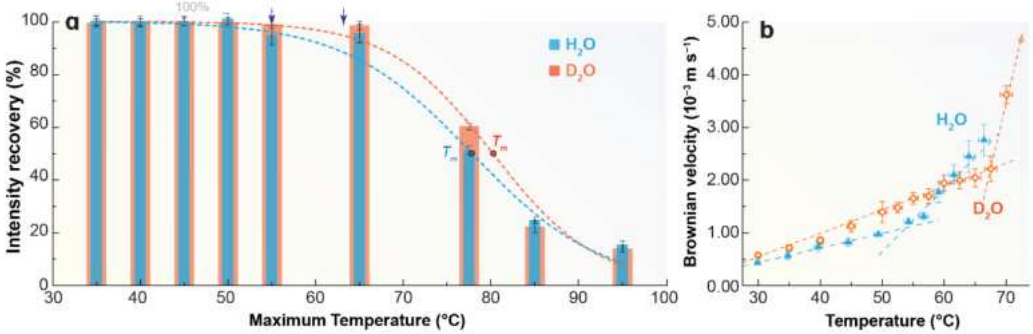

Figure. (a) Fluorescence intensity recovery of EGFP after heating/cooling cycles between 25.0 and 95.0 °C in H_2O and D_2O. The lines are the best fit to the data using Boltzmann functions (r^2>0.988). The points mark the melting temperature T_m, while the arrows mark the onset of protein unfolding. (b) Temperature-dependent Brownian velocity of EGFP in H_2O and D_2O. The dashed lines are the best linear fit to the data (r^2>0.944).

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SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Optical reactor for light-driven chemistry

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Please indicate preference: Oral

Specify Technical Area: Energy applications, Nanophotonics, Plasmonics, Full wave simulation

Precise control over light delivery at the micro- and nanoscale is crucial for applications in photochemical reactions, plasmon-enhanced catalysis, and on-chip optical manipulation. Efficient light transport is essential for activating catalytic sites, driving specific reactions, and enhancing yields in photochemical reactors. However, conventional light-driven reactors struggle with effective light injection due to high scattering, leading to non-uniform illumination, significant energy losses, and poor excitation localization—factors that limit efficiency and scalability. Overcoming these challenges requires innovative strategies to direct light with minimal loss to target reaction sites.

Our approach explores photonic structures to deliver light directly to catalytic environments. In this work, we present a straightforward experimental platform for studying light–matter interactions relevant to reactor design. By tuning the excitation conditions, we demonstrate control over propagation direction and efficient coupling into optical modes. We further visualize outcoupled light patterns and confirm that localised metallic nanostructures can be excited effectively within this configuration. Experimental results show strong agreement with numerical simulations, laying the groundwork for systematic optimisation of next-generation light-driven reactors.

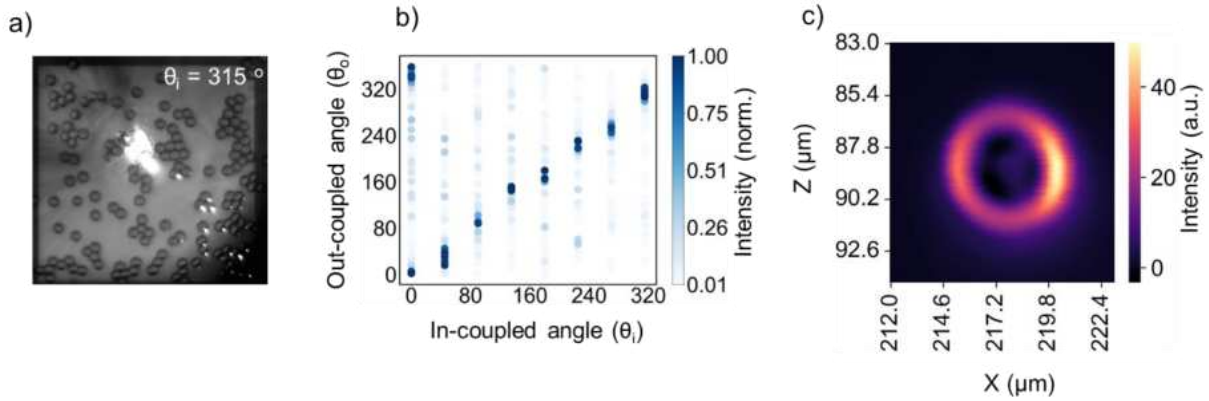

Figure (Illustrative only): *a) Optical micrograph showing directional out-coupling from the photonic structures under controlled excitation. b) Dependence of output light angle on excitation conditions. c) Spatial distribution of light in-coupling at different excitation positions, shown in relative intensity (a.u.), highlighting position-dependent mode excitation.*

SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Force and Light (UV-NIR) emissions from Nd^{3+} and Mn^{2+} doped ZnS/CaZnOS Heterojunction for thermal and biological applications via Mechanoluminescence and Photoluminescence

Jan Moszczyński[1,*], Marcin Runowski[1], Kevin Soler-Carracedo,[1] Przemysław Woźny[1], Teng Zheng[2], Justyna Barzowska[3], Sebastian Mahlik[3], Dengfeng Peng[4]

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Please indicate preference: __Poster _X_ Oral
Specify Technical Area: __Biomedical _X_ Energy and other Applications

Mechanoluminescence (ML) and luminescence thermometry offer complementary routes to generate light via mechanical or acoustic excitation and to gauge temperature without direct contact [1, 2]. Here, we report the design and characterization of a ZnS/CaZnOS heterojunction co-doped with Nd^{3+} and Mn^{2+} ions, yielding a multifunctional platform for remote force, sound and temperature sensing. Owing to its potenitally biocompatible composition and emission in the near-infrared biological window (650–900 nm), this platform is ideally suited for deep-tissue imaging and mechanobiological sensing. Under both UV and NIR (up-conversion) excitation, the material displays tunable photoluminescence (PL), with $Nd^{3+} \rightarrow Mn^{2+}$ energy transfer adjusting the emission in color and as well in IR. Such tunability enables contrast optimization in soft tissues and could facilitate mapping of cell-scale traction forces or localized thermal gradients in vitro and in vivo. We quantify ML by recording output intensity versus applied mechanical power for Nd^{3+}- and Mn^{2+}-related bands in co-doped sample. Temperature-dependent PL measurements of thermally coupled Nd^{3+} levels transitions serve to calibrate the luminescent thermometer across a broad range. By merging sound-induced ML with calibrated luminescence thermometry, we achieve optical temperature under pulsed sonication, and via continuous sonication-driven heating – altogether demonstrating excitation-light–free thermal monitoring. This work underscores the promise of sound-to-light conversion materials for non-invasive, remote diagnostics in diverse mechanical and thermal environments. What more this materials seems to have potential usage in biological applications.

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Acknowledgments:
Work supported by the National Science Center (grant 2023/50/E/ST5/00021)

SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Luminescence-encoded materials for next-generation security inks

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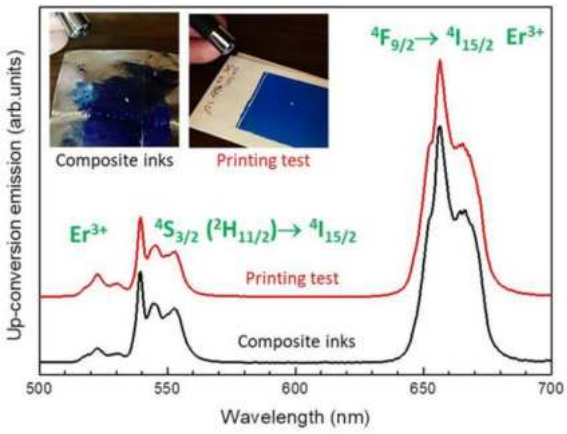
Please indicate preference: __Poster X Oral
Specify Technical Area: __Biomedical X Energy and other Applications

Counterfeiting of documents and commercial products represents an escalating challenge that requires the development of protection strategies based on advanced functional materials. Rare-earth-doped compounds are particularly promising due to their unique luminescent properties, including up-conversion processes, which enable the generation of spectroscopically encoded optical signatures. In this work, several families of such materials were synthesized by solvothermal and melt-based methods, allowing precise control over composition and structural features. Their subsequent integration into commercial security inks produced highly stable luminescent patterns, activated by near-infrared excitation, that are extremely difficult to replicate, providing enhanced anti-counterfeiting functionalities. Furthermore, the demonstrated compatibility with large-scale industrial processes, including "offset" printing, underscores their potential for deployment in high-security applications, ranging from banknotes and official documents to textiles, smart tags, and integrated circuits.



Up-conversion emission spectra of Yb–Er–SAC40/offset composite inks (10 wt% in offset ink) under 980 nm excitation, comparing ink dispersion (lower curve) and printed test (upper curve).

References:

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Acknowledgements:

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SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Boosting photo-electrochemical hydrogen generation via up-conversion in rare-earth doped materials

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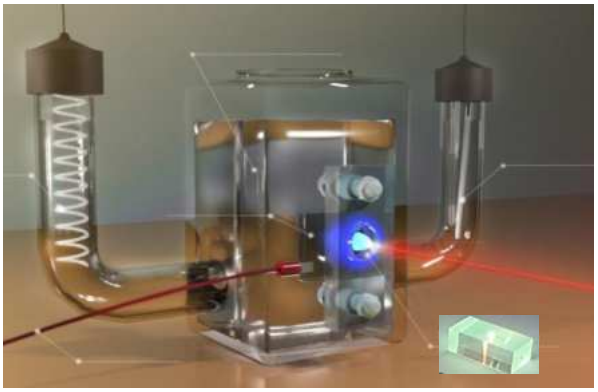

3D schematic infographic of the photoelectrochemical cell setups with the ZBLAN sample emitting a visible bluish light under 980 nm excitation.

Abstract

Optimizing the overall energy we harvest from the Sun is one of the greatest challenges in advancing sustainable energy technologies and developing efficient pathways for large-scale solar-to-chemical conversion. In order to harness a broader range of the solar spectrum, rare-earth–doped luminescent materials can be used. In this work, specifically ZBLAN [1] glasses co-doped with Yb-Er-Tm, which enable near-infrared (NIR) to UV–visible spectral conversion via up-conversion, thereby enhancing photoelectrochemical hydrogen generation [2]. This approach provides infrared-stimulated hydrogen production from water splitting in a photoelectrochemical cell in which TiO_2 is used as a photocatalyst, mediated by RE-doped ZBLAN glass that uses the NIR region of solar radiation [3], which is generally inaccessible to conventional systems for hydrogen production and environmental remediation. Control experiments and power-dependent up-conversion luminescence measurements confirm the role of a unique photonic mechanism, wherein incident NIR photons are up-converted and effectively driving photocatalytic water-splitting reactions.

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SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Leveraging Cross-Sensitivity for Multiparameter Luminescence Sensing with Tunable Sensitivity-Specificity Balance.

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Please indicate preference: Oral
Specify Technical Area: Energy and other Applications

Luminescence sensing of physical stimuli is redefining how we study dynamic environments within increasingly confined spaces.[1] Sensitivity (the precision metric) toward critical physical parameters such as temperature and pressure continues to improve.[2,3] Yet, cross-sensitivity—interfering readout modulation by non-target parameters—remains a long-standing challenge *en route* to high specificity (the accuracy metric). A common approach to mitigate cross-sensitivity is to either ignore its contribution or apply a correction, depending on the degree of cross-dependence on a known interfering parameter. However, the effectiveness of this mitigation approach is often difficult to evaluate due to the lack of standardized cross-sensitivity quantification and frequent reliance on assumptions about sensor behaviour beyond the calibration range.[4]

This work directly addresses this problem by unifying existing figures of merit into a single metric, which we believe offers a more robust quantification of cross-sensitivity. More importantly, we reconceptualize cross-sensitivity as a latent design feature that can be leveraged for *multiparameter* sensing using a single sensor. Employing ruby ($Al_2O_3:Cr^{3+}$) as a model for our study—owing to its well-characterized emission dependence on temperature and pressure—**we develop a machine learning strategy for accurate decoupling of the two-parameter influence and tunable adjustment of the sensitivity-specificity balance**. Notably, this strategy, along with the reformulated metric, may be applied to any luminescent sensor exhibiting cross-sensitivity to any combination of physical (and chemical) stimuli. Together, these advances establish a generalizable framework for transforming cross-sensitivity from a limitation into a powerful asset for multiparameter sensing and application-specific sensor optimization.

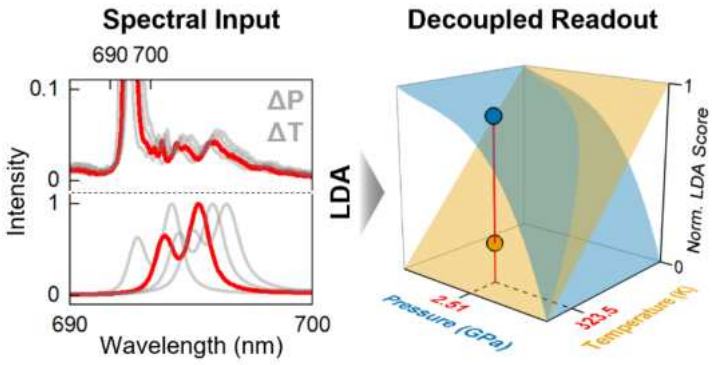

Fig 1. Linear Discriminant Analysis (LDA) is employed to decouple the simultaneous influence of temperature (T) and pressure (P) on the emission of Ruby ($Al_2O_3:Cr^{3+}$).

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SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Synthesis of composites for 3D-printing of tuned luminescent objects using up-conversion rare-earth doped ceramics for anti-counterfeiting applications

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Please indicate preference: __Poster X Oral
Specify Technical Area: __Biomedical X Energy and other Applications

Rare-earth doped materials are gaining attention for their application in luminescent security materials in fighting counterfeiting, offering advantages over standard dyes, such as low background noise and minimal substrate interference [1]. Yb-Er-SAC40 ceramic material exhibit strong visible up-conversion luminescence under 980 nm excitation with potential applications as encrypted luminescent patterns and anti-counterfeiting features [2]. In addition, the interest in composite materials to be used in advanced fabrication technologies (such as 3D-printing) has increased in high-tech sectors due to their potential to enable functional objects with complex shapes, improved performance and tailored properties [3, 4]. Herein, we synthesized 10 wt.% Yb-Er-SAC40/ABS polymer composite by solution casting [4] to be extruded into flexible filaments (Fig 1(a)) for 3D-printing objects by Fused Filament Fabrication (FFF) technology (Fig 1(b)). The characteristic luminescence of the starting material under 980 nm NIR excitation is preserved throughout all stages of the process: composite synthesis, extrusion of filament, and 3D-printing. As shown in Fig. 1(c), the characteristic up-conversion emission bands at 550 and 660 nm of the composite retains the features of the starting material. Therefore, 3D-printing expands its potential by enabling the fabrication of objects with complex geometries and encrypted luminescence.

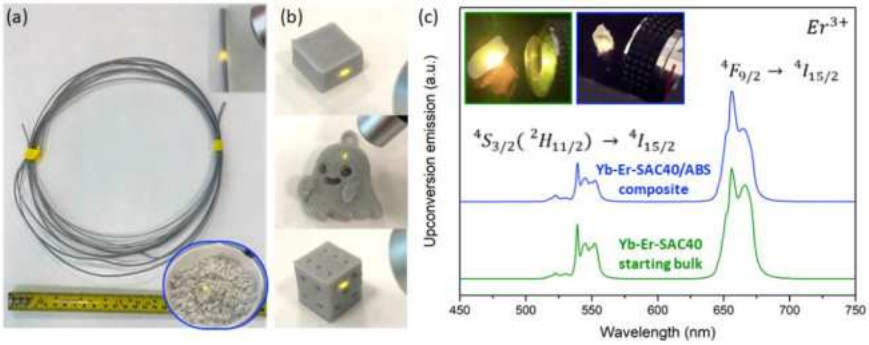

Fig.1. (a) Meters-long extruded Yb-Er-SAC40/ABS filament obtained from the synthesized composite (inset); (b) 3D-printed objects using the extruded filament showing luminescence under NIR 980 nm excitation; (c) Up-conversion emission spectra under 980 nm laser diode excitation of the composite compared to the Yb-Er-SAC40 starting bulk.

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Acknowledgements. Authors acknowledge financial support from Gobierno de Canarias (MAGEC-REEsearch project, ProID2017010078 and “Tierras raras”, Grant number SD - 22/25), and MICIU-AEI by the project 3D4ENERGY (Ref. CNS2023-145011). Z.C.-C. acknowledges support from the MICINN-AEI through the grant PRE2022-104444 (Ref. CEX2020-001039-S-20-4), funded by MCIN/AEI/10.13039/501100011033 and FSE+. E.M.P. acknowledges support by the Ramón y Cajal Program (Ref. RYC2023-042484-I) funded by MICIU/AEI/10.13039/501100011033 and FSE+.

SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Towards chiral acoustoplasmonics

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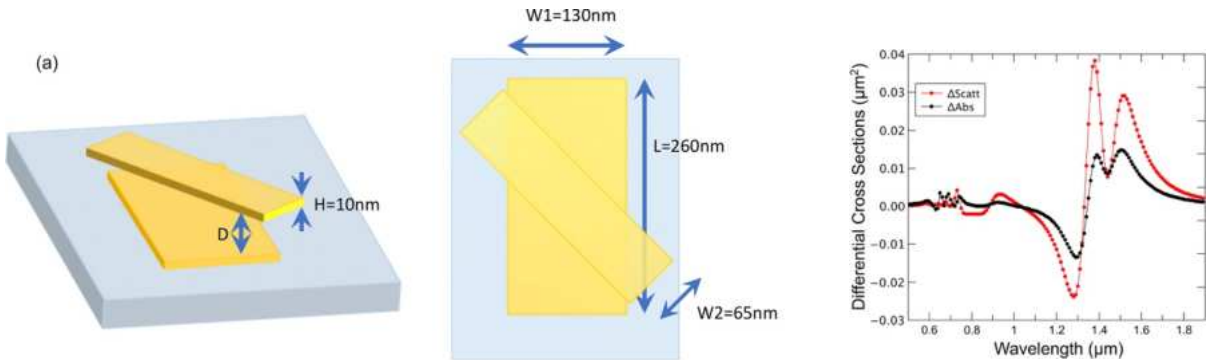
Please indicate preference: Oral
Specify Technical Area: Energy and other Applications

The ability to design and tailor nanostructured materials has opened new avenues for controlling light–matter interactions at the nanoscale. Among the most compelling architectures are those exhibiting optical chirality—structures that respond differently to circularly polarized light. Here, we introduce a nanophotonic platform based on crossed elongated bars that exhibits a strong helicity-dependent response, with over 200% contrast between absorption and scattering for opposite circular polarizations.

The structure's simplicity allows for clear physical interpretation, ease of fabrication, and flexibility for future optimization. We further propose a time-resolved pump-probe experiment exploiting circularly polarized light to demonstrate selective coherent acoustic phonon generation and detection. In this scheme, maximum absorption for one helicity enhances phonon excitation, while tailored scattering for the opposite helicity improves detection—without requiring separate wavelengths. Our findings represent an initial yet promising step toward chirality-based acoustoplasmonic transducers, with offering promising routes for applications in acousto-optic modulation, nanoscale sensing, and next-generation nanophotonic systems.



SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Rare-Earth Doped $Cs_3Bi_2Cl_9$ for Optical Thermometry and Anticounterfeiting

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Please indicate preference: Oral
Specify Technical Area: Other Applications

Introduction: Lead-free, bismuth-based halide perovskites have emerged as promising alternatives to toxic lead halide perovskites for many applications. Inorganic bismuth (Bi)-based halide perovskites have gained considerable attention due to their better stability and tunable band gaps. Recent studies have demonstrated that doping lanthanides into these lead-free perovskites can significantly enhance their luminescent properties, unlocking new potential applications.[1] Er^{3+}/Yb^{3+} co-doped upconversion (UC) materials show a temperature-dependent UC phenomenon where the UC emission intensity of green and red light is enhanced once the temperature increases, which is unlike other luminescent materials where a temperature quenching phenomenon is observed, and it acts as a limitation for higher temperature applications.

In this work, we synthesised Er^{3+}/Yb^{3+} co-doped $Cs_3Bi_2Cl_9$ (CBC) microcrystals (MCs) that exhibit negative thermal quenching, where UC emission intensity increases with temperature. This unique property, combined with decent stability, makes them highly suitable for high-temperature optical thermometry applications. Further, the material is explored for anticounterfeiting applications.

Results: The optimised Er/Yb: CBC MCs exhibited intense UC emission under 980 nm laser excitation. Remarkably, temperature-dependent UC measurements showed an unusual negative thermal quenching effect, with both green and red emission intensities of Er^{3+} increasing with temperature. This enhancement is attributed to efficient energy transfer from Yb^{3+} sensitisers to Er^{3+} activators due to reduced inter-ionic distance, as confirmed by the negative thermal expansion of the lattice. The reduced moisture content in heated samples further contributed to this effect.

Different emission colours under different excitation sources have enabled us to develop anticounterfeiting patterns. These patterns were stable for more than one month in ambient conditions. Also, the brightness of the patterns enhances as the temperature increases, which adds another level of security. Thus, a single compound has been explored for two different applications.[2]

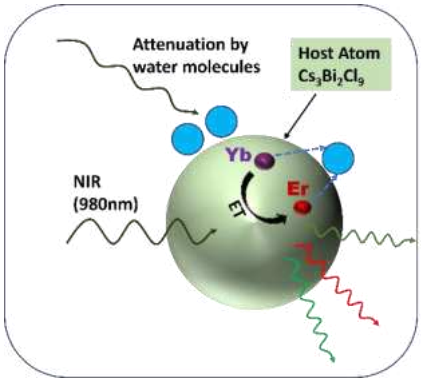

Figure: *Negative thermal quenching effect in Er/Yb: CBC MCs*

Acknowledgement:
Shanas Fatima acknowledges the Department of Physics, IIT(BHU) and the Prime Minister Research Fellowship (PMRF), Ministry of Education, Government of India.

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SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

A Revival of Unusual Transition Metal Ions

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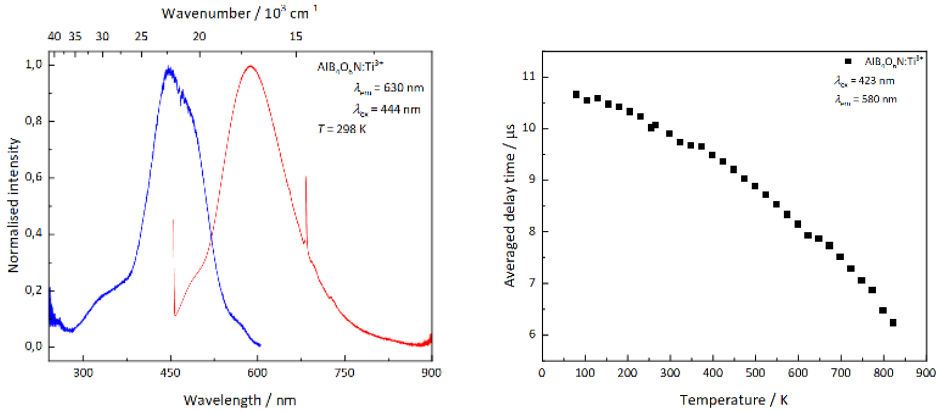
Please indicate preference: Oral
Specify Technical Area: Energy and other Applications

In 1982 Peter F. Moulton firstly demonstrated that Ti^{3+} shows lasing in sapphire (α-Al_2O_3:Ti^{3+}). [1] Since then, this material has become a primary standard for femtosecond-pulsed ultrafast spectroscopy.

We have recently reported on the exceptional luminescence properties of Cr^{3+}-activated AlB_4O_6N and GaB_4O_6N and the similarities to ruby (α-Al_2O_3:Cr^{3+}) and α-Ga_2O_3:Cr^{3+}. It turns out that the combination of structural and electronic features renders the ligand field even somewhat stronger in the oxonitridoborates, which leads to a record-high thermal quenching temperature of over 600 K for AlB_4O_6N:Cr^{3+}. [2]

Motivated by these results, we were interested similarly comparing AlB_4O_6N:Ti^{3+} to the benchmark lasing phosphor sapphire. The luminescence spectrum is characterized by a broad-band emission in the red range, which can be explained by a spin-*allowed*, but parity-*forbidden* $^2E_{(g)} \rightarrow {}^2T_{2(g)}$ transition of a $3d^1$ ion. [3] Like the Cr^{3+}-activated analogue, Ti^{3+} shows a thermally very robust emission over a wide temperature range with decay times in the order of 10 µs in AlB_4O_6N:Ti^{3+}. A detailed ligand field analysis sheds light onto the influence of the metal cation site on the Ti^{3+} emission. Although the ionic radius of Ga^{3+} only marginally differs from that of Al^{3+}, the change in the ligand field strength and performance of GaB_4O_6N:Ti^{3+} compared to the Al-congener is quite drastic, which will be also analyzed within this contribution. It will be demonstrated that an angular overlap modelling approach to ligand field theory can generally help get insights into such delicate questions. [2]



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SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Ketocyanine-based supramolecular switches for near-infrared-to-visible thermochromism

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Please indicate preference: Oral

Specify Technical Area: Energy and other Applications

Abstract:

Thermochromic materials with tunable absorption over the visible and near-infrared (NIR) regions are of relevance for many important applications such as solar light-energy management, sensors, and invisible security inks. For these applications, thermally induced colorless-to-colored transition is of special interest for smart windows application, and colorimetric sensing, as the color formation they produce is much more appreciable than other transitions (e.g. color change). Nevertheless, the current commercial thermochromic materials, based on phase-change materials (PCMs) of spirocompounds (leuco dyes),[1] present spectral modulation from visible to UV spectral regions thus producing colored-to-colorless transitions, which prevents their use beyond novelty products. While reverting the UV to visible absorption modulation (positive thermochromism) results quite challenging in these mixtures, an alternative approach might rely in exploiting the negative thermochromism of mixtures absorbing in the near infrared region (NIR) in the cold state (i.e. colorless), and in the visible once thermally activated. However, readily available leuco dyes manifesting absorption modulation in the NIR are not known, or their design and preparation is highly complex and time consuming.

Herein, we overcome these challenges by replacing, for the first time, spirocompounds with ketocyanine dyes, in PCM-based mixtures. Thanks to their very high chromic sensitivity on the external medium properties (e.g., polarity, pH), ketocyanines manifest quite straightforwardly large spectral absorption shifts, reaching even the NIR region (λ_{max}= 870 nm). These obtained thermochromic materials exhibit tunable and large absorption shifts in the visible, but also in the NIR region, giving access to the desired colorless-to-colored transitions too, via negative thermochromism (Scheme 1).[2] Moreover, the encapsulation of these mixtures yielded thermochromic inks, which also manifested colormiteric response to acidic/basic vapors. Such multistimuli response makes them attractive for anti-counterfeiting, bioimaging, optical storage, and food packaging applications.

Scheme 1. Different ketocyanine-based thermochromic materials in the cold and hot state.

(1) *Chem. Eng. J.* **2021**, *408*, 127276.
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Acknowledgments: This work was supported by grants PID2021-127983OB-C21 funded by MICIU/AEI/10.13039/501100011033 and by ERDF – "A way of making Europe", and with the grant TED2021-131709B-I00 funded by MCIN/AEI/10.13039/501100011033 and by the European Union Next Generation EU/PRTR. The ICN2 is funded by the CERCA program/Generalitat de Catalunya and supported by the Severo Ochoa Centres of Excellence programme, Grant CEX2021-001214-S, funded by MCIU/AEI/10.13039.501100011033.

SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

$NaYF_4:Er^{3+}$, Yb^{3+} UCNP and their highly polarized luminescence as flow sensors

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Please indicate preference: X Oral
Specify Technical Area: X Energy and other Applications

The study and control of micro- and nano- fluidic flows are fundamental due to their wide range of applications in biotechnology and advanced material systems. Upconversion nanoparticles (UCNPs) are particularly well-suited for use in biological environments thanks to their low cytotoxicity and ability to emit visible light under near-infrared (NIR) excitation. Previously they have been used as sensors for temperature and pressure.

In this work, we propose to use of UCNPs as flow sensors. Preliminary results demonstrate that the highly polarized luminescence of optically trapped [1] single $NaYF_4$: Er^{3+}, Yb^{3+} nanoparticles can be used to detect and quantify flow at the micro- and nanoscale. These results are compared with previous approaches, such as flow quantification via photobleaching of fluorescent dyes in the bulk medium [2], or flow accumulation in the compliant membrane of a commercial piezoresistive pressure sensor [3], where light-based methods are employed to validate flow measurements.

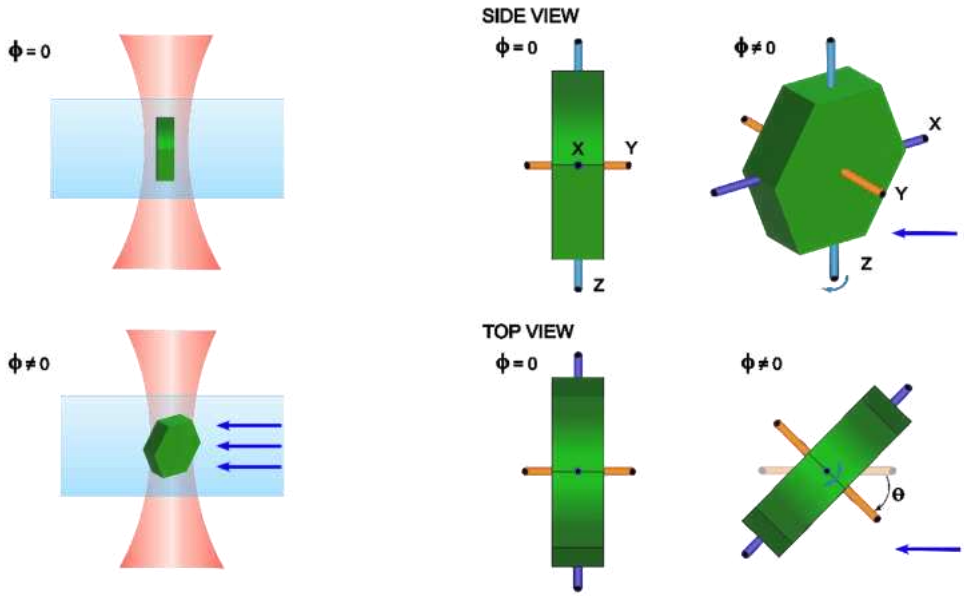

Figure 1: Orientation of the particle inside the trap as the flow goes from ϕ=0 to ϕ≠0.

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SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Optical trapping of upconverting nanoparticles on ferroelectric substrates

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Please indicate preference: Oral
Specify Technical Area: Energy and other Applications

Optical tweezers (OT) are widely used for the manipulation of micro-and nanoparticles, especially in areas such as biomedicine. In this field, upconverting nanoparticles (UCNP) are employed due to their luminescence properties, emitting visible light under infrared excitation —useful for bioimaging among other applications.[1] Their low brightness for a single UCNP and small size, which reduces the effectiveness of the optical trap, make detection and stable manipulation difficult. However, it has been proved that manipulation above plasmonic structures enhances both UCNP's luminescence and trap stiffness.[2]
Recently, it has been reported the use of the so-called photovoltaic platforms for generating electric charge or/and NP patterns [3-4]. These applications rely on the bulk photovoltaic effect exhibited by certain ferroelectrics such as $LiNbO_3$:Fe (LN:Fe). Light patterns induce correlated electric charge distributions in the bulk and surface of the photovoltaic crystal. Moreover, these electric fields are able to massively trap and pattern NPs on the platform.
In this work, we investigate manipulation of UCNPs by optical tweezers in close proximity with a LN:Fe ferroelectric crystal substrate, (see Figure 1a). By measuring the optical trapping force, we analyze the interaction between the OT and the charge distributions induced in the LN:Fe crystal by the trapping laser beam. Results show a relevant difference in the optical trapping force when manipulating the UCNPs on the ferroelectric compared to a glass substrate, (Figure 1b). These preliminary results seem to promise an advantageous interaction OT-ferroelectric substrate that should allow improving/optimizing the trapping strength for nanoparticles. As a further step, we will also explore the case in which the PV substrate has a metallic nanoparticle pattern.

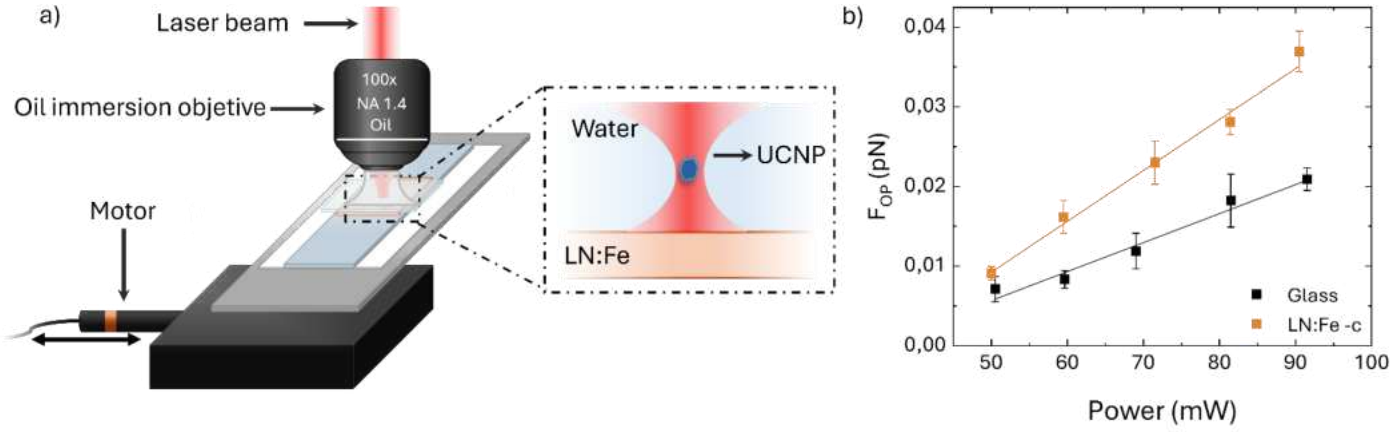

Figure 1: a) schematic of the setup used. b) Optical force versus laser power for glass and LN:Fe as substrate.

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Founding by MCIN/AEI/10.13039/501100011033 and by the European Union NextGenerationEU/PRTR, under the grants PID2020-116192RB-I00, PID2023-151078OB-I00, and CNS2022-135495.

SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Towards Photochromic Smart Windows: Nanodroplet Technology for Scalable and Durable Film Coatings

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Please indicate preference: Oral

Specify Technical Area: Energy and other Applications

Photochromic materials are widely used in applications such as ophthalmic lenses, rewritable devices and fashion. They also offer dynamic light control capabilities that are highly attractive for smart window technologies. Passive regulation of light and light-generated heat (solar heat gain) in response to incident solar irradiation allows photochromic materials to contribute to both visual and thermal comfort[1]. The main competition in the smart windows field, electrochromic systems, require electrical circuitry and control systems that contribute to expensive installation costs. However, photochromics poor long-term stability has reduced the opportunities for their use in architectural applications, which demand highly stable materials with expected lifetimes of up to 20 years[2].

A photochromic technology was developed at Futurechromes in partnership with the ICN2 based on nanostructuration[3]. Although it shows promising performance for most photochromic applications, it's still undergoing optimization to incorporate it into scalable and durable window coating films. To achieve this goal, two major obstacles need to be overcome: 1) increasing the photochromic systems' long-term durability and 2) scaling up the production of both the nanostructures and the photochromic films.

Durability of the photochromic smart windows is treated as the major goal; fatigue resistance is promoted by nanodroplet structuration of the photochromic dyes, which enables the addition of stabilizers that reduce photodegradation. Additionally, UV filters are also incorporated into the film architecture to minimize exposure to highly energetic radiation. Moreover, protective topcoats made of water-resistant materials are used to enhance mechanical resistance, reduce moisture sensitivity, and compatibilize with multifunctional laminations in order to make integration into window systems easier.

Figure 1: Laminated photochromic films of 28 x 28 cm under direct sunlight irradiation.

On the other hand, it is a challenge to scale up the preparation of the photochromic nanostructures and the film-forming methodology that embeds them; continuous microfluidization has replaced batch ultrasonication for scaling up nanostructures with great success. Films preparation from the obtained emulsions can be prepared via blade coating methods on top of various substrates such as glass and PET foil. This lab-scale method is compatible with industrially scalable techniques such as roll-to-roll coating or slot die coating.

According to preliminary tests, optimized formulations of the photochromic films maintain high transmittance in the bleached state (>80%), fast coloration (<1 min) and fading (<5 min), and over 70% of their contrast performance after 1500 hours of continuous irradiation. These findings mark a major advancement in the development of scalable, reasonably priced photochromic coatings for energy-efficient smart windows.

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2 S. Wijewardane, M. Santamouris, *Solar Compass*, **2025**, 14.

3 H. Torres-Pierna, D. Ruiz-Molina, C. Roscini, *Mater. Horiz.*, **2020**, 7.

SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Investigating the structural stability of GNR under pulsed light illumination inside the transmission electron microscope for light driven catalysis

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Please indicate preference: __Poster _x_ Oral
Specify Technical Area: __Biomedical x Energy and other Applications

Dynamic and resonant plasmonic thermal photocatalysis is a new and exciting field that can overcome the classic Sabatier limit in catalysis. The goal is to use short laser pulses to induce fast heating and cooling of plasmonic nanoparticles, such as gold nanoparticles (GNPs), in order to control chemical pathways spatially and temporally. However, GNPs have been shown to be morphologically unstable under laser excitation, even for temperatures below the bulk melting temperature of gold which limits their application in this new field of catalysis [1,2]. This project aims at investigating the structural stability of GNPs under pulsed light excitation. For this study, we use an aberration-corrected transmission electron microscope (TEM) equipped with a light in-coupling unit which allows us to couple a ps laser into the column of the TEM (Figure 1a). The laser wavelength, fluence and repetition rate are tuned while keeping the laser beam (spot size of about 50µm) and electron beam spatially overlapped.

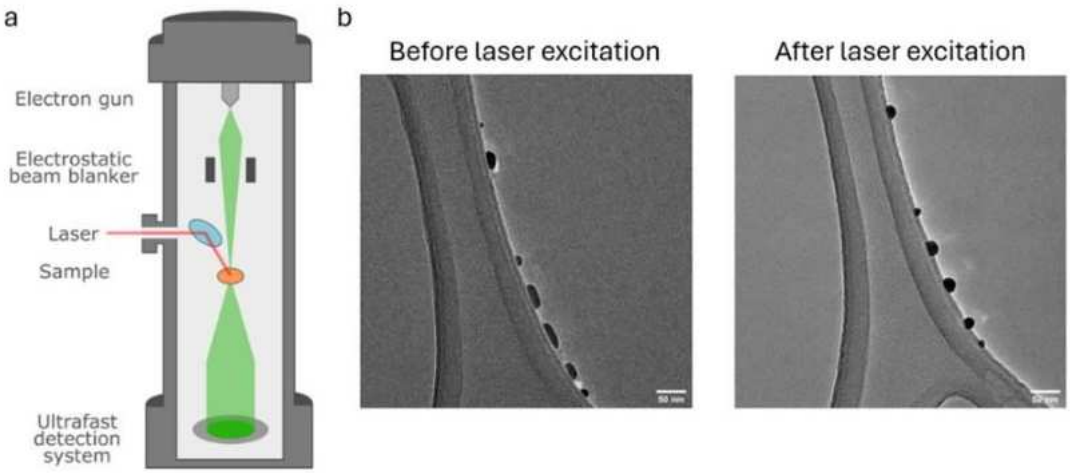

Figure 1. (a) Scheme of the TEM with the fiber coupled laser through the column. (b) demonstration of the structural changes of gold nanorods on a lacey carbon grid before (left) and after (right) laser excitation at resonance. The GNPs were illuminated at a wavelength of 680nm with a fluence of $2.1 \times 10^{-3}\ mJ\ cm^{-2}$.

In this work, we demonstrate that the laser excitation scheme as well as the substrate play a crucial role for the structural stability of GNPs (Figure 1b). Specifically, we find that if the substrate is allowed to cool down between pulses, the GNRs maintain their morphology. Further, we correlate these in situ observations to single particle optical spectroscopy and heat dissipation simulations. Future steps include the use of a TEM holder equipped with a small reactor allowing to mimic the operational conditions of a light driven catalytic reactor.

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SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Plasmon-enhanced colloidal upconverting nanoparticles: brighter luminescence and controllable motion

Fengchan Zhang[1,*], Manuel Romero[2], Thi Tuyen Ngo[2], Khouloud Hamraoui[3], Gabriel Lozano[2], Daniel Jaque[1], Patricia Haro González[1]

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Please indicate preference: Oral
Specify Technical Area: Energy and other Applications

The unique ability of lanthanide-doped upconverting nanoparticles (UCNPs) to convert infrared light into visible light holds considerable potential in various applications. However, their relatively low absorption cross-section and low quantum yield limit their brightness, hindering their practical utility. Previous studies have demonstrated that coupling UCNPs with plasmonic nanostructure can enhance their emission through localized surface plasmon resonance enhancement.[1] Nevertheless, colloidal UCNP in aqueous environments-typical for biological applications-is subject to Brownian motion, resulting in a reduced interaction between UCNP and plasmonic nanostructure, thereby limiting the luminescence enhancement effect.[2]

To address this challenge, we propose to integrate optical tweezers with well-ordered gold nanoantenna arrays (gold nanopyramid with size of 140 nm and spacing of 190 nm). This strategy offers two primary advantages: (1) The excitation intensity is increased in an enhanced localized electromagnetic field (hot spot), leading to stronger upconversion emission. (2) The localized field enhances the optical trapping force that suppresses Brownian motion of the UCNP, leading to further improvement in luminescence intensity. In addition, the position and movement of a single UCNP can be precisely controlled by scanning the laser on the nanoantenna array to change the hot spot dynamically.

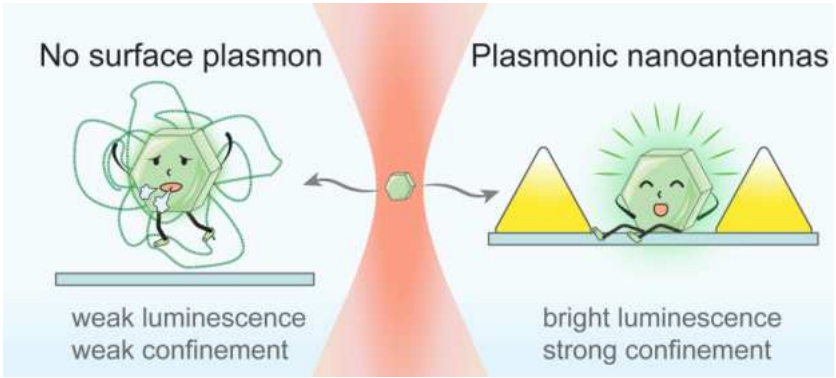

Figure. Schematic illustration of a single colloidal upconverting nanoparticle within an optical trap under different conditions: in absence and presence of plasmonic nanoantennas.

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Acknowledgements

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SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

2D-semiconductor nanoplatelets as laser gain medium in liquid-core-fibers

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Please indicate preference: __ Poster x Oral
Specify Technical Area: __Biomedical x Energy and other Applications

Fused silica fibers are a prominent, flexible, and rugged technology platform for state-of-the-art lasers. At the same time, the growing amount of syntheses routines for colloidal nanoemitters allow to address any desired spectral range. However, the implementation of nanoparticles into fused silica fibers poses a formidable challenge due to high processing temperature of fused silica. In recent years liquid-core fibers (LCFs) have emerged as a versatile photonics platform, e.g., to implement solution-processed nanoparticles or molecules [1]. Particularly, the implementation of colloidal semiconductor nanoplatelets (NPLs) and similar nanostructures such as quantum dots into LCFs is a promising route towards new gain fibers. In recent years, NPLs have emerged as a promising new gain material covering the VIS to IR wavelength range due to their low gain thresholds [2], large absorption cross sections [3], high gain coefficients [4], and tunability of the emission wavelength by size-dependent modification of the bandgap [5]. Here, we present amplified spontaneous emission (ASE) from LCFs filled with a colloidal dispersion of 2D semiconductor NPLs and provide a deeper insight into the gain mechanisms of such particles.

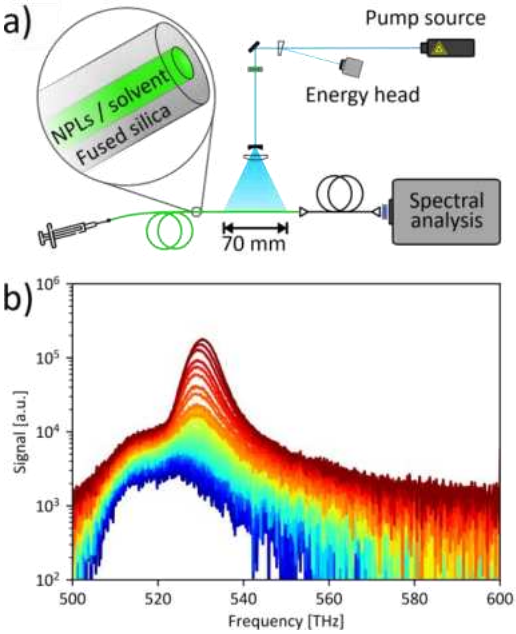

Figure 1 a) Measurement setup. b) Stimulated emission spectra of CdSe/CdS NPLs in a LCF.

We demonstrate optical gain from 4.5 monolayer CdSe/CdS core-crown NPLs in a LCF with a core diameter of 26 µm. The NPLs were excited below the bandgap via transversal pumping with a line focus, see Fig. 1 a). We investigated the spectral contributions of excitons and biexcitons across different emission regimes. The NPLs emit biexcitonic ASE which is red-shifted compared to the spontaneous emission originating from excitons, see Fig 1 b). We discuss two different explanations for the gain-mechanism of this particle class. We analyzed the role of light guiding within the fiber and by using different solvents, which allows us to enable and prevent light guiding within the LCF. This highlights the advantage of the photonic environment provided by the LCF. Further investigations show the importance of an optimized photonic environment by comparing LCFs with different core diameters.

Our work highlights a novel and promising class of hybrid fibers that can contain different types and classes of dispersed nanomaterials.

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Shift'25 TENERIFE

Oral Regular

SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Artificial seeds that fly and sense environmental parameters

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Oral
Biomedical Applications

Monitoring environmental parameters improves the sustainability of farming and land management and aids the management of climate change effects. Current environmental monitoring technology is based on electronics that is comparatively costly, bulky, and ends its life as *e*-waste.[1] We propose new technologies for wireless environmental monitoring based on self-deployable, biocompatible artificial flying seeds inspired from nature. Optical communication enables the use of passive "robots" that communicate with drones.

Artificial "I-Seeds" are inspired from natural *Acer campestre* seeds. They are carried passively by the wind and are dispersed in large distances and areas. I-Seeds were printed via 3D technologies to emulate the morphometric and aerodynamic characteristics of the natural seeds.[2] Their body was composed of fluorescent and/or plasmonic particles embedded into biodegradable polymers such as polylactic acid and cellulose derivatives. These polymers are compatible with fused deposition modelling 3D printing technologies.[3] The resulting I-Seeds are deployed and read-out by drones. They distribute over large areas and fall onto the top of the soil, allowing to sense environmental parameters locally.

We will discuss the optical response of I-Seeds that react to environmental stimuli. Environmental sensing is based on the change of the optical properties of the fluorescent and/or plasmonic particles. These fluorescent particles emit in the red, green and blue (RGB) wavelengths when excited with near infrared (NIR) lasers.[2,4] The plasmonic particles transmit light at the visible or NIR wavelengths. The intensity of the fluorescence or levels of the transmittance, upon proper design of the structure, depend on environmental parameters, such as temperature, humidity, CO_2 gas and Hg vapours.

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SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Development and characterization of motexafin lutetium - loaded hydrogels for NIR-activated photodynamic therapy in breast cancer

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Please indicate preference: Oral
Specify Technical Area: Biomedical

Breast cancer remains a major global health concern, with high incidence and mortality rates among women. Despite therapeutic progress, significant challenges such as treatment resistance, diagnostic invasiveness, and systemic toxicity persist. Photodynamic therapy (PDT) presents a promising alternative, relying on light-activated photosensitizers to induce localized cytotoxic effects with reduced harm to healthy tissue. However, traditional PDT methods are limited by low light penetration and non-specific distribution of agents.

This work proposes a hydrogel-based phototheranostic platform incorporating motexafin lutetium (MLu), a water-soluble, near-infrared activated photosensitizer with high singlet oxygen yield and tumor selectivity. By embedding MLu into poly(vinyl alcohol), poly(ethylene glycol), and copolymer hydrogels, we aim to achieve precise delivery, enhanced imaging, and localized therapy.

This approach includes two experimental evaluations. First, we performed photophysical and spectroscopic characterization of MLu. Solutions were prepared in concentrations ranging from nanomolar to micromolar, and UV-Vis-NIR absorption spectroscopy was used to assess spectral stability before and after irradiation. Laser-induced fluorescence and phosphorescence were recorded in real time using a photomultiplier coupled with an oscilloscope to determine fluorescence and singlet oxygen quantum yields, relative to appropriate standards. FTIR spectroscopy was employed to evaluate structural changes in MLu post-irradiation. Second, hydrogels based on poly(vinyl alcohol), poly(ethylene glycol), and their copolymers (up to 20 wt%) were synthesized with Irgacure 2959 as a photoinitiator (up to 1 wt%). Real-time fluorescence monitoring of the photoinitiator enabled optimization of crosslinking conditions. The resulting hydrogels were characterized using UV-Vis and FTIR spectroscopy for chemical analysis, and contact angle measurements to assess surface hydrophilicity.

These combined results enabled the identification of the most effective MLu-loaded hydrogel formulation for future investigations involving targeted and image-guided photodynamic therapy on breast cancer cells.

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SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Effect of the synthesis route of Er^{3+}-based photon-upconversion nanoparticles on immunoassays for disease biomarkers

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Please indicate preference: __Poster X Oral
Specify Technical Area: X Biomedical __ Energy and other Applications

Nanoparticles (NPs) doped with lanthanide ions show unique spectroscopic properties, making them outstanding materials for various applications in many fields. One of the most promising examples is represented by NPs showing upconversion, a high-energy emission obtained by the excitation of two or more low-energy photons. This, combined with excitation in the ranges known as "biological windows", reduces autofluorescence and damage to biological tissues while facilitating deeper penetration.[1] Therefore, upconversion NPs (UCNPs) are excellent materials for labeling and detecting molecules of biomarkers, which may indicate disease states in the body.[2]

Enzyme immunoassays are widely used to detect biologically relevant analytes in the environment and the human body, including biomarkers, toxins, and microorganisms. However, they also show several limitations, mainly connected to their limited sensitivity and the instability of enzymes. Consequently, a novel approach proposes to replace enzymes with UCNPs, leading to upconversion-linked immunosorbent assay (ULISA).[3,4] ULISA has proven to be an excellent diagnostic approach with ultra-low detection limits.[3]

In this work, we synthesized core/shell Er^{3+}-doped UCNPs, excited by 980 and 1532 nm, based on the reaction of suitable precursors in high-boiling organic solvents.[2] Their surfaces were modified with alkyne-PEG-neridronate ligands and functionalized with streptavidin to obtain structures forming stable aqueous colloids that possess biorecognition properties. Surface-bound chemical groups can prevent the agglomeration of UCNPs and reduce their toxicity.[5] The UCNPs prepared in this way have been used to check the effect of the nanoparticle synthesis route on the detection of cancer biomarkers, human serum albumin (HSA), and SARS-CoV-2 virus.[2,3]

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SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Engineered Ag@Au@Iron Oxide Trimers for Synergistic Magnetic and Photothermal Therapy of Heat-Resistant Glioblastoma

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Please indicate preference: Oral
Specify Technical Area: Biomedicine

Magnetic-plasmonic heterostructures have emerged as powerful tools in nanomedicine, owing to the synergistic integration of magnetic and plasmonic functionalities within a single nanoparticle system. Typically constructed by combining iron oxide-based magnetic nanoparticles (MNPs) with noble metal-based plasmonic nanoparticles (PNPs), such as gold, silver, or copper, these hybrid structures exhibit a wide range of morphological and structural configurations.[1] In cancer therapy, they enable a dual-modality treatment approach: magnetic hyperthermia therapy (MHT) induced by MNPs and photothermal therapy (PTT) triggered by PNPs. This duality enhances therapeutic efficacy, particularly against tumors that are resistant to conventional treatments, such as chemotherapy and radiotherapy.[2] In this work, we have developed silver@gold@iron oxide nanoparticles (Ag@Au@IONPs) as novel trimer heterostructures, in which Ag NPs were selectively grown on the Au domains of pre-synthesized Au@IONP dimers. The resulting trimers demonstrated a high specific absorption rate (SAR) of up to 839 W/gFe and exhibited an efficient thermal response (ΔT = 6.7 °C in 10 min at [Fe] = 1 g L^{-1}) under biosafe alternating magnetic field (AMF) conditions. This performance is attributed to the advanced magnetic characteristics of the synthesized IONPs, which enhance heating efficiency for potential MHT applications. Moreover, improved plasmonic properties from the Ag@Au combination enable a highly effective photothermal heating response (ΔT = 31 °C) under 808 nm laser irradiation at a power density of 0.6 W /cm². We further evaluated the therapeutic potential of these trimers against glioblastoma (U87) cells, which are known for their high thermal resistance and poor response to conventional therapies.[3] Ag@Au@IONPs, with their biocompatible surface coatings, showed negligible cytotoxicity across a wide range of concentrations. However, dual-mode MHT-PTT treatment under moderate AMF and laser conditions resulted in significant cell death even with low concentrations of trimers. We conducted an in-depth analysis of the individual and combined therapeutic effects and the associated cellular responses. These findings highlight the promise of Ag@Au@IONPs as multifunctional nanoplatforms for overcoming therapeutic resistance in aggressive cancers like glioblastoma multiforme.

Acknowledgements
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SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
TENERIFE, CANARY ISLANDS
13-17 TH OCTOBER, 2025

Random laser emission of fluorescent molecules for biomedical applications

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Please indicate preference: Oral
Specify Technical Area: Biomedical

Random lasers (RLs) arise from the interaction between an optical gain medium and a disordered scattering environment. Unlike conventional lasers, where optical feedback is provided by mirrors, RLs rely on multiple scattering events to achieve stimulated emission and lasing action, eliminating the need for external resonators. Due to this dependence on scattering, the RL emission is highly sensitive to the optical properties of the gain medium itself.

In this work, we present our studies on RL emission from biological tissues/cells impregnated with various dye molecules. Specifically, we investigate RL emission from tissues treated with commercial rhodamine dyes. Our analysis includes RL signals obtained from mouse brain slices infused with dye solutions. Indeed, we examine a transgenic mouse model of Huntington's disease (HD), a neurodegenerative disorder characterized by progressive motor and psychiatric symptoms. Brain slices from HD transgenic mice were impregnated with a dye solution, and the RL emission data were explored using multivariate statistical methods, including principal component analysis and linear discriminant analysis. This statistical analysis successfully classified RL spectra from healthy and transgenic mice, and it was also applied to study the effect of an experimental drug on HD transgenic mice. Finally, we extend our research to human blood samples, assessing the potential of RL as a diagnostic tool. A case study is presented in which spectral analysis enabled differentiation between blood samples from patients with Chronic Lymphocytic Leukemia and healthy controls [1].

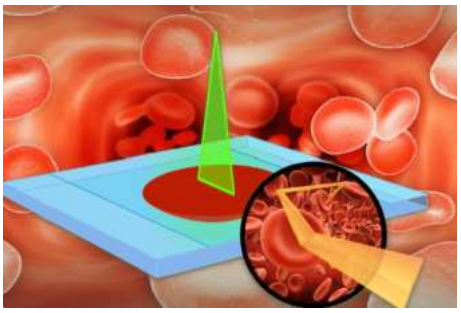

Figure 1. Scheme of RL analysis of a human blood sample.

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SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Exploring the Er,Yb-doped upconversion system for BW-I thermometry: does the detection system matter?

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Please indicate preference: __Poster ✕ Oral
Specify Technical Area: ✕Biomedical __ Energy and other Applications

The field of luminescence (nano)thermometry has developed enormously in the past two decades. This technique allows precise and non-invasive temperature sensing, essential features for real-time biological monitoring considering that inflammatory conditions and tumors cause local temperature increase[1,2] In this context, Er^{3+},Yb^{3+}-doped upconversion nanoparticles (UCNPs) have been deeply investigated for ratiometric thermometry. These UCNPs can be excited with near-infrared (NIR) lasers (*e.g.* 980 nm), and the Er^{3+} emissions $^2H_{11/2}\rightarrow{}^4I_{15/2}$ (~520 nm) and $^4S_{3/2}\rightarrow{}^4I_{15/2}$ (~550 nm) arise from the thermally coupled $^2H_{11/2}$ and $^4S_{3/2}$ levels, allowing temperature monitoring in physiological conditions. However, these Er^{3+} emissions are located in the visible range of the electromagnetic spectrum, which is highly absorbed by biological tissues. Therefore, it is important to design materials that fully operate in the biological windows (BWs), being them BW-I (700–950 nm), BW-II (1000–1350 nm), and BW-III (1550–1870 nm).

In this work, we explored the NIR Er^{3+} emissions $^2H_{11/2}\rightarrow{}^4I_{13/2}$ (~780 nm) and $^4S_{3/2}\rightarrow{}^4I_{13/2}$ (~840 nm) (Fig. 1a), located in the BW-I. For this, $NaGdF_4$:Yb18%,Er2% UCNPs of different sizes and morphologies were synthesized, as well as bulk powders, to be investigated as model materials. As these NIR Er^{3+} emissions fall in a range of low sensitivity for standard visible-range PMTs, different detectors were employed in studying the luminescent and thermometric properties of these materials (Fig. 1b–d). Distinct spectral profiles were obtained from a single sample, due to the detectors' different response for the BW-I wavelength range. The effects of such different responses were deeply investigated in terms of fitted ΔE values, relative sensitivity (S_r), and temperature uncertainty (δT). These results highlight the importance of deeply understanding how experimental conditions may alter thermometry results, and could assist researchers in properly selecting detectors for nanothermometers which operate in the BW-I spectral region.

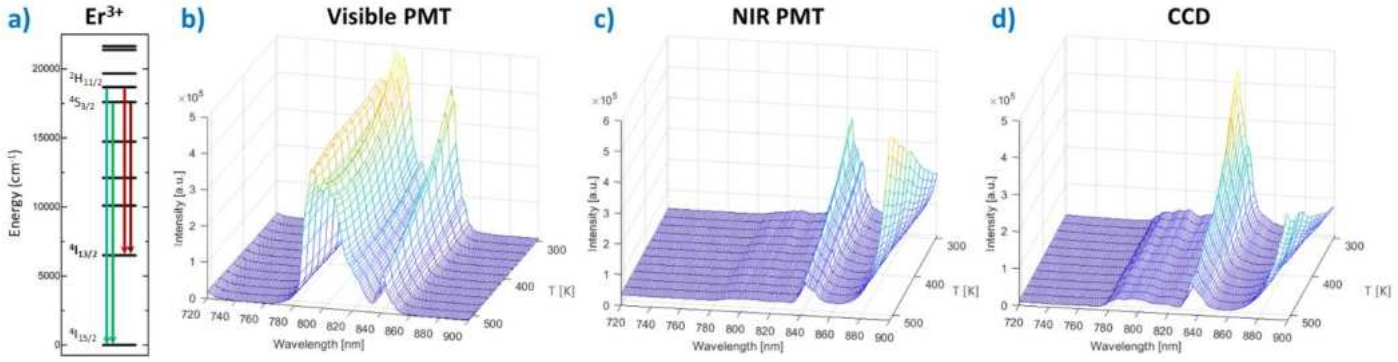

Figure 1. **(a)** Energy level structure of Er^{3+} ion, highlighting its green and NIR emissions. Photoluminescence NIR emission maps with increasing temperature of $NaGdF_4$:Yb18%,Er2% materials recorded using **(b)** visible-range photomultiplier tube (PMT) detector, **(c)** NIR-range PMT detector, and **(d)** charge-coupled device (CCD) detector.

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SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Detection of specific analytes using upconverting nanoparticles coated by molecularly imprinted polymers as biomimetic receptors

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Please indicate preference: __Poster x Oral

Specify Technical Area: x Biomedical __ Energy and other Applications

Diagnostic markers are measurable biological molecules used to detect, monitor, or predict disease states. Found in blood, urine, or tissues, they support clinical decision-making across various conditions. Examples include CRP (inflammation), troponins (myocardial infarction), PSA (prostate cancer), and CA-125 (ovarian cancer).[1] Their detection often relies on molecular sensing techniques, e.g., enzyme-linked immunosorbent assay, polymerase chain reaction, immunohistochemistry, and radioimmunoassay.[2] However, these methods are expensive, time-consuming, and require laboratories with expensive equipment.

An exciting alternative for biorecognition elements like antibodies, enzymes, peptides, DNA, or RNA are chemically synthesized molecularly imprinted polymers (MIPs), so-called "biomimetic receptors" or "artificial antibodies."[3] MIPs are obtained during the polymerization process with functional monomers, cross-linkers, and polymerization initiators in the presence of a template removed after synthesis. Such an approach creates specific binding sites of the template within the matrix, acting on a "lock and key" principle.[4] To improve the binding affinity and selectivity of MIPs, they are often combined with other materials, like semiconductor quantum dots, carbon dots, noble metals, upconverting nanoparticles (UCNPs), and more.[5] Among the mentioned materials, UCNPs are highly promising for optical sensing. The UCNPs doped with Ln^{3+} ions possess the unique ability to convert multiple low-energy photons into higher-energy ones. As a result, they emit light in the ultraviolet and visible ranges when exposed to near-infrared radiation.[6] UCNPs are incredibly convenient for biolabeling applications due to large anti-Stokes shift, narrow emission and excitation bands, negligible photobleaching and background autofluorescence, high signal-to-noise ratio, deep tissue penetration of near-infrared radiation, and low toxicity.[7]

However, before implementing UCNPs@MIPs for marker detection, preliminary studies with simple analytes are necessary to assess their suitability. In this study, we tested several synthesis procedures and different monomers to obtain optimal UCNPs@MIPs materials. We also investigated their morphology and optical properties (emission increase/decrease) in the presence of analytes such as Rhodamine B, Crystal Violet, Cytochrome C, and lysozyme.

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SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Toward accurate photoluminescence nanothermometry using rare-earth doped nanoparticles

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Please indicate preference: Oral
Specify Technical Area: Biomedical

Owing to the noninvasive temperature sensing with high spatial resolution, luminescence nanothermometry has showcased its advantages and has been successfully applied in biomedical sciences. Rare-earth doped nanoparticles (RENPs) have substantially aided this field due to their unique optical properties, which can be excited by low-energy photons to emit higher-energy (upconversion, UC) or lower-energy (downshifting, DS) photons. With the widespread development of RENPs—from structural optimization to manipulation of optical performance, both UC and DS emissions of RENPs have demonstrated their leading roles as temperature probes in biomedicine. Yet, challenges remain, e.g., low emission intensity and efficiency of small nanoparticles, which induces a low signal-to-noise ratio in detection. Moreover, the luminescence properties of RENPs are affected by various factors such as excitation power density and surrounding media, potentially compromising the reliability of the measured temperature and limiting further applications. To paint a realistic outlook on the potential and pitfalls of RENP nanothermometry: developing RENPs with high luminescence intensity and studying the influence factors on the optical performance of RENPs are indispensable.

Here we present Er^{3+} doped $LiLuF_4$ RENPs, taking advantage of both visible and NIR emissions by UC and DS luminescence processes under the same excitation source. The luminescence intensity is enhanced by core-shell architecture and co-dopant Ce^{3+} ions. By evaluating how UC and DS emissions are affected in the physiological range (i.e., 20−45 °C) by H_2O, the reliability of RENP nanothermometry is examined to raise awareness about the importance of the surrounding media on the accuracy of nanothermometry.

SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Single nanoparticle temperature mapping

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Please indicate preference: Oral

Specify Technical Area: Biomedical

Temperature is a fundamental physical parameter reflecting the average kinetic energy of a system, with critical importance in the study of biological environments. Non-contact luminescence-based techniques are widely used for such measurements[1,2]. In this work, we employ single-particle microscopy to achieve submicron-resolved temperature mapping using $NaYF_4$:Er^{3+},Yb^{3+} upconversion nanoparticles (UCNPs)[3], whose temperature-dependent luminescence enables local thermometry through a ratiometric analysis of two thermally coupled emission bands. This approach provides high robustness to fluctuations in excitation intensity and environmental conditions, surpassing methods that rely solely on luminescence intensity, polarization, or lifetime.

To enhance the temperature sensitivity of UCNP-based nanothermometers, especially within the physiologically relevant range, we introduce a surfactant modification strategy. This treatment significantly amplifies the ratiometric response by altering the nanoparticles local environment, leading to improved thermal resolution in biologically relevant conditions.

A key challenge we also address is verifying whether the bright luminescent spots observed in the microscope correspond to single nanoparticles. Unlike quantum dots or dye molecules, UCNPs exhibit highly stable, non-blinking emission due to luminescence from thousands of rare-earth ions with long excited-state lifetimes. This stability, while advantageous for photostability, complicates the distinction between single particles and small aggregates. In this study, we develop and apply experimental strategies to discriminate single UCNPs from clusters, enabling accurate single-particle thermometry.

Acknowledgements:

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SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Two-photon excited luminescence of advanced colloidal nanomaterials for heavy metal ions detection

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Please indicate preference: __Poster ✓ Oral
Specify Technical Area: ✓ Biomedical __Energy and other Applications

For many years, numerous research groups have been actively seeking improved third-order nonlinear optical materials for various applications in laser technology, telecommunications, and biophotonics [1]. In this context, we quantitatively demonstrate the nonlinear optical response of emerging colloidal quantum dots across an extended spectral wavelength range [2,3]. We have been exploring several pathways towards more versatile systems where one could optimize both the nonlinear optical effect of interest and other functionalities of the system such as two-photon induced bright luminescence or other advanced biological function. One direction that proved particularly promising is that of nanoparticles of various kinds that can be engineered for specific functions, employing nanotechnological approaches, especially bottom-up wet chemistry techniques for synthesizing colloidal nanoparticles and efficient ligand exchange. Our findings highlight the potential of these nanomaterials for use as two-photon excited luminescence-based optical sensors for detecting metal ions, including heavy metals [4].

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SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Optical and lasing properties of the novel antiestrogen derivative endoxifen-NBD (FLTX3) and its potential for the diagnosis of breast cancer resistance

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Please indicate preference: _X_Poster __ Oral
Specify Technical Area: _X_Biomedical __ Energy and other Applications

Endoxifen is the most powerful metabolite of tamoxifen (Tx). Tamoxifen is the most common endocrine therapy administered worldwide to women with estrogen-receptor positive (ER+) metastatic breast cancer or as adjuvant therapy for early stages of the disease. Tamoxifen itself is a prodrug with weak affinity for ER, but it is converted into its active metabolite, endoxifen, in the liver by the action of cytochrome P450 2D6, with up to 100-fold higher affinity for ER than Tx.

In this study we have designed and synthetized the first fluorescent endoxifen derivative (FLTX3), by the covalent attachment of the small fluorophore NBD (7-nitrobenzo[c][1,2,5]oxadiazol-4-yl) to the basic amine group in the side chain of endoxifen. We have characterized the basic optical properties of FLTX3 and demonstrated its ability to behave as a laser dye. FLTX3 is an efficient probe for the cellular labelling of ER in MCF7 breast cancer as well as in uterine tissues expressing ER. Further, we show that under nanosecond pulsed laser irradiation at the optimal excitation wavelength of NDB, FLTX3 develops amplified spontaneous emission (ASE), showing the optical gain behavior of the conjugate. We also demonstrate that cellular incubation with FLTX3 can lead to random laser (RL). Accordingly, the light emitted by the drug is scattered in the cell cultures and tissue under similar excitation conditions as the ones leading to ASE, the light emitted by the drug is scattered within the medium and gives raise to both coherent and incoherent RL. Indeed, analyses of coherent spectra by power function Fourier transform revealed a random laser dominant cavity in the range of average cell sizes.

One of the main causes for tamoxifen treatment failure is tamoxifen resistance. One of the mechanisms explaining such resistance in ER+ breast cancer cells is the deficient or null expression of hepatic cytochrome P450 2D6, which lowers the systemic levels of endoxifen, and therefore tamoxifen effectiveness. We explored the potential discriminative value of FLTX3-induced RL between tamoxifen-resistant and tamoxifen-sensitive MCF7 cells. Using multivariate approaches based on principal component analyses and linear discriminant function analyses of the emitted spectra, we detected statistically significant differences between the RL signal from tamoxifen-sensitive and tamoxifen-resistant cells. These findings suggest that RL might provide a diagnostic tool for the prediction of tamoxifen sensitivity in metastatic ER+ breast cancer even before tamoxifen chemotherapy is chosen as therapeutic strategy.

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SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Hybridization transfer assay based on UCNPs detects ultralow concentrations of DNA

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Please indicate preference: __Poster _x_ Oral
Specify Technical Area: _x_Biomedical __ Energy and other Applications

Due to their anti-Stokes emission, UCNPs are detectable without optical background interference, which is very important for biomedical applications [1]. UCNP labels allowed us to achieve low limits of detection in immunoassays, e.g. for the detection of the nucleocapsid protein of SARS-CoV-2, as well as in branched hybridization assays for the detection of DNA that do not require nucleic acid amplification steps such as PCR. UCNP labels even enable the design of single-molecule (digital) immunoassays in a relatively simple way by counting the individual labeled immunocomplexes.

With the optical background switched off, the performance of our biomedical assays is now limited by non-specific binding of UCNP labels, which cannot be completely avoided. In our contribution, I will showcase how this limitation can be addressed: We recently used UCNP labels to develop a hybridization complex transfer assay that enables the direct detection of short DNA sequences without nucleic acid amplification [2]. Target-labeled DNA complexes were captured on magnetic beads (first solid phase). The addition of releasing oligonucleotides specifically eluted the target-UCNP complexes, whereas the non-specifically adsorbed labels remained on the magnetic beads. After magnetic separation of the beads including non-specifically absorbed labels, only the target-UCNP complexes were recaptured on a microtiter plate (second solid phase), which enabled their background-free, ultrasensitive detection (limit of detection: 46 aM).

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SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

From Synthesis to Application: Biocompatible Gd_3TaO_7 Nanoprobes for Multimodal Biomedical Imaging

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Please indicate preference: __Poster _x_ Oral
Specify Technical Area: x__Biomedical __ Energy and other Applications

Nanoparticles doped with rare earth (RE) ions have great potential for biomedical applications, as optical markers imaging and diagnostics, as well as multifunctional probes for Theranostics [1,2]. Besides the fact that they exhibit emissions in the region of biological transparency windows in the near infrared (NIR), among other great advantages, these RE^{3+}-based materials can also be prepared on a nanometric scale and are highly biocompatible [3]. However, the optical imaging technique, as promising as it is, still has limitations and the combination of two or more imaging techniques (multimodal imaging) becomes very interesting. Multimodal imaging is an emerging field and, nowadays, the goal is to obtain good contrasting capacities in different techniques in one single probe [4]. For this, RE tantalates are suitable candidates and can be explored for this application. The obtention of these materials in a nanoscale form with controlled morphology is still a challenge. In this sense, to design RE_3TaO_7 with size and shape control, the use of the polyol method has been proved effective. Spherical RE^{3+}-doped Gd_3TaO_7 nanoparticles were synthesized by refluxing the precursors in ethylene glycol (EG), followed by annealing at 1000 °C. Transmission electron microscopy (TEM) exhibited particles with approximately 170 nm of diameter for the annealed samples. Even for high annealing temperature, the spherical form was retained, and no formation of agglomerates was observed. Phase purity and stabilization were observed by X-ray diffraction (XRD) analysis, affording the cubic Gd_3TaO_7 crystalline phase. Raman spectroscopy was used to confirm the formation of the cubic phase, as well as luminescent spectroscopy using Eu^{3+} as a structural probe. Upconversion luminescence with intense red and NIR emission bands were observed for the samples Er^{3+}/Yb^{3+} and Tm^{3+}/Yb^{3+} co-doped Gd_3TaO_7, respectively, under 980 nm excitation. An investigation of the signal detection of the samples doped with Tm^{3+} was conducted using a Time-Gated Luminescence (TGL) system, under 808 nm excitation. Their application as contrast agents in other imaging modalities, such as magnetic resonance (MR) and computed tomography (CT) was also explored. These results show that these materials emerge as promising candidates for future development of multimodal imaging probes, combining optical, MR, and CT functionalities.

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SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Nanotechnology-Enabled Contrast Agents for Rapid Detection of Myocardial Infarction

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Please indicate preference: __Poster __ Oral X
Specify Technical Area: _X_Biomedical __ Energy and other Applications

Cardiovascular diseases are the leading cause of mortality worldwide, and acute myocardial infarction is the most adverse cardiovascular event. Fast and precise localization of ischemic tissues after a heart attack ("time is muscle") could therefore enable a more accurate and efficient treatment and alternatives to classical imaging techniques (e.g. time-consuming procedures like MRI or low spatial resolution in ultrasound) are investigated. Developments in nanotechnology and infrared detectors have enabled approaches based on the use of near-infrared (NIR)-emitting luminescent nanoparticles that provide fast optical imaging in the near-infrared transparency windows, regions in the electromagnetic spectrum where tissues become partially transparent (NIR-I: 680 – 950 nm, NIR-IIa: 1000 – 1350 nm). Furthermore, it has become possible to target these nanoparticle contrast agents directly to the infarcted myocardial tissue in vivo, improving contrast and allowing the identification of damaged areas.[1-3]
Here we present our results in this area, including the use of Ag_2S nanodots and rare-earth-based nanoparticles as contrast agents and the role that different surface functionalization strategies play in achieving the targeting of the myocardium in ex vivo and in vivo models. Finally, the use of a pre-targeting strategy employing biorthogonal click-chemistry is presented, demonstrating a way to further improve targeting and convert near-infrared-based imaging into a molecular imaging technique.[3]

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SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
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Applying Luminescent Nanoparticles in Biological Research of Nano- and Microplastics

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Please indicate preference: __Poster _X_ Oral
Specify Technical Area: _X_Biomedical __ Energy and other Applications

Nano- and microplastics are among the most intensively studied environmental hazards today. Recent scientific findings have revealed a world contaminated at multiple levels by residues from plastic degradation. These particles have been detected in environments ranging from the oceans' depths to Antarctica's glaciers. However, the field of monitoring nano- and microplastic transmission is still developing and requires more research. Many established analytical techniques fail to accurately determine how these particles form and migrate within the natural environment.

One promising method for visualizing nano- and microplastics in plants and invertebrates is the use of labeled particles with luminescent dyes. Detecting their luminescent signals makes it possible to confirm the presence of nano- and microplastics in biological systems under investigation. Unfortunately, autofluorescence from biological materials often interferes with accurately detecting such labeled particles, especially when tagged with organic dyes. This limitation arises because the excitation wavelengths required for organic dyes are frequently absorbed by compounds naturally present in biological samples.

A highly effective solution to this challenge is the application of luminescent nanoparticles, such as upconversion nanoparticles (UCNPs), e.g., $NaYF_4:Yb^{3+}/Er^{3+}@NaYF_4$ type. These particles can be excited in the near-infrared region (975 nm), where biological materials exhibit lower absorption than in the UV-VIS range. This enables the visualization of nano- and microplastics containing UCNPs in biological samples without interference from autofluorescence.

Another promising approach for tracking the uptake of nano- and microplastics by terrestrial plants or aquatic organisms, such as Daphnia magna, involves using polymers containing nanoparticles showing persistent luminescence. These materials emit light for several seconds after the cessation of excitation, allowing the use of fluorescence microscopy to detect whether the studied organism has absorbed plastic particles without activating autofluorescence. Nanoparticles like $ZnAl_2O_4:Cr^{3+}$ (ZGO) are particularly well-suited for this purpose due to their emission within the first biological window, which is crucial for studying biological materials.

In this study, UCNPs- and ZGO-labeled polystyrene (PS) and polyethylene terephthalate (PET) nano- and microplastics were employed to visualize their uptake by selected plants (wheat, *Triticum aestivum*) and simple aquatic organisms, including the cladoceran *Daphnia magna* and *Daphnia longispina*. The materials were characterized in terms of their structural, morphological, and spectroscopic properties. Imaging was conducted using a modified Nikon ECLIPSE Ti2 Inverted Microscope and an Upcon® plate reader. The findings demonstrate the feasibility of visualizing luminescently labeled nano- and microplastics, thereby broadening the scope of laboratory research on this globally significant issue.

SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Optical Nonlinearities in Excess of 500 through Sublattice Reconstruction

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Please indicate preference: Oral
Specify Technical Area: Biomedical applications/Photon avalanche nanomaterials

The ability of materials to respond to stimuli with significant optical nonlinearity is crucial for technological advancement and innovation. While photon avalanche upconversion nanomaterials with nonlinearities exceeding 60 have been developed, further enhancement remains challenging. Here, we present a method to increase photon avalanche nonlinearity beyond 500 by reconstructing the sublattice and extending the avalanche network. We demonstrate that lutetium substitution in the host material induces significant local crystal field distortions. These distortions strengthen cross-relaxation, the key process governing population accumulation. As a result, the optical nonlinearity is significantly amplified, enabling sub-diffraction imaging through single-beam scanning microscopy, achieving lateral and axial resolutions of 33 nm (~1/32 of λ) and 80 nm (~1/13 of λ), respectively. Moreover, our research reveals regional differentiation within photon avalanche nanocrystals, where photon avalanche performance varies across different regions at the single-nanoparticle level. This effect, coupled with extreme optical nonlinearity, enables visualization of nanoemitters at resolutions beyond their physical size using simple instrumentation. These advancements open new possibilities for super-resolution imaging, ultra-sensitive sensing, on-chip optical switching, and infrared quantum counting.

Comparison of our work with previously reported achievements in photon avalanching technology.

PA emitter	Host and dopant	D (nm)	λ_{ex} (nm)	λ_{em} (nm)	I_{th} (kW cm^{-2})	T_{rise} (ms)	Nonlinear-ity	Resolution (nm)	SNR/Pixel dwell time (ms)	Reference
Nd	KPb_2Cl_5:Nd (16%)	40	1,064	810	10	70	11.9	-	-	Angew. Chem. Int. Ed. 62, e202212549 (2023)
Pr/Yb	$NaYF_4$:Yb/Pr (15/0.5%)@$NaYF_4$	26	852	450-700	60	19.2	46	62	9.5/0.1	Nat. Nanotechnol. 17, 524–530 (2022)
Pr/Yb	$NaYF_4$:Yb/Pr(15/0.5%) @$NaYF_4$	26	852	450-700	70	-	26	58	-/0.2	Sci. Bull. 69, 458-465 (2024)
Tm	$NaYF_4$:Tm(8%) @$NaY_{0.8}Gd_{0.2}F_4$	28	1,064	800	6	608	26	65	3.9/-	Nature 589, 230–235 (2021)
Tm	$KMgF_3$:Tm (5%)@$KMgF_3$	30	1,064	802	16.6	281	27	-	-	Nano Lett. 23, 8576–8584 (2023)
Tm/Eu	$NaGdF_4$:Tm(20%)@ $NaGdF_4$@ $NaGdF_4$:Eu(15%)@$NaYF_4$	24	1,064	615	30	87	14.6	-	-	Nano Lett. 23, 7100–7106 (2023)
Tm/Er	$NaYF_4$:Tm(8%)@$NaYF_4$:Er (5%)@$NaYF_4$:Er/Ce(5/5%)	46	1,064	540	7.1	1100	41	-	-	Adv. Mater. 36, 2307848 (2024)
Tm/Yb	$NaYF_4$:Tm(8%)@$NaYF_4$:Yb/ Tm (10/1%)@$NaYF_4$	43.6	1,064	452	75.0	-	60	-	-	Laser Photonics Rev. 18, 2400290 (2024)
Pr/Tm	$NaYF_4$:Yb/Pr(25/0.5%)@ $NaYF_4$:Yb/Tm(10/4%) @$NaYF_4$:Yb/Pr(25/0.5%) @$NaYF_4$	41	852	452	320	-	63.3	48	-/0.1	Adv. Photonics, 6, 056010 (2024)
Tm	$NaLuF_4$:Tm(15%)	27	1,064	805	605	8.5	156	33	20.2/10	**This work**
Tm	$NaLuF_4$:Tm(15%)	176	1,064	805	102	226.0	507	89	1,036/1	**This work**

SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
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Ag_2S nanocrystals as next-generation, heavy-metal free short-wave infrared emitters for biomedical imaging and sensing applications

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Please indicate preference: __Poster X Oral
Specify Technical Area: X Biomedical __ Energy and other Applications

There is a growing interest in the exploitation of the short-wave infrared (SWIR), which refers to the wavelength band of light between 900 nm and 2500 nm. Luminophores that emit in the SWIR are used in various areas of telecommunications, photovoltaics, security systems (night vision), and in biomedicine. In particular for biomedical applications, the SWIR range is highly promising because light scattering, absorption, and autofluorescence of tissue and biological compounds are strongly reduced compared to the visible (400–700 nm) and NIR (~700–900 nm). The benefits of SWIR-emissive QDs have been demonstrated for a variety of applications, such as in thermal sensing, as photoelectrochemical biosensor, in in vivo vascular imaging, and for fluorescence-guided surgery.[1]
Full exploitation of SWIR photoluminescence (PL) imaging and sensing is currently hampered by i.) a lack of suitable advanced nanomaterials with a high PL quantum yield (PL QY) and a high brightness, that can be used safely in vivo and ii.) a lack of quantitative and reliable data on the optical properties of many SWIR emitters. Promising nanomaterials for the SWIR are heavy metal-free Ag_2S quantum dots (QDs).
Aiming for the development of SWIR advanced nanomaterials with optimum performance, we have dived deeper into the photophysical processes occurring in these nanomaterials, thereby exploring in depth how the environment such as temperature, surface ligand composition, and the incorporation of transition metals influence the optical properties Ag_2S QDs. We observed a strong enhancement of the SWIR emission of upon addition of metal ions such as Zn^{2+}, yielding PL quantum yields of about 10% and thus making them highly suitable for non-invasive deep imaging of vascular networks and 3D fluid flow mapping.[2]

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SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Multiparametric thermal sensing: how far can we go in luminescence thermometry?

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Please indicate preference: __Poster _X_ Oral

Specify Technical Area: _X_Biomedical __ Energy and other Applications

Multiparametric thermal sensing has emerged as a promising trend in luminescence thermometry, enabling the combination of multiple temperature-dependent optical features (thermometric parameters, Δ) from a single luminescent material. This strategy is driven by the need to improve thermal sensitivity (specifically, the relative thermal sensitivity S_r), which is crucial for accurate temperature prediction in fields such as biomedicine,[1] where small temperature variations can disrupt biological functions. However, a key challenge often overlooked is overparametrization: using too many correlated Δ values can artificially inflate S_r and compromise the reliability of the predictions.

To tackle this issue, we propose a rational selection strategy based on principal component analysis (PCA), using strontium aluminate doped with europium and chromium ($SrAl_{12}O_{19}$:Eu,Cr) as a case study. This material displays characteristic emission bands from Eu^{2+} (4f-4f and 5d-4f transitions), Eu^{3+}, and Cr^{3+}, giving rise to six distinct Δ values. PCA reveals strong correlations among Δ_{1-6}, showing that not all should be used simultaneously for multiparametric sensing. By examining the correlation matrix, we identify the least correlated parameters suitable for multiple regression, achieving a maximum S_r value (S_m) of 24.1 % K^{-1} and a minimum temperature uncertainty of 0.01 K without misleading temperature predictions.

This approach offers practical guidelines for improving multiparametric thermal sensing by ensuring more accurate and robust data interpretation.

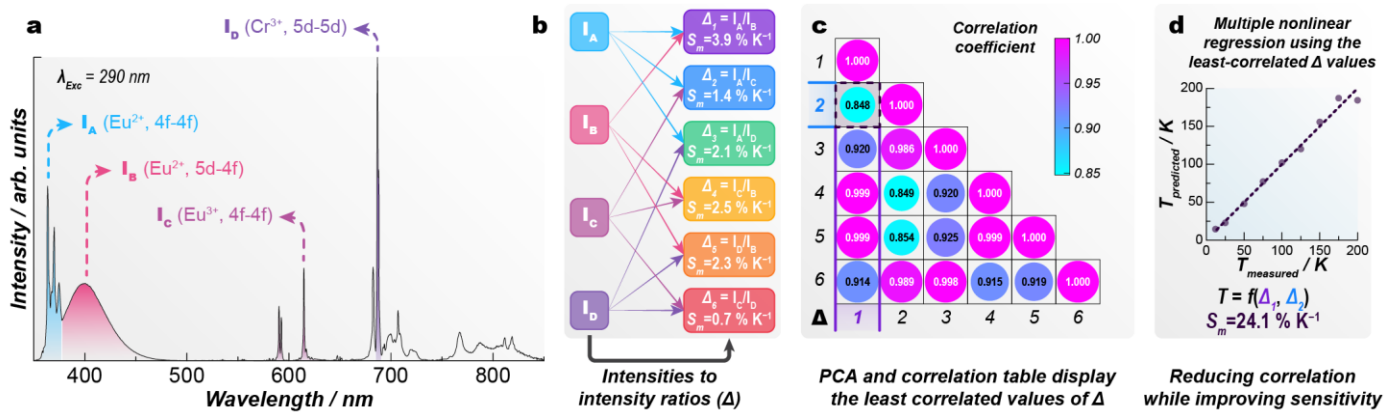

Figure 1. ***(a)*** *Emission spectra of $SrAl_{12}O_{19}$:Eu,Cr measured at 150 K under excitation at 290 nm, showing the distinct emissions.* ***(b)*** *Definition of the thermometric parameters Δ_{1-6} from the integrated emission as a function of the temperature.* ***(c)*** *PCA and correlation matrix analysis displaying the least-correlated values of Δ (Δ_1 and Δ_2).* ***(d)*** *Multiple nonlinear regression using Δ_1 and Δ_2 as temperature predictors, simultaneously.*

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SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Mechanistic Insights into the Enhancement of Persistent Luminescence in $ZnGa_2O_4$: Cr^{3+} Nanoparticles upon H_2O_2 Exposure

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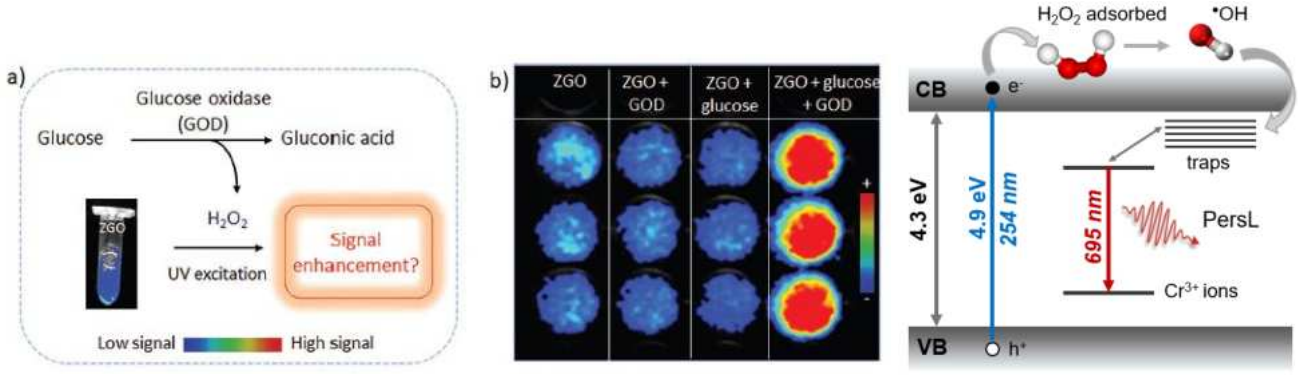
Please indicate preference: Oral, Specify Technical Area: Biomedical

Persistent luminescence (PersL) materials exhibit prolonged light emission, lasting from seconds to hours after excitation ceases, enabling their use in safety signage, road markings, anti-counterfeiting, and data storage.[1] In recent years, these materials have emerged as promising candidates for *in vivo* imaging, photodynamic therapy (PDT), and biosensors.[2] Their key advantage for sensor applications over conventional luminescent systems lies in the temporal separation of excitation and emission signals, which significantly enhances the signal-to-noise ratio by minimizing tissue autofluorescence. In 2023, a novel *in vitro* strategy for biomolecule detection was introduced, utilizing the dose-dependent enhancement of PersL in $ZnGa_2O_4$:Cr^{3+} nanoparticles (ZGO:Cr NPs) upon exposure to hydrogen peroxide (H_2O_2).[3] This approach enables both quantitative and qualitative detection of H_2O_2, a product of various enzymatic reactions and an essential biomarker in numerous diseases, including diabetes, cancer, Alzheimer's, and Parkinson's.[4] The development of sensitive, rapid, and user-friendly H_2O_2 sensors holds immense biological relevance. In this study, we elucidated the fundamental mechanism underlying H_2O_2-induced PersL enhancement in ZGO NPs. Through a comprehensive investigation including structural, surface chemical, spectroscopic, and electrochemical analyses, we demonstrated that ZGO:Cr NPs under UV-C irradiation produce photoelectrons, initiating a redox reaction with H_2O_2 at the surface of the NPs ($H_2O_2 + e^- \rightarrow {}^{\bullet}OH + OH^-$). Consecutively, the product of this reaction, namely highly reactive hydroxyl radicals ($^{\bullet}OH$), further interact with ZGO:Cr NPs surface generating additional charge carriers that intensify and prolong Cr^{3+} persistent luminescence.[5] These crucial findings reveal a previously unrecognized charging pathway in persistent phosphors and lay the foundations for further advancements in the application of PersL materials in biosensing and other emerging technologies.



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SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Artificial Neural Networks as Key Enablers for Advanced Luminescence Thermometry

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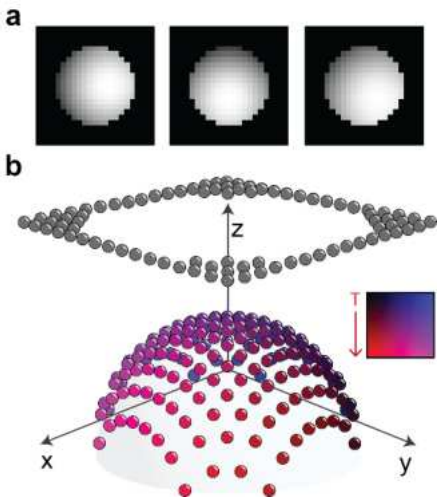
Please indicate preference: Oral
Specify Technical Area: Energy and other Applications

Luminescent thermometry has emerged as a powerful tool for minimally-invasive temperature sensing at micro- and nanoscales, with applications spanning from material science to biomedical diagnostics.[1] However, its broader deployment remains constrained by inherent limitations in temporal responsiveness, three-dimensional spatial resolution, and signal fidelity in highly scattering environments. In this presentation, we introduce a unified machine learning framework that leverages artificial neural networks (ANNs) to overcome these longstanding challenges. We first demonstrate that ANNs can reconstruct fast thermal transients from undersampled or delayed luminescence decay signals, significantly enhancing the effective temporal resolution of the sensors.[2] We then show how ANNs can be integrated into imaging pipelines to enable three-dimensional thermometric reconstructions from multi-angular or even single-view datasets. Finally, we illustrate how neural networks can demultiplex spectrally and temporally overlapping luminescence signals in turbid media, thereby recovering multiplexed functional information otherwise lost due to photon scattering. Collectively, these approaches delineate a transformative paradigm wherein data-driven models augment physical sensing, paving the way for a new generation of intelligent, high-dimensional, and deep-tissue-compatible luminescent thermometers.



a) Imágenes hiperespectrales . b) Reconstrucción en tres dimensiones del mapa de temperatura.

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SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Engineering Metal–Semiconductor Nanostructures for Enhanced Photocatalysis

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Please indicate preference: __Poster X Oral
Specify Technical Area: __Biomedical X Energy and other Applications

Metal-semiconductor nanocomposites have emerged as promising materials for the development of advanced photocatalytic hybrids. In this context, plasmonic nanoparticles have proven to be highly effective photosensitizers, extending the photocatalytic activity of semiconductors like TiO_2 across a broader range of the electromagnetic spectrum. A key mechanism for plasmonic photosensitization of TiO_2 is hot-electron injection, where excited electrons generated by light absorption are transferred from the metal's Fermi level to the semiconductor's conduction band. For this process to be effective, physical contact between the metal and semiconductor is required. Additionally, the population of charge carriers is directly related to the intensity of the electromagnetic field at the plasmonic nanoparticle's surface. For these reasons, a careful design of the metal-semiconductor nanohybrid can lead to enhanced photocatalytic properties. Additionally, using different substrates for assembly can lead to new functionalities and applications.

SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
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TiO_2-based heterojunction deposited on the membrane for photocatalytic wastewater treatment

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Please indicate preference: Oral
Specify Technical Area: Energy and other Applications

In this study, we present a $CuWO_4$-TiO_2 photocatalytic material for the removal of organic pollutants from wastewater. $CuWO_4$, which has a very favorable bandgap of 2.2 eV, was prepared by a precipitation reaction in the form of spherical nanoparticles with an average diameter of ~65 nm. However, the rapid recombination of charge carriers makes the use of $CuWO_4$ alone impossible. It was therefore used as a cocatalyst to the well-known TiO_2, whose main disadvantage is its sensitivity to radiation only in the UV region. The $CuWO_4$-TiO_2 heterojunction was confirmed by UV-VIS and photoluminescence analysis and its bandgap was shifted to visible region with the value of 2.7 eV. The final composite was deposited on inert 3D printed gyroid-type membrane providing a large surface area. To ensure the possibility of future scale-up, the heterojunction deposited on the gyroid placed in a transparent flow reactor with a flow rate of 50 ml per minute was tested in a closed circulation mode. Methylene Blue molecules were used as model pollutants with the concentration of 20 ppm. LED module with adjustable light regions was used for irradiation (UV vs. UV with visible range). The pure TiO_2 photocatalyst coated on a gyroid in a UV-irradiated flow reactor achieved 71% degradation of the methylene blue with the photocatalyst concentration of 0.5 g/L in 60 minutes. It is a lower value compared to photocatalyst in a dispersion (71% versus 96%), but the lower efficiency is balanced by the ease of replacement of the photocatalyst at the end of its lifetime. In the case of UV-VIS light, no change of efficiency was observed with TiO_2, while the degradation efficiency of $CuWO_4$-TiO_2 photocatalyst was increased by 10%. The degradation performance of the catalyst coated on the membrane can be increased with proper bandgap manipulation of the heterojunction.

Acknowledgment:
This work was supported by the Slovak Research and Development Agency under the contract by grant VEGA 1/0045/24.

SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
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Influence of Integrating Sphere Geometry on Absolute Measurements of Photoluminescence Quantum Yields of Light Scattering LED Converter Materials

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Please indicate preference: __Poster _x_ Oral

Specify Technical Area: __Biomedical _x_ Energy and other Applications

Scattering luminescent materials dispersed in liquid and solid matrices and luminescent powders are increasingly relevant for fundamental research and industry. Examples are luminescent nano- and microparticles and phosphors of different compositions in various matrices or incorporated into ceramics with applications in energy conversion, solid-state lighting, medical diagnostics. A key performance parameter is the photoluminescence quantum yield (Φ_f), i.e., the number of emitted per number of absorbed photons. Φ_f of transparent luminophore solutions can be obtained relative to a fluorescence Φ_f standard of known Φ_f, meanwhile available as certified reference materials.[1] The determination of Φ_f of scattering liquid and solid samples requires, however, absolute measurements with an integrating sphere setup.

Fist we present the results of an interlaboratory comparison of 3 labs from academia and industry on measurements of transparent and scattering dye solutions and YAG:Ce optoceramics, an optical converter material, with commercial stand-alone integrating sphere setups of different illumination and detection geometries.[2] Second we present results for a series of 500 µm-thick polymer films containing different concentrations of photoluminescent and scattering YAG:Ce microparticles.[3] We systematically explored and quantified pitfalls of absolute Φ_f measurements with special emphasis dedicated to the influence of measurement geometry, optical properties of the blank for determining the number of incident photons absorbed by the sample, and sample-specific surface roughness. Matching Φ_f values could be easily obtained for transparent dye solutions and scattering dispersions with a blank with scattering properties closely matching those of the sample, Φ_f measurements of optoceramic samples with different blanks revealed substantial differences of more than 20 %. Our results further reveal that setup configurations can introduce systematic errors resulting in under- or overestimation of the absorbed photon flux and hence an under- or overestimation of Φ_f.

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SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
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Colloidal Nanocrystals for Quantum Dot-based Luminescent Solar Concentrators

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Please indicate preference: Oral
Specify Technical Area: Energy and other Applications

Luminescent Solar Concentrators (LSCs) promise to revolutionize solar energy technology by replacing building materials with energy-harvesting devices [1]. Their deployment has however been hindered by the lack of suitable luminophores. Colloidal semiconductor nanocrystals (quantum dots, QDs) are promising luminophores for LSCs, due to their very broad absorption spectra, large absorption cross-sections, narrow emission spectra, high photoluminescence quantum yields and solution processability [2]. Nevertheless, most QD compositions lead to low device efficiencies due to reabsorption losses [3]. In our group, we have been investigating QD compositions characterized by small reabsorption cross-sections. In this contribution, I will provide an overview of our work, with particular emphasis on compound copper chalcogenides (*e.g.*, $CuInS_2$), which are ideally suited for LSCs, as they combine low toxicity with large absorption coefficients across a broad spectral range, small reabsorption cross-sections, and unparalleled PL tunability spanning a spectral window that extends from the blue to the NIR (470 – 1100 nm), depending on their exact composition and size [4]. I will also discuss the results of a long-term (2-year) outdoor test comparing the performance of three different large-area (50x45 cm^2) QD-based LSCs (CdSe/CdS/ZnS, InP/ZnSe/ZnS and $CuInS_2$/ZnS QDs) [5,6]. An organic dye (Lumogen)-based LSC and a blank device with no luminophore were used as references. This study showed that the polymer matrix used to embed the QDs (*viz.*, SEBS-g-MA) accelerated the photodegradation of the Lumogen dye but, under illumination, protected $CuInS_2$ and InP-based QDs from degradation, ensuring their stable performance during the entire duration of the study [5,6]. In contrast, the power conversion efficiency of the CdSe-based QD-LSC dropped by 80% due to reduction of the photoluminescence quantum yield. Our results show that the efficiency changes in the QD-based LSCs are related to an interplay between photodarkening and photobrightening processes in the QDs, which are strongly dependent not only on the nature of the QDs themselves but also on the environment into which they are embedded [6]. Our work thus demonstrates for the first time that the interaction between the luminophores and the matrix is a critical determinant of the long-term success of LSCs [6]. These results are relevant not only to LSCs but also to any application involving QDs as emitters and spectral shifters.

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SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
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Narrow-band Eu^{3+}-based red phosphors for warm white lighting

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Please indicate preference: __Poster X Oral
Specify Technical Area: __Biomedical X Energy and other Applications

Decades of research and development have brought the LED-based lighting industry to a high standard where cost, efficiency, stability and the exact color point of the emitter material all have to be excellent to be viable in general customer applications like warm white LED-based lighting devices. Whereas blue LEDs and green emitting materials, generally down conversion phosphors, are on par with all requirements, finding the optimal red-emitting phosphor remains challenging.
Current industry standards like KSF:Mn^{4+} (hygroscopic, requires HF in production) and CASN:Eu^{2+} (efficiency losses in IR region) have their own weaknesses and limits in applicability for warm white lighting and high power devices. Trivalent europium ions (Eu^{3+}) have long been considered as the perfect dopant due to their sharp emission line around 610 nm. However, as all optical transitions are narrow, parity forbidden f-f transitions, implying their absorbance is very weak and narrow, their use as phosphor has been limited.

Seaborough, a company based in Amsterdam, has developed a solution for this based on interparticle Förster resonance energy transfer (IFRET). With this developed technology, Eu^{3+} emitters are excited via a FRET mechanism by f-d excitable Ce^{3+} ions which absorb significantly stronger. To prevent MMCT, an interaction between Eu^{3+} and Ce^{3+} that degrades the optical properties, the donor and acceptor ions are separated from each other in different particles, further allowing the Eu^{3+}-spectrum to be altered to specific applications. At this moment, Seaborough is focused on increasing the IFRET efficiency such that this phosphor blend can be used as a stable and relatively cheap down conversion phosphor with a preferred color point, furthermore allowing energy consumption to be reduced by as much as 20% when compared to the current industry standards.

In this presentation, the purpose, development and progress over time, and the broad applicability of the IFRET technology of Seaborough's EuroLED phosphors will be discussed.

SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
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Oil Nanodrops-based Luminescent Solar Concentrators

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Preference: Oral

Technical Area: Energy applications

Luminescent solar concentrators (LSCs) are semi-transparent panels that convert sunlight into electricity using edge-mounted solar cells. They consist of a transparent matrix containing luminescent dyes that absorb and re-emit light, which is guided to the edges by total internal reflection. LSCs offer a low-cost, scalable solution for solar energy harvesting in densely populated urban environments, particularly in settings where large glass surfaces are continuously exposed to sunlight. However, this technology still faces important challenges hampering its implementation in real world. A major one is the trade-off between dye concentration and optical efficiency: while higher concentrations are needed for sufficient light absorption, they also increase reabsorption losses as emitted photons travel through the waveguide, significantly limiting performance.[1] Moreover, at elevated concentrations, molecular dyes dispersed in solid matrices tend to aggregate, which lowers their luminescence quantum yield and further exacerbates reabsorption losses.[2]

In this work, we present an LSC design that combines the advantages of solid-state structures with those of dyes in solution. This is achieved by encapsulating dye-loaded nanodroplets of a hydrophobic solvent within a polyvinyl alcohol (PVA) matrix. The resulting composite provides a solution-like nanoenvironment that maintains the dyes' high quantum yield, while the solid matrix contributes essential mechanical properties such as film-forming ability, adhesion and stability in time. This allowed the fabrication of functional LSC devices by simply drying dye-loaded emulsions on 5x5 cm^2 glass substrates (Figure 1). These devices, obtained by low-energy methods and sustainable aqueous-based coatings, maintained high internal and external optical efficiencies even at elevated dye concentrations (up to 2 wt.% for perylene red), demonstrating that the encapsulated solution-like environment effectively mitigates aggregation-induced losses.

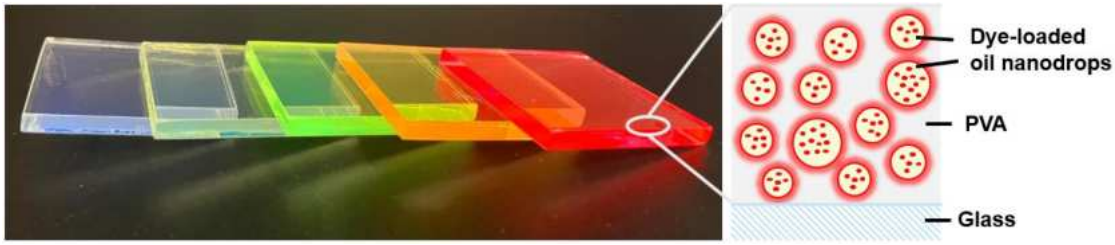

Figure 1. Left: picture of oil nanodrops-based LSCs containing different dyes exposed to indoor natural illumination. Right: structure of the fluorescent film.

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SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Spin manipulation in electrochemistry: From catalyst design to energy applications

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Please indicate preference: __Poster _X_ Oral
Specify Technical Area: __Biomedical _X_ Energy and other Applications

Recent breakthroughs in electrochemical water splitting have addressed key limitations in reaction kinetics by harnessing spin polarization effects[1]. This novel approach has shown significant enhancements in both photocatalytic and electrocatalytic processes, paving the way for the development of spin-dependent electrochemical technologies. Spin polarization can be induced using external stimuli such as permanent magnets, which can modify rate-determining steps or alter reaction mechanisms via radical pathways[2]. Additionally, chiral molecules have demonstrated magnet-like spin-filtering effects, offering another route to influence reaction dynamics. Functionalization of inorganic catalyst surfaces—particularly in transition metal oxides—has further improved catalytic activity for reactions like the oxygen evolution reaction (OER)[3]. These findings underscore the potential of spin manipulation as a versatile strategy to enhance selectivity and kinetics in key electrochemical reactions, including OER and CO_2 reduction (CO_2RR)[4].

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SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
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Artificial Photorepair of DNA ε-Adducts via NIR-Activated Upconversion Nanomaterials

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Please indicate preference: Oral
Specify Technical Area: Energy and other Applications

Genome stability is essential for correct cellular function, as any modification in DNA sequences can disrupt key biological processes and lead to diseases such as cancer. Among various DNA lesions, etheno adducts (ε-adducts) are significant marker of oxidative damage.[1] Formed endogenously via reactions with lipid peroxidation byproducts, these adducts (εdA, εdC, εdG, and N2,3-εdG) are mutagenic and frequently associated with base substitutions in mammalian cells. Traditionally, their repair involves base excision pathways and AlkB-mediated oxidative demethylation. However, recent studies have explored the photochemical behavior of ε-adducts as an innovative repair pathway.[2,3] Photosensitizers like 4-carboxybenzophenone and Rose Bengal (RB) can induce partial photorepair of εdA and εdG via Type I and Type II oxidative mechanisms, resulting in products that resemble the original nucleosides.[2,3]

Despite these promising findings, the limited penetration of UV-Vis light in tissue is a major challenge for clinical application. To overcome this barrier, we propose a nanotechnology-based solution involving near-infrared (NIR)-activated upconversion nanoparticles (UCNPs). These nanoparticles absorb NIR light and emit higher-energy photons, which can activate photosensitizers like RB. Our recent work has demonstrated that RB-capped UCNPs can efficiently generate singlet oxygen ($^1O_2$) upon NIR excitation.[2]

In this work, we introduce a nanohybrid composed by core-shell UCNPs, specifically $NaYF_4$:Yb^{3+}(16%),Er^{3+}(2%)@$NaYF_4$ and RB covalently linked to the UCNP surface (UC@RB).[5] The effectiveness in photosensitized oxidation reactions for artificial photorepair of ε-adducts will be discussed.

Acknowledgements
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SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Rare-Earth Doped Molybdate–Tungstate Phosphors for Optical Thermometry and White LED Applications

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Oral
Energy and other Applications

This study explores the development of luminescent materials based on $CaMoO_4$ and $CaWO_4$ matrices co-doped with rare-earth ions (Eu^{3+}, Sm^{3+}, Dy^{3+}), engineered for ratiometric optical thermometry and white light generation. These materials were synthesized using a high-temperature solid-state reaction and carefully characterized by XRD and SEM, revealing high phase purity and microcrystallinity. Spectroscopic investigations demonstrated efficient energy transfer processes and emission tuning dependent on dopant concentrations. Co-doping with Sm^{3+} and Dy^{3+} ions notably facilitated white light emission with correlated color temperatures adaptable via doping ratios. The phosphors exhibited warm white light with a high color rendering index (Ra ≈ 89.5), confirming their suitability for solid-state lighting. Furthermore, Eu^{3+}/Sm^{3+} co-doped systems showed temperature-sensitive emission characteristics, enabling their application in luminescent thermometry. These findings highlight the multifunctionality and practical relevance of RE^{3+}-doped molybdate–tungstate phosphors in advanced optical technologies.

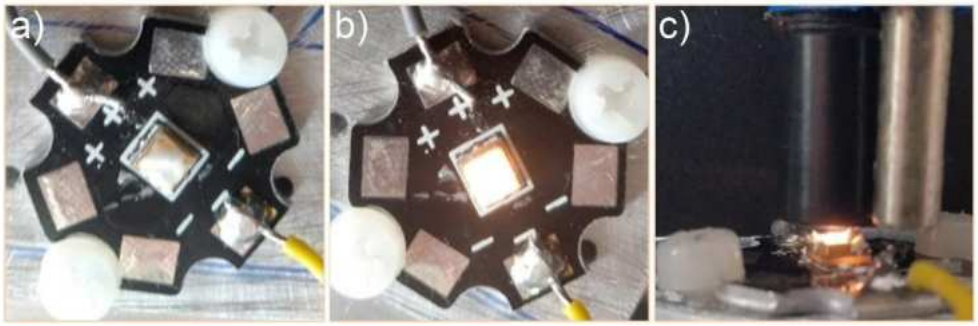

Fig. LED diode with a sample layer applied (a), LED diode with a sample layer applied and power supply turned on (I = 300 mA, PWM 50%) (b), a measurement system with the LED diode turned on, a black spectrophotometric probe, and a metal sensor probe CR100 (c).

SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
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Eu^{3+} based luminescent ratiometric thermometer for thermal sensing and imaging? Phase transition in action

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Please indicate preference: __Poster x Oral
Specify Technical Area: __Biomedical __x Energy and other Applications

Phosphors doped exclusively with Eu^{3+} ions are seldom considered as candidates for ratiometric luminescent thermometry. This is primarily due to the fact that their most intense emission bands originate from radiative depopulation of the same excited energy level ($^5D_0$), typically limiting their ratiometric potential. However, as will be demonstrated during this lecture, Eu^{3+}-doped materials can indeed serve as effective ratiometric luminescent thermometers with high relative sensitivity, suitable not only for temperature sensing but also for thermal imaging applications.

The key lies in employing host materials that undergo a thermally induced first-order structural phase transition[1,2]. Such transitions result in significant modifications to the point symmetry of the crystallographic sites occupied by Eu^{3+} ions. Consequently, the relative intensities of electric dipole transitions (e.g., $^5D_0 \rightarrow {}^7F_2$) to the magnetic dipole transitions (e.g., $^5D_0 \rightarrow {}^7F_1$) are strongly influenced. This leads to a pronounced and sharp change in their luminescence intensity ratio within the phase transition temperature window, yielding high relative sensitivity.

Using $LaGaO_3:Eu^{3+}$ and $Na_3Sc_2(PO_4)_3:Eu^{3+}$ as model systems, this presentation will show how the thermal operating range of such thermometers can be tuned by adjusting the phase transition temperature through the incorporation of optically inactive dopants. Furthermore, a strategy enabling filter-free thermal imaging based on colorimetric analysis of Eu^{3+} emission will also be introduced, highlighting the practical potential of these materials for low-cost, high-performance temperature mapping.

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SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
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Extending NIR emission into the SWIR via cross-relaxation tuning in Tm^{3+}-doped nanoparticles

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Please indicate preference: Oral
Specify Technical Area: Energy and other Applications

The ability to tailor lanthanide emission in the near-infrared (NIR) region is of growing interest for applications in luminescent spectroscopy, optical communication, and bioimaging.[1] Emission within the short-wave infrared (SWIR, 1550–1870) transparency window has attracted particular attention due to reduced photon scattering, deeper tissue penetration, and minimal autofluorescence in biological media.[2,3] However, the development of efficient, tunable, and colloidally stable emitters in this spectral range remains a significant challenge, especially in nanoparticle form. In this work, we demonstrate that the NIR emission profile of Tm^{3+}-doped nanoparticles can be precisely modulated by adjusting the dopant concentration, allowing control over two distinct bands centered at 1485 and 1855 nm. Under 980 nm excitation, increasing the Tm^{3+} content results in decreased 1485 nm emission ($^3H_4$ to $^3F_4$) and enhanced 1855 nm emission ($^3F_4$ to $^3H_6$) (Figure 1a). This behavior is attributed to enhanced cross-relaxation processes, particularly energy transfer from the $^3H_4$ excited state to the $^3H_6$ ground state, which promotes the population of the intermediate $^3F_4$ state (Figure 1b). As a result, the dynamics of the excited states are modified, leading to measurable changes in emission intensity and lifetime. Tunable emission within the SWIR window highlights the potential of these nanoparticles for high-resolution, deep-tissue biomedical imaging.

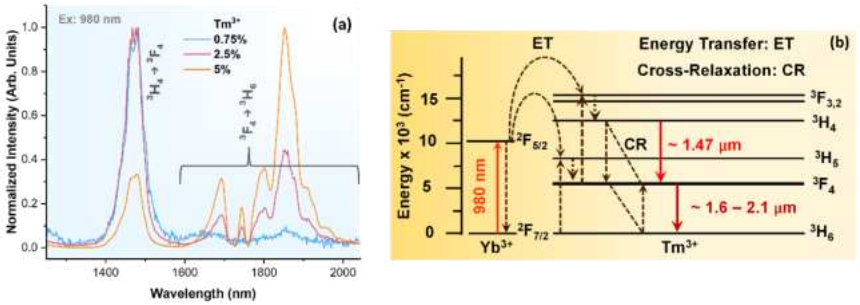

Figure 1. (a) Tm^{3+} concentration-dependent NIR emission under 980 nm laser excitation. (b) Energy level diagrams of Yb^{3+} and Tm^{3+} summarizing the photophysical processes involved in Tm^{3+} NIR emission.

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SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
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Inverted Triple-Cation Perovskite Architectures Outperform Conventional Counterparts in Photovoltaic and Photodetector Applications

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Please indicate preference: __Poster _X_ Oral
Specify Technical Area: __Biomedical _X_ Energy and other Applications

Triple-cation perovskite materials have gained significant prominence in the field of optoelectronics due to their outstanding stability, tunable bandgap, and high-efficiency performance [1]. This study presents a comprehensive dual-functionality evaluation of triple-cation perovskite devices, assessing their performance in both conventional n-i-p (ITO/SnO_2/perovskite/Spiro-OMeTAD/Au) and inverted p-i-n (ITO/2PACz/perovskite/C_{60}–BCP/Ag) architectures. Our investigation focuses on their performance as both high-sensitivity photodetectors and efficient solar cells [2][3]. As photodetectors, both configurations exhibit ultralow dark currents (~1 nA). However, the p-i-n structure consistently delivers superior performance. It achieves a higher photocurrent, demonstrates reduced hysteresis, and shows enhanced linearity and improved operational stability. This configuration also attains superior figures of merit crucial for high-sensitivity detection, including a remarkable responsivity higher than 0.4 A/W. Furthermore, the p-i-n devices exhibit an enhanced responsivity across the entire visible spectrum and an impressive maximum external quantum efficiency (EQE) of 90%, indicating highly efficient charge collection. The inverted architecture also showcases a higher cutoff frequency, which is vital for high-speed communication and sensing applications.
Similarly, as photovoltaic cells, the p-i-n configuration significantly outperforms its n-i-p counterpart. It achieves a higher power conversion efficiency (PCE) of 18.2%, minimized current-voltage hysteresis and maintaining better stability across the time. We correlate these performance differences with a more favorable energy level alignment at the interfaces, which leads to reduced trap-assisted recombination and more efficient charge extraction in the p-i-n configuration. By linking these enhancements to specific interfacial and bulk properties, we definitively identify the p-i-n architecture as the optimal design for dual-functionality perovskite devices.
Our work provides crucial guidelines for advancing perovskite optoelectronics by highlighting the critical role of device architecture in unlocking the material's full potential.

Thanks to the project ***X-Ray photodetectors based on perovskites*** with ams OSRAM (15% contribution), from the PERTE CHIP Universidad de Valencia, Next Generation – MCIU – GVA.

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SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
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Investigating Yb^{III} Quantum Cutting Emission in Molecular Systems Based on Coordination Polymers

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Please indicate preference: Oral
Specify Technical Area: Energy and other Applications

The quantum cutting (QC) mechanism is widely employed to enhance Yb^{III} near-infrared (NIR) luminescence by converting a single high-energy photon into two (or more) lower-energy photons.[1] Yb^{III}-based QC phosphors are particularly promising for photovoltaic applications, as their emission near 10,000 cm^{-1} closely aligns with the bandgap of crystalline silicon solar cells.[2] While most studies have focused on QC in matrices such as oxides, Yb^{III} coordination compounds with strong molar absorptivity within the near-ultraviolet spectral window and efficient NIR QC emission could offer compelling alternatives for application in photovoltaic cells. To mediate Yb^{III} QC in molecular systems, herein, it is reported the Tb^{III}-to-Yb^{III} energy transfer (ET) in a 1D coordination polymer based on $[Ln(tfa)_3(\mu\text{-dppeo})]_n$[3] ($tfa^-$ = trifluoroacetylacetonate, dppeo = [(diphenylphosphoryl)ethyl](diphenyl)phosphine oxide, Ln = Yb^{III} and/or Tb^{III}). The structures and compositions were characterized by single-crystal X-ray diffraction, FTIR, elemental analysis, and powder X-ray diffraction. The contribution of the QC mechanism to the Yb^{III} luminescence was investigated in terms of Tb^{III}/Yb^{III} content, emission behavior under different excitation power densities, and modelling excited-state dynamics. Upon ligand excitation, the emission profile is based on typical Tb^{III} visible luminescence (quantum yield reaching 45%) and Yb^{III} NIR emission (quantum yield close to 1%). Although the $^5D_4$ lifetime remained statistically unchanged for all compositions, higher Tb^{III} contents prolonged the Yb^{III} $^2F_{7/2}$ lifetimes, underscoring the role of Tb^{III} in boosting Yb^{III} luminescence. The sub-unit slope in the log-log plots of the Yb^{III} emission intensity dependence on the excitation power density hinted at potential Yb^{III} QC emission. This hypothesis was further supported by luminescence-dynamics calculations, which reproduced the experimentally observed sub-unit trend. This behaviour is consistent with a cooperative quantum cutting mechanism, initiated by the ligand-centred absorption, followed by ET to Tb^{III}, and subsequently to two Yb^{III} centres. The calculations also suggest that both ligand-to-Yb^{III} ET and Tb^{III}-to-Yb^{III} ET play competing roles in the luminescence dynamics. The findings offer insights into enhancing NIR luminescence in lanthanide(III) molecular systems and provide new directions for designing advanced materials for applications in renewable energy.

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SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
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Er^{3+}-enabled Cathodoluminescence Nanothermometry of Plasmonic Nanoparticles under Laser Excitation

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Please indicate preference: __Poster ☑ Oral

Specify Technical Area: __Biomedical ☑ Energy and other Applications (Nanothermometry)

Understanding and controlling heat dissipation at the nanoscale remains a significant challenge for the development of novel photothermal catalysts.[1] Here, we use thermally coupled transitions in erbium ions to map the temperature distribution around photothermal plasmonic nanoparticles. We perform the measurements in a scanning electron microscope (SEM), equipped with a cathodoluminescence (CL) spectrometer. Our samples consist of gold nanorods deposited onto a 20 nm thin film of Si_3N_4 implanted with 10^{14} Er^{3+} ions. We utilize the thermally coupled $^4S_{3/2}$ and $^2H_{11/2}$ transitions in erbium, described by the Boltzmann distribution, to extract the local temperature around the gold nanorod.[2,3] A schematic of the experiment is shown in Fig. 1a. In Fig. 1b, we show a spatially resolved hyperspectral map, which reveals that the temperature readout varies by less than 1°C over large areas (3µm x 3µm). However, under the presence of gold nanoparticles, the temperature readout is affected by plasmon-induced artifacts.

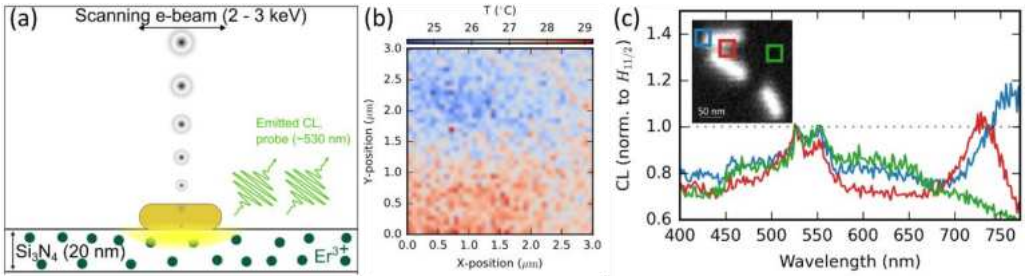

Figure 1. (a) Schematic of the experiment: a 2keV electron beam scans the region around the particle. (b) Temperature distribution map without nanorods. (c) Comparison of different spectra in a region with gold nanorods. (Inset) SE survey.

Fig. 1c shows a comparison of three different spectra taken at a region with gold nanorods. The secondary electron (SE) survey is shown in the inset. Blue, red and green squares mark the position where the selected spectra are taken. The hyperspectral dataset was acquired with an acceleration voltage of 2kV to ensure maximum emission from the first 20 nm - where the erbium is found -, and low CL emission from plasmons in gold.[4] We observe the activation of both the longitudinal and transverse plasmonic modes of the nanorods for the blue and red spectra, which are taken close to the tips of the rods. Photons coming from the transverse mode, at approximately 530 nm, overlap with the erbium transitions and could directly influence the temperature readout. The longitudinal mode, at 750 nm, does not contribute to the counts in the temperature determination, but it is still unclear whether it affects local temperature measurements by changing the local density of states (DOS), as shown in other thermometry experiments.[5] Our results are crucial for future nanothermometry measurements of laser-induced heating around nanoparticles, highlighting the potential artifacts and positioning erbium as a high-accuracy temperature probe.

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SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
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From Waste to Resource: The Potential of Recycled Lithium Batteries

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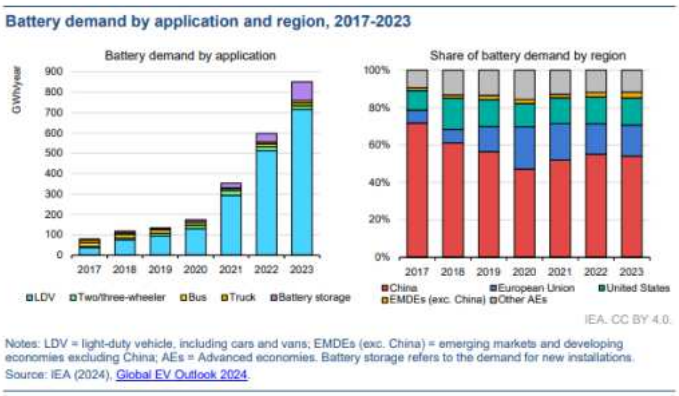
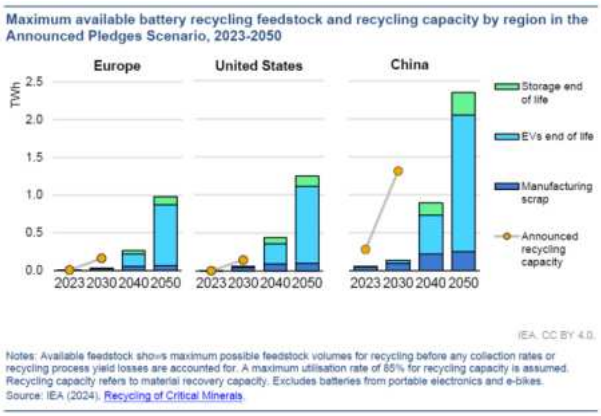
Please indicate preference: __Poster x Oral
Specify Technical Area: __Biomedical x Energy and other Applications

The rapid adoption of electric vehicles (EVs) is reshaping global battery demand, already accounting for nearly 90% of total use. This growth, which pushed battery demand past 1 TWh in 2024, will generate a delayed but substantial wave of end-of-life (EoL) lithium-ion batteries (LIBs) in the 2030s. When mismanaged, LIBs pose environmental and safety risks, but within a circular-economy framework they represent a high-value resource.





Recycling is the first key pathway. Industrial processes such as pyrometallurgy and hydrometallurgy recover 80–95% of critical minerals (Ni, Co, Li). While pyrometallurgy is mature and flexible, hydrometallurgy achieves higher yields but requires more complex flows. Promising direct-recycling and biometallurgical methods aim to lower energy use and preserve materials. Substituting recycled for virgin inputs can cut production costs by 5–30% and reduce energy, water, and CO_2 impacts. Although capacity is expanding worldwide, it still lags behind the EoL wave expected later this decade.

Reuse, or "second life," adds a crucial complementary dimension. EV batteries typically exit traction service at ~70–80% state of health (SoH), yet can be repurposed for stationary storage or less demanding mobility. This extends life by 5–10 years, reduces lifecycle CO_2 emissions by up to 50%, and cuts system costs by ~40%. The second-life market is projected to exceed $28 billion by 2031 at a 43.9% CAGR. As with recycling, challenges remain, such as dismantling, lack of standards, and feedstock competition. However, these are increasingly being addressed through diagnostics, modular reassembly, and new safety frameworks.

Together, reuse and recycling are sequential stages of circularity. At SecondLife, we focus on diagnostics-led repurposing and safe reassembly for different applications, showing that repurposed and recycled LIBs are not waste but critical enablers of sustainable, resilient electrification.

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Whispering Gallery Modes in Rhodamine B-Doped Cellulose Microfibers for High-Sensitivity Optical Thermometry

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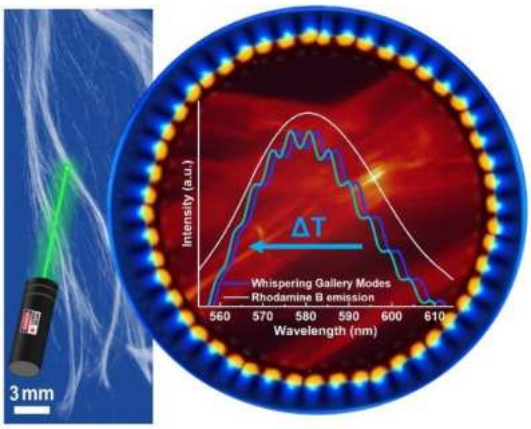
Please indicate preference: __Poster _x_ Oral
Specify Technical Area: __Biomedical _x_ Energy and other Applications

Developing novel optical temperature sensors is essential for enabling precise, non-invasive, and real-time thermal monitoring in advanced scientific, industrial, and biomedical applications [1]. We present optically active cellulose microfibers doped with Rhodamine B as highly sensitive temperature sensors based on whispering gallery modes (WGMs)[2]. The fibers were fabricated via a spinning method using N-methylmorpholine N-oxide and exhibited well-defined absorption and emission features, confirming dye integration[3]. Upon edge excitation with a 532 nm laser in a confocal setup, sharp WGMs were observed, highly responsive to temperature changes due to the material's negative thermo-optic coefficient. A record spectral shift of ≈0.47 nm K^{-1} was measured—27 times higher than in previously reported microresonators—enabling temperature resolution down to 0.17 K. These results highlight the strong potential of this system as a super-sensitive, fiber-based optical thermometer for remote sensing applications.



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SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
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Multifunctional lanthanide-doped YAB and YBO_3 nanomaterials with visible and infrared emissions for photonic devices

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It will present recent and relevant results on multifunctional oxide nanomaterials doped and co-doped with lanthanides, exhibiting emissions in the visible and near-infrared regions. The studied materials were synthesized using soft-chemistry methods (specifically the sol-gel process and the polymeric precursor method) to obtain the $YAl_3(BO_3)_4$ (YAB) and YBO_3 crystalline phases doped with Nd, Yb, and/or Er, targeting applications such as random lasers, luminescent nanothermometers, and display technologies. We investigated the structural, microstructural, and spectroscopic properties using a range of techniques, including X-ray diffraction (XRD), high-resolution transmission electron microscopy (HR-TEM), selected area electron diffraction (SAED), diffuse reflectance spectroscopy, Raman spectroscopy, photoluminescence emission spectroscopy, and lifetime measurements of lanthanide ions. In summary, Nd-doped $YAl_3(BO_3)_4$ and YBO_3 show efficient and stable random laser emissions in the visible and infrared regions. Nd-doped YAB nanocrystals exhibit a high relative thermal sensitivity of 2.0%/K in the infrared region, making them suitable for biological applications. Er-doped YAB glassy films demonstrated waveguiding behavior, along with strong emission around 1530 nm. In Er/Yb co-doped YAB particles, green, red, and near-infrared emissions were observed, and the associated energy transfer mechanisms were analyzed. Finally, YBO_3 compounds co-doped with Er, Nd, Yb, Eu, and Tb exhibited multiple emission bands ranging from visible to infrared, confirming their multifunctionality. The energy transfer mechanisms involved will be discussed in detail. These materials demonstrate strong potential for applications in random lasers, lighting systems, and luminescent nanothermometers for use in biological and optoelectronic systems. The support of UFG-LabMic and CRTi for assistance with structural characterizations is acknowledged. This research was founded by the Brazilian agencies CNPq, CAPES -Finance Code 001, FAPEG, CEHTES, FAPESP, FACEPE, and FINEP.

SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
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Bioinspired Intelligent Interface Materials and Self-powered Devices for Wearable/On-skin Health Monitoring

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Please indicate preference: X Oral. Specify Technical Area: X Energy and other Applications

The development of intelligent, soft electronics that conform to the human body is essential for next-generation health monitoring. Here, we present a bioinspired materials and systems framework that integrates multiscale interfacial design, self-powered sensing, and AI-assisted signal processing to enable real-time, noninvasive physiological monitoring. We fabricate flexible and stretchable self-powered devices that intimately adhere to the skin. These systems integrate humidity-responsive ionotronic layers, triboelectric sensors, and soft nanogenerators, enabling continuous and autonomous monitoring of skin hydration, body motion, and acoustic signals. The devices maintain stable performance under mechanical deformation and high humidity, ensuring reliable operation in wearable environments. To realize intelligent functionality, we incorporate lightweight deep learning models capable of decoding biosignals and generating responsive feedback. The system accurately predicts dehydration risks, detects physical fatigue, and classifies voice commands, supporting closed-loop health management. At the materials level, we design transparent dual-ion conductive hydrogels via molecular assembly and interfacial functionalization. These hydrogels mimic biological ion channels, facilitating directional ion transport and efficient hydrovoltaic energy harvesting from ambient moisture and perspiration. Our work presents a unified strategy for developing bioinspired, flexible, and intelligent electronic systems, bridging materials science, energy harvesting, and artificial intelligence to advance personalized, adaptive, and autonomous health monitoring.

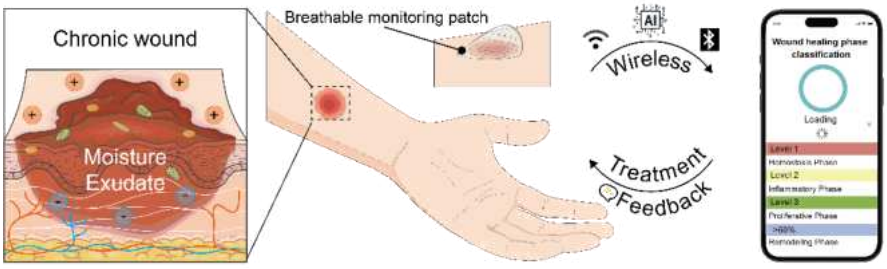

***Figure caption**: Schematic of a self-powered bioinspired moisture-ionic wound patch enabling closed-loop management—exudate-driven ionic signals, on-skin monitoring with optional microcurrent stimulation, and wireless AI-assisted classification of wound-healing phases (hemostasis, inflammatory, proliferative, remodeling).*

SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Luminescence Thermometry in Pure TeO_2 Glasses Doped with Er^{3+}/Yb^{3+} and Eu^{3+}: Remote Sensing Capability Across the Biological Temperature Range

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Please indicate preference: Oral
Specify Technical Area: Energy and other Applications

The development of non-contact and remote temperature sensors based on rare-earth (RE^{3+})-doped glasses is crucial for emerging applications in biomedical diagnostics and microscale thermal monitoring. In this study, we explore the fundamental thermometric properties of pure tellurite (TeO_2) glasses doped with either Er^{3+}/Yb^{3+} or Eu^{3+} ions in a wide range of temperature. The Er^{3+}/Yb^{3+}-co-doped system was analyzed through upconversion emission thermometry, particularly involving thermally coupled levels $^2H_{11/2}$ and $^4S_{3/2}$. The intensity ratio between these levels exhibits a clear temperature dependence from 100 K to 530 K, with an inversion near 160 K and optimal sensitivity above 250 K. At 300 K, the relative sensitivity (S_R) reached 1.1% K^{-1}, and the absolute sensitivity peaked at 6.5 × 10^{-3} K^{-1} at 460 K.

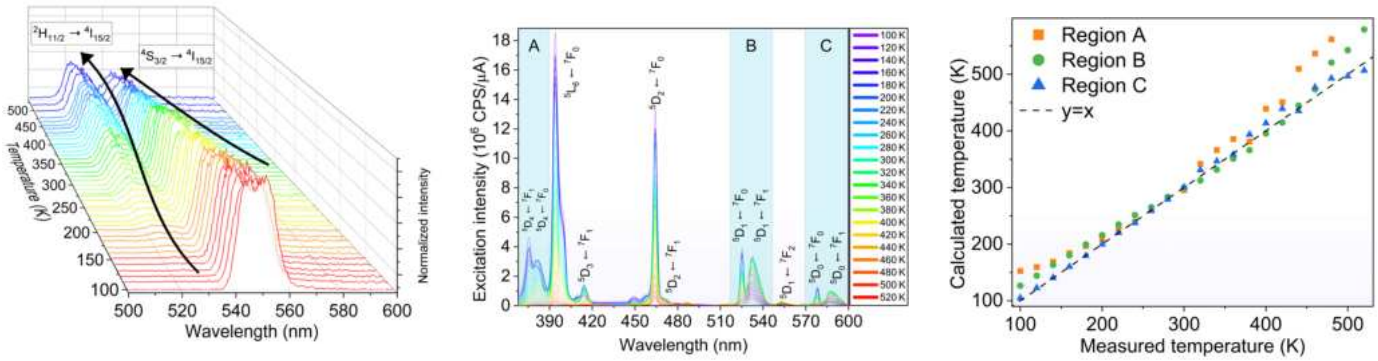

Figure on the left is the Er^{3+} upconversion luminescence dependency on temperature, in the center is the excitation spectra of Eu^{3+} with temperature, and on the right is the comparison between calculated and measured temperature for Eu^{3+} samples. In parallel, the excitation spectra of Eu^{3+}-doped TeO_2 glasses were acquired from 100 K to 520 K, revealing three thermally responsive spectral regions. These transitions exhibited temperature-dependent intensity inversions, enabling the use of excitation-based thermometry. Notably, one of the regions provided the most accurate temperature predictions, with a relative sensitivity of 0.5% K^{-1} at 300 K. Both systems benefit from the high optical transparency, chemical stability, and low phonon energy of pure TeO_2 glass, making them ideal candidates for remote sensing platforms, such as fiber-optic tips or implantable probes. While the Er^{3+}/Yb^{3+} system provides robust upconversion emission for conventional thermometry, the Eu^{3+} system introduces an innovative excitation-based strategy, broadening the applicability of RE^{3+}-doped tellurite glasses for optical thermometry.

Acknowledgements
This work was supported by the São Paulo Research Foundation (FAPESP – N. 2020/11038-2, 2023/05994-6, 2024/04675-7) and National Council for Scientific and Technological Development (CNPq - 304718/2023-8)

SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Multiparametric luminescent thermometry using a new series of iridium^{III} complexes: unveiling temperature dependence via ^{3}LC–^{1,3}MLCT hybrid states

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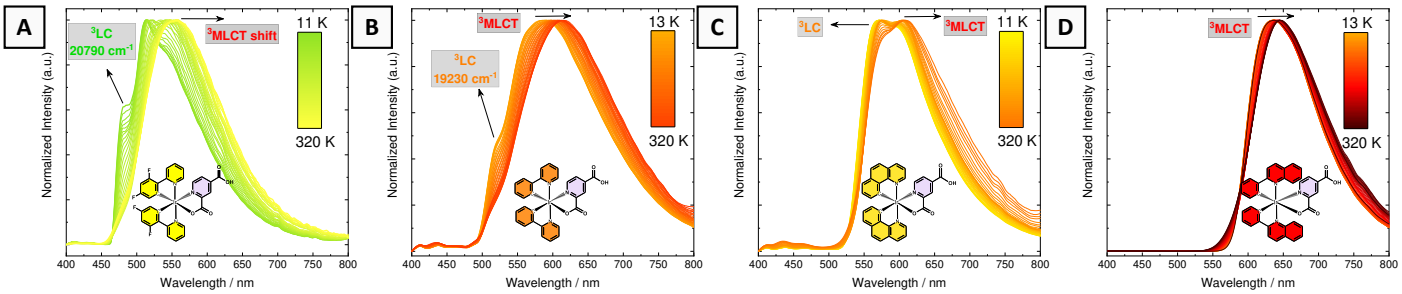
Please indicate preference: __Poster X Oral
Specify Technical Area: Energy and other Applications

Luminescence thermometry (L-T) has advanced significantly, becoming more compatible with conventional temperature sensing technologies throughout the years, with performance typically benchmarked by the relative thermal sensitivity (S_r) and the temperature uncertainty (δT). Recent advances have focused on enhancing thermometer reliability by combining multiple luminescent parameters (Δ), such as intensity, spectral shift, bandwidth, emission ratios, and excited-state lifetimes.[1] Despite the growing interest, Ir^{III} complexes remain underexplored. Their photoluminescence originates from a hybridized ^{3}LC-^{1,3}MLCT state whose population balances between ^{3}MLCT and ^{3}LC character as temperature shifts, endowing the complexes with pronounced rigidochromic effects. In this study, four unreported Ir^{III} complexes, i.e., [Ir(C^N)$_2$pdc] (C^N = Fppy, ppy, bzq, and phq), with Fppy = 2-(2,4-difluorophenyl), ppy = 2-phenylpyridine, bzq = benzo[h]quinoline, phq = 2-phenylquinoline, and pdc = 2,4-pyridinedicarboxylic acid, abbreviated as **Ir-Fp**, **Ir-Pp**, **Ir-Bp**, and **Ir-Qp**, respectively, were synthesized and evaluated as multiparametric luminescent thermometers. In degassed DMSO, the complexes display photoluminescence quantum yields (Φ) of 47, 25, 13, and 45%, with monoexponential lifetimes (τ) of 0.85, 0.53, 1.80, and 0.98 μs, respectively. Solid-state emission spectra at 298 K (under λ_{ex} = 370 nm) exhibited broad-unstructured bands typical of dominant ^{3}MLCT emission, peaking at 553, 612, 604, and 634 nm. Temperature-dependent measurements in the 11–320 K range (Figure 1) revealed marked spectral evolution – most pronounced for **Ir-Fp** and **Ir-Pp** – stemming from ^{3}MLCT destabilization and increased vibronic ^{3}LC splitting. For **Ir-Fp**, the thermally coupled ^{3}LC/^{3}MLCT pair supports a ratiometric readout due to the strong rigidochromic effect, attaining S_r of 1.25% K^{-1}. Complementary probes – the redshift of the ^{3}MLCT band (18507→17410 cm^{-1}) and lifetime shortening – yield sensitivities of **0.033% K^{-1}** and **4.40% K^{-1}** at 11 K. By merging lifetime, intensity ratio, and spectral shift data through multiple linear regression S_r was amplified to **11.7% K^{-1}**, underscoring the power of a multiparametric strategy for Ir^{III}-based luminescent thermometry.

Figure 1: Normalized photoluminescence emission spectra with temperature dependence of complexes **Ir-Fp** (A); **Ir-Pp** (B); **IrBp** (C); and **Ir-Qp** (D). Spectra acquired in the solid state (powder) λ_{ex} = 370 nm; Slits: 0.5 nm; Increment 0.5 nm; filter 385 nm.



Acknowledgments: FAPESP for the scholarship (24/21506-4; 22/14042-6; 19/26103-7) and CNPq (308868/2022-6).

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SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Towards Measuring Spatial Thermal Gradients with Nanothermometers During Ultrafast Laser-Driven Dissipative Self-Assembly

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Please indicate preference: __Poster _x_ Oral
Specify Technical Area: __Biomedical _x_ Energy and other Applications

Driven dissipative colloidal systems are practical experimental platforms to study emergent phenomena ubiquitous in nature, such as the formation of complex structures and dynamic adaptive behaviour, unavailable in equilibrium conditions. We have established such a system, driven far from equilibrium by the continuous input of energy from ultrafast laser pulses (Fig. 1a) [1,2]. A garden variety of simple and complex patterns emerge from this system, which dynamically transitions from one to another reacting to external changing conditions. The system's purely physical dynamics (passive polystyrene (PS) microspheres suspended in water and confined between two glass slides) has provided first evidence of universality in driven dissipative self-assembly (DSA) from quantum dots to human cells [3]. The next major goal is to

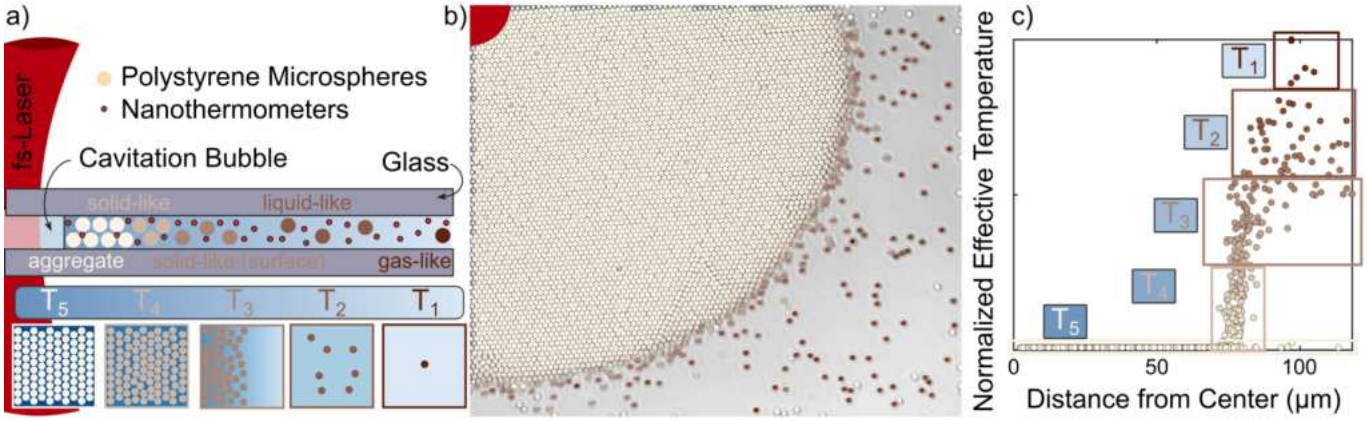

Fig 1: a) Schematic: ultrafast laser driven self-assembly of polystyrene particles in water gives rise to regions of solid, liquid, and gas-like properties. b) Microscope image showing the different regions, corner red spot marks the laser position. c) The effective temperature varies with distance from the laser spot and provides a natural separation for the regions.

develop a theoretical understanding of our models' internal dynamics, which could lay the foundation for a more general theory applicable to a wide range of driven dissipative systems. A key challenge is accurately measuring the spatially varying temperature profile *in situ* and *in operando*, as driven systems often exhibit non-uniform temperature distributions. In our system, the particles' Brownian motion and diffusive character differ across solid-, liquid-, and gas-like regions (Fig 1a). Since thermochromic dyes are not sensitive enough, the temperature can, so far, only be calculated as an effective temperature from the mean square displacement of particles (Fig. 1b and 1c). To solve this problem, we add upconverting β-$NaYF_4$:Er^{3+},Yb^{3+} nanoparticles to the particle suspension. Such particles are excellent ratiometric luminescence nanothermometers [4]. We image their luminescence ratio during DSA experiments and compare it to effective temperature calculations. In the future, our thermal imaging approach will be applicable to other samples used in biology and elsewhere.

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SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Ln^{3+}-doped Cellulose Nanocrystals Cholesteric Films: Influence on Lanthanide Spectroscopy and Potential Photonic Applications

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Please indicate preference: X Oral
Specify Technical Area: __Biomedical X Energy and other Applications

The research and development into luminescent materials depends on the nature of the emitting centers, as well as the host matrix; and control of both will allow defining properties that qualify them for the development of photonic devices, such as random lasers, sensors, nanothermometers, catalysts, etc. For example, the physicochemical properties of cellulose nanocrystals (CNC), combined with the luminescent behavior of lanthanide ions (Ln^{3+}), have been proving their potential role in the development of new functional materials. In fact, the control of chiral nematic structure, and self-assembly of cellulose nanocrystal is a smart methodology for the development of these new materials. This work aims to obtain new free-standing iridescent films based on CNCs with adjustable cholesteric pitch, in the presence of lanthanide ions, specifically Eu^{3+} and Tb^{3+} ions (Fig. 01a), as a new platform for optical systems. The results from scanning electron microscopy confirmed the chiral nematic structure of CNC film, and it was corroborated by Bragg diffraction band observed at specular reflectance analysis, with the control of cholesteric pitch. As observed in Fig. 01b, the emission band intensity depends on the angle of incidence excitation light beam, with preferential effect on Eu^{3+} ion emission. In addition, the ability to control the cholesteric pitch and reflectance band of the iridescent CNC films affects the selection of the excitation wavelength and, consequently, the material's emission, as already observed for films doped only with Tb^{3+} ions. Studies are being carried out to better understand the CNC structure influence on the spectroscopy of others Ln^{3+} ions, and this work could be an innovative path with potential applications in polarized luminescence and CNC-based optical devices, sensors, tunable filters and Laser.

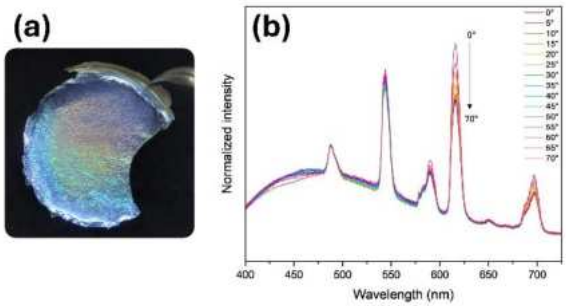

Fig. 1 (a) image of Eu^{3+}/Tb^{3+} doped CNC iridescent films, and (b) emission spectra of the film shown in (a), analyzed at different angles (λ_{exc} = 273 nm).

Acknowledgements: Brazilian agency FAPESP (2021/08111-2), CNPq (303580/2021-6 and 303616/2024-5) and Universidade de São Paulo (USP) for financial support.

SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Optoelectronic properties of Two-Dimensional Metal Halide Perovskites

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Please indicate preference: __Poster X Oral
Specify Technical Area: __Biomedical X Energy and other Applications

The continuous development in smart devices and microsystems for the control of industrial processes, biomedical sensors and instruments, visible and NIR light communications, photovoltaics and many other applications, is triggering new demands for novel and low cost semiconductors. Metal halide perovskites can be a good solution, because of their good optoelectronic properties and tolerance against crystalline defects, other than low-cost processing and low CO_2 footprint. Particularly, 2D lead halide perovskites, as PEA_2PbI_4 and higher order Ruddlesden-Popper phases, can be easily synthesized in the form of single cyrstals with a multilayered structure defined by the octahedral planes of PbI_4^- separated by the long organic cations PEA^+ and stacked by van der Waals interaction. In this way, multilayered nanoflakes can be exfoliated from single crystals in a wide range of thicknesses (tens to hundreds of nm) and lateral sizes of several tenths of microns in order to study their optical and optoelectronic properties. These nanoflakes were transferred to micrometric photodevices by using Pt-prepatterned Si/SiO_2 substrates with 10 µm of channel length (Fig. 1a). Interestingly, photocurrents from 10 pA to 100 nA can be measured at 1 V of voltage bias under laser (450 nm) incident powers in the range from 10 pW to more than 500 nW in steady state (Fig. 1b). The linear behaviour of photocurrent with incident power and near constant responsivity ≈ 0.2-0.3 A/W would be indicative of a negligible presence of nonradiative channels associated to deep levels. The spectral photoresponse exhibits a clear exciton resonance, slightly shifted to the red by reabsorption with respect to micro-photoluminescence (523 nm), as shown in Fig. 1c. Furthermore, the rise/decay of the photocurrent is very fast, < 1 µs, hence with a frequency cut-off over the MHz. Our results on samples with different thicknesses point out to phototransport taking place at the monolayer/s touching the Pt-contact with photogenerated carriers originated from direct absorption followed by those produced from photons re-emitted at top monolayers and absorbed at the bottom monolayers.

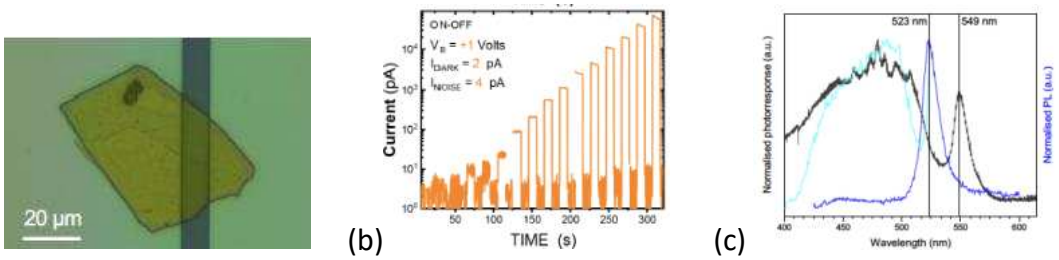

Figure 1 – Nanoflake 135 nm thick onto Pt electrodes (a). ON/OFF current measurements using a 450nm laser (b). Spectral photoresponse (black line), Photoluminescence (PL) and PL Excitation (dark and light blue lines) (c).

Acknowledgments
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SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

BODIPY/Eu^{3+}-Tetrakis luminescent PMMA films aiming for smart window applications

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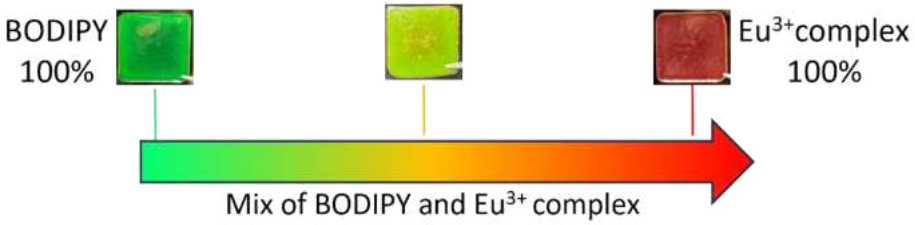
Please indicate preference: Oral
Specify Technical Area: Energy and other Applications

In recent years, multifunctional luminescent films displaying near-UV-to-visible downshifting conversion and luminescence thermometry capabilities have been investigated as luminescent solar concentrators (LSC) to be applied in smart windows.[1] These systems could be employed to improve the efficiency of photovoltaic cells while monitoring the temperature in smart buildings. In particular, polymeric films doped with Ln^{3+} complexes or organic dyes have gained considerable attention owing to their optical properties, flexibility, transparency, and mechanical and thermal resistance. In this work, new luminescent PMMA (polymethyl methacrylate) films simultaneously doped with BODIPY ligand (boron-dipyrromethene) dye and the Eu^{3+} β-diketonate complex $Et_4N[Eu(ntfa)_4]$ were fabricated. The drop-casting method was employed to fabricate the films, and the concentration was varied as 0.5–20.0wt.% for the Eu^{3+} complex, keeping the BODIPY amount as 0.01wt.%.[2,3] Upon 460 nm excitation, the films present intense green emission (λ_{max} = 511 nm) corresponding to the $S_1 \rightarrow S_0$ transition of BODIPY. Moreover, when excited at 300 nm, a bright red emission was observed owing to the $(Eu^{3+})^5D_0 \rightarrow {}^7F_{0\text{-}4}$ transitions. This reveals that the system presents a tunable emission color depending on the excitation wavelength. Intrinsic emission quantum yield (Q_{Eu}^{Eu}) values are in the range of 52 – 58%. The emitting state lifetimes (τ) of BODIPY (8.87 – 12.29 ns) and Eu^{3+} complex (0.4593 – 0.4786 ms) were monitored for each doped film, and these results suggested that there is an intermolecular energy transfer process from BODIPY to the Eu^{3+}-complex in the range of 0.5 – 2.5 wt.% as well as an energy transfer process from the complex to BODIPY at higher concentrations of Eu^{3+} complex (5.0 – 20.0 wt.%). The thermometric study was conducted for the film containing 0.01 wt.% of BODIPY and 2.0 wt.% of Eu^{3+} complex through heating and cooling cycles (233 to 393 K) (λ_{ex} = 410 nm), obtaining a ratiometric response (I_{613nm}/I_{538nm}) with a maximum relative thermal sensitivity 3.60% K^{-1} at 393 K and 0.54% K^{-1} at 298 K. The reversibility of the thermometric process was effectively demonstrated. Besides, under solar exposure, emission bands gradually shift from green to red depending on the BODIPY and Eu^{3+} complex ratio. Therefore, these optical results demonstrate the potential of the PMMA:(x%)$Et_4N[Eu(ntfa)_4]$,(y%)BODIPY materials for use as luminescent temperature sensors targeting applications such as smart windows.



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SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Unlocking affordable and sustainable CO_2 capture and purification to enable downstream conversion

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Please indicate preference: __Poster _ X _ Oral
Specify Technical Area: __Biomedical _X_ Energy and other Applications

Over the past decades, human activity and fossil fuel use have led to critical environmental and climate challenges. Carbon dioxide, a major greenhouse gas emitted in diluted form (e.g., flue gases), could become a valuable feedstock if efficiently captured and purified. Indeed, most valorization processes require high-purity CO_2 to be effective. Capturing and recover high-purity CO_2 from low-concentration gas streams is costly and energy-intensive. Conventional methods like amine scrubbing require significant energy and generate toxic byproducts, while most current technologies lack versatility across different conditions and applications, highlighting the need for more sustainable and adaptable solutions.

We have developed TAMOF-1, a robust and highly porous MOF based on Cu^{2+} centers and an L-histidine-derived linker. This non-critical, IP-protected material[1] can be sustainably synthesized at large scale (>10 kg) in both powder and pellet forms. Thanks to its high porosity and homochirality, TAMOF-1 exhibits remarkable molecular recognition capabilities, enabling the separation of racemic mixtures and small organic molecules in both gas and liquid phases[2,3]. More recently, we have discovered its exceptional and highly stable performance as a solid physisorbent for CO_2/CH_4 separation[4], highlighting its strong potential for biogas upgrading applications.

In this work, we report recent founding on the performance of TAMOF-1 as a solid physisorbent for post combustion carbon capture, through a combined experimental and theoretical approach. TAMOF-1 demonstrates excellent performance, with high selectivity (CO_2/N_2 above 200) and significant CO_2 adsorption capacity (>1.5 mmol/g for flue gas at ambient pressure). The material also shows low-energy and rapid regenerability, maintaining over 97% of its working capacity at ambient temperature under mild vacuum conditions, due to its minimal regeneration energy demand. Furthermore, CO_2 of very high purity (>99.9%) can be recovered. Remarkably, the material exhibits excellent cyclic stability, even in the presence of contaminants such as water and NO_x. These performance results highlight TAMOF-1 as a strong candidate to address the main technical and economic challenges in CO_2 capture. Critically, we will also present performance data from real industrial conditions, demonstrating the effectiveness of the material at prototype scale, marking a key step towards practical deployment.

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SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Color shifting and dynamic visual effects introduced by color moires

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preference: Oral
Specify Technical Area: Energy and other Applications

Security features are needed for modern valuable and expensive goods to protect them from hurting their authenticity and integrity. Among many security features, holograms and spectral colors are found in paper money, credit cards, identifications and so on due to its color shifting and dynamic visual effects whenever viewing direction and/or illumination condition changes occur.

Moires are a natural interference effects occurring whenever two regular line pattern plates are superposed together. But the color shifting and dynamic visual effects can also be produced when a transparent plate having a certain thickness is inserted between two regular line pattern sheets [1]. This means that the color moires can also be used as a security feature: A hologram shows continuously varying color shifting and can display 3 dimensional images, which the color moires can hardly reveal. But the color moires are chirped, so their fringe periods and the colors within each period are continuously varying. Furthermore, there are many different parameters which can change the color combinations, fringe varying patterns and degrees. Fig. 1 shows a chirped color moire fringes when it is viewed from the center of the panel, respectively. The waveform in Fig. 1 depicts the period of color moire fringes. The period of the waveform increases as away from the centers. So, fringes are chirped. When the viewing position is moved away from the center, the fringe pattern at the center will be shifted to the moved position. This generates a color shifting effect and dynamic visual effects. The number of colors expressible with both hologram and the moires will not be different because human ability of discriminating different colors is 2 to 10 million. This number is smaller than the expressible colors of both hologram and the moire.

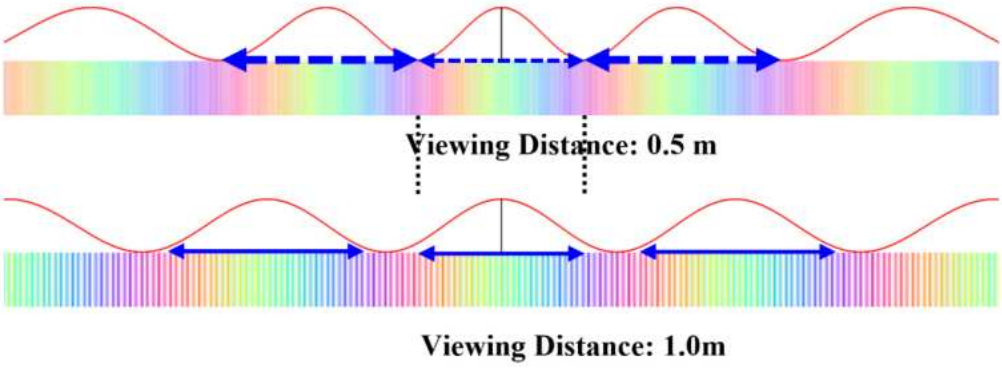

Fig. 1: Chirped Moire Fringes of two different viewing distances of 0.5 m and 1.0 m

1. Hyoung Lee, Sung-Kyu Kim, Kwanghoon Sohn, Jung-Young Son, and Oleksii O. Chernyshov, "Fringe Periods of color moires in contact-type 3-D displays," Opt. Express, 24(13), 14183-14195(2016)

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SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Optical tweezers, laser refrigeration, Raman thermometry and anti-Stokes luminescence of Yb-doped microcrystals

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Please indicate preference: Oral
Specify Technical Area: Energy and other Applications

We study laser refrigeration and anti-Stokes luminescence of Ytterbium-doped YVO_4 and CaF_2 microcrystals, see Figure 1. The studies are performed on a single particle level using optical tweezers. The temperature of the microcrystals is measured using Raman scattering and analysis of the motion of the particles inside the optical trap. We additionally performed spectroscopic studies of anti-Stokes luminescence versus excitation wavelength and laser power for particles with different dopant concentrations. The combination of various spectroscopic techniques allowed us to identify different competitive luminescence pathways, which determine the cooling and heating of microcrystals. In consequence we optimized the laser wavelength, power and concentration of Yb^{3+} ions for maximum temperature decrease of a single microcrystal in an optical trap in water. Knowledge and understanding of these luminescence pathways leading to cooling and/or heating will allow better improvement of materials for laser refrigeration in the future.

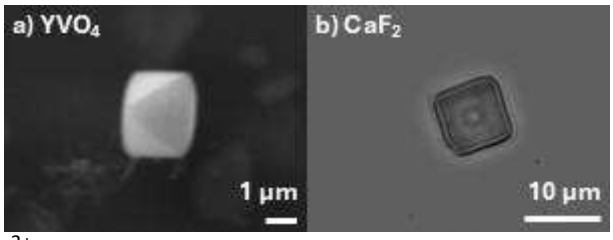

Fig. 1 a) SEM image of YVO_4:Yb^{3+} microcrystal and b) optical microscopy image of CaF_2:Yb^{3+} microcrystal.

Acknowledgments
This work was financially supported by the National Science Center, Poland, 2020/39/I/ST3/01827.

SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Scintillation and optical properties of advanced YAS:Ce glass system

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Please indicate preference: Oral
Specify Technical Area: Energy and other Applications

In presented submission, we are aiming to provide detailed scintillation and optical characterization of the highly interesting novel YAS:Ce (yttrium-aluminum-silicate) glass system with respect to potential use in advanced opto-electronics applications, such as scintillation detectors or optical fibers. The composition of the glass samples was 12.6 Y_2O_3 – 19.2 Al_2O_3 – (68.2-X) SiO_2 – X CeO_2, where X = 0, 0.5, 1.0, 1.5. The glass samples were prepared by the standard melt-quenching technique in the temperature range 1500 – 1600 °C using Pt-Rh crucible. The glass melt was poured into a steel mould, annealed to relieve the glass of tension, cut into wafers and polished into optical quality. Their structural and morphological characteristics are investigated by the X-ray diffraction and transmission electron microscopy analysis. Their scintillation and optical properties are afterwards studied by the methods of time-resolved luminescence spectroscopy and by the setup for a fast scintillation decay measurement with time resolution below 100 ps. All studied samples exhibit the broad and efficient near-UV/violet emission under the X-ray (40 kV, 15 mA) excitation which peaks at around 390 nm of spectral range. Furthermore, this emission, for even unoptimized samples, reaches almost 20% of the intensity of the standard $Bi_4Ge_3O_{12}$ single crystal scintillation material, yet leaving a huge space for improvement. Corresponding fast scintillation decay time below 20 ns of these scintillating glasses makes them worth further investigation in the field of distributed radiation detectors (see Figure 1). The steady-state and time-resolved photo- and radioluminescence properties are further analyzed in broad temperature range using a variety of excitation sources including also synchrotron radiation facility. The scintillating properties are evaluated, and the potential of prepared scintillating composites was assessed.

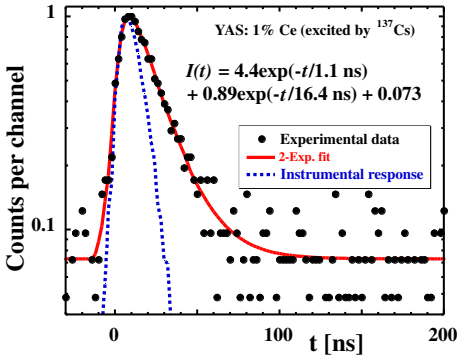

Figure 1: *Scintillation decay of YAS:Ce 1% glass sample excited by the ^{137}Cs radioisotope).*

Acknowledgement: This work was supported by the Czech Science Foundation project no. GA23-05507S and DESY (Germany) projects for the research with synchrotron radiation no. I-20211395 EC, I-20231298 EC.

SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Emission control for enhanced diffuse light concentration

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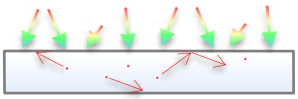
Preference: Oral

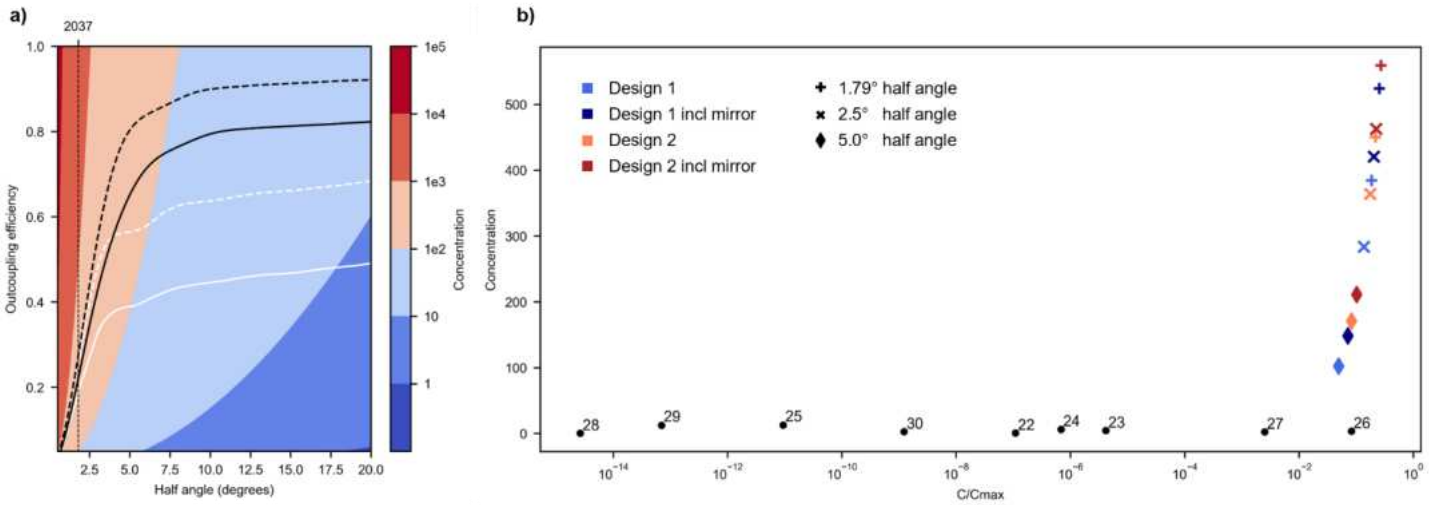
Technical Area: Energy and other applications, Diffuse Light Concentration, (Nano)Photonics

Conventional design



Improving lenses to reach close to their theoretical performance limits was the most important breakthrough enabling microscopes and telescopes. However, conventional lenses can only concentrate collimated light, while many light sources (including a large fraction of solar illumination) are uncollimated (diffuse). Concentrating diffuse light is possible using luminescent solar concentrators (LSCs), but even record LSCs fall orders of magnitude short of their theoretical performance limits, which can be calculated by the Stokes shift. This inefficiency stems from a single layer fulfilling three distinct functions: light absorber, emitter, and concentrator (lens). While the most LSCs perform well as an emitter, they typically absorb weakly, collimate poorly, and fail miserably as a concentrator. This is not surprising – the transverse design requires long propagation distances in the absorbing layer to reach high concentration values. The long path length leads to reabsorption and scattering losses and an unavoidable trade-off between absorption and concentration.

We propose a novel approach that leverages the same thermodynamic limits as traditional LSCs but improves performance by decreasing the scattering and re-absorption losses significantly and therefore increasing the overall efficiency. Finite-Difference Time-Domain simulations on two different innovative designs **demonstrate concentration factors above 500X, reaching 25% of its thermodynamic limit. This is a 1000X improvement over current LSCs**. Our design maintains efficiency regardless of scale, potentially opening up a revolution in active lenses for diffuse light concentration.



Concentration factor achieved by our novel designs. A) demonstrates the concentration factor for the half angle of the emitted light. The white and black lines correspond to design 1 and 2, respectively. The solid and dashed lines show the result excluding and including a micromirror, respectively. The champion design shows a concentration factor of 559 with a 27.4% efficiency. B) compares our results with results found in literature.

SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Dynamic Plasmonic Photothermal CO_2 Hydrogenation

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Please indicate preference: Oral

Specify Technical Area: Energy applications, dynamic catalysis, plasmonic photothermal heating, Multiphysics modelling

Catalysts play a central role in the chemical industry, enabling reactions to proceed with lower energy input and faster rates. Yet, despite over a century of optimization, the chemical industry remains the third largest greenhouse gas emitter. Further enhancements are limited by the Sabatier principle, which describes what catalyst is optimal for a particular reaction and dictates a maximum production rate for the system. This limitation exists under steady-state conditions, where the input energy and reactant species surface coverage are constant in time. To surpass this limit, a dynamic stimulus can be applied, inducing oscillations between high and low coverage states, potentially leading to productivity and selectivity beyond the static regime.

Plasmonic metal nanoparticles pumped with ultrafast laser pulses serve as an ideal system for dynamic catalysis. These materials efficiently absorb light and rapidly convert it into heat, enabling heating and cooling rates faster than those of elementary steps of chemical reactions (bond breaking, desorption). This precise kinetic control can enhance reaction rates, reduce catalyst deactivation and improve selectivity compared to continuous heating.

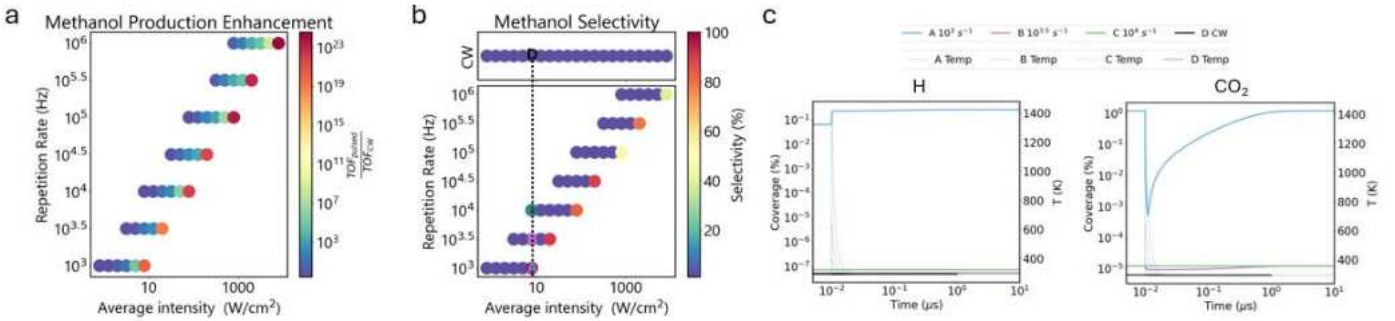

Figure: a) Methanol pulsed production enhancement $\left(\frac{TOF_{pulsed}}{TOF_{CW}}\right)$*, b) Methanol selectivity for pulsed (bottom rectangle) and continuous wave (CW) (top bar), c) Surface coverage of bound reagents H and* CO_2

We have developed a Multiphysics model coupled to a microkinetic model to simulate dynamic photothermal CO_2 hydrogenation to methanol on TiO_2 supported Cu nanoparticles at ambient pressure. Converting CO_2 into valuable chemicals is key for sustainable fuel production but is kinetically and thermodynamically limited under steady state conditions. We show that pulsed light increases both methanol production (fig a) and allows for selectivity switching between different branches of the mechanism. (fig b) This is enabled by manipulating the coverage of the strongly bound formate intermediate during the high temperature pulses, while allowing for high reactant surface coverage between pulses (fig C). Additionally, this approach improves energy efficiency, producing more methanol per watt of input power.

SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Controlling Emission of Tm-based Upconverting Nanoparticles via Multi-Wavelength Near-Infrared Co-Excitation

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Please indicate preference: __Poster X Oral
Specify Technical Area: __Biomedical X Energy and other Applications

Upconversion nanoparticles (UCNPs) are luminescent materials capable of absorbing low-energy radiation (e.g., near-infrared) and emitting higher-energy photons in the visible range. This process, known as energy transfer upconversion (ETU), involves photon absorption by sensitizer ions (Yb^{3+}), followed by energy transfer to activator ions such as Tm^{3+} or Er^{3+}.

Typically, a single excitation source is used—most often a 970–980 nm laser that excites the Yb^{3+} ions. In our work, we propose a dual-excitation strategy involving both indirect excitation (via Yb^{3+}) and direct excitation (via Tm^{3+}), using two beams: a 975 nm laser and a tunable beam in the 1050-1875 nm range.

Spectroscopic analysis identified two broad absorption bands for Tm^{3+} at 1213 nm and 1732 nm. Exciting these bands alongside the 975 nm source resulted in a dramatic enhancement of the 800 nm emission—up to a 1000% increase or the emergence of emission from near-zero levels. This nonlinear response, termed **surplus emission**, indicates strong photophysical synergy between the excitation channels.

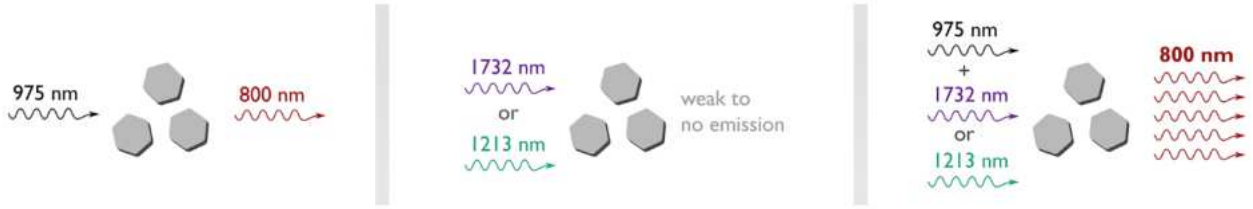

Figure 1: Conceptual diagram of co-exciting Tm^{3+}-doped nanoparticles using a 975 nm beam and an additional NIR beam. The 975 nm laser alone produces power-dependent emission at 800 nm. The selected NIR wavelengths alone yield no signal, but their combination results in a strong emission enhancement.

Crucially, this effect allowed us to visualize NIR radiation above 1700 nm—a range beyond the sensitivity of standard InGaAs detectors. Neither excitation source alone produced a measurable signal, but their combined use generated a distinct emission, confirming a **synergistic excitation mechanism**.
These findings highlight the potential of co-excitation for designing optical logic systems (e.g., AND gates) and light control. With optimized core-shell nanoparticle architectures and tailored wavelengths, co-excitation offers a powerful strategy for emission control in both scientific and technological contexts.

SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Ratiometric luminescence manometry based on broadband-emitting phosphors: a new class of highly sensitive pressure sensors

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Please indicate preference: __Poster X Oral
Specify Technical Area: __Biomedical X Energy and other Applications

Precise pressure measurement plays a crucial role in scientific research and in technologies that operate under high-pressure conditions. One of the most promising strategies in this area is luminescent manometry - a technique based on monitoring changes in the luminescent properties of phosphors in response to applied pressure. Owing to their high sensitivity, as well as the capability for remote and non-invasive real-time readouts, luminescent pressure sensors are increasingly recognized as advanced solutions that address the key requirements of modern detection systems.

For decades, ruby has been regarded as the gold standard for optical pressure measurements in diamond anvil cells, offering high reliability under controlled laboratory conditions.[1] However, its relatively low sensitivity to pressure variations and the pronounced temperature dependence of its emission band position considerably limit its performance under dynamic and unstable conditions typical of industrial environments.

In response to these limitations, research was conducted to evaluate the potential of using phosphors that exhibit broadband emission, primarily associated with the $^4T_{2g} \rightarrow {}^4A_{2g}$ and $^3T_{2g} \rightarrow {}^3A_{2g}$ electronic transitions of Cr^{3+} and Ni^{2+} ions, respectively, for application in luminescence manometry.[2-4] The adopted approach based on ratiometric analysis of broadband emission integrated over two selected spectral ranges, represents a novel concept in this field and, to date, has not been systematically explored. This strategy resulted in the development of luminescent pressure sensors exhibiting record-high sensitivity values, exceeding 100% GPa^{-1}, while maintaining high readout precision. A particularly important advantage was the pressure readout's independence from temperature fluctuations of the system.

These findings led to the identification of a new class of luminescent pressure sensors, combining a unique set of features - exceptionally high sensitivity, temperature invariancy, and remote readability - that significantly enhance their suitability for practical implementation, especially in demanding and dynamic operating environments.

Acknowledgements: This work was supported by the **National Science Center (NCN) Poland** under project No. **2023/49/N/ST5/01020**. Maja Szymczak also gratefully acknowledges the support received from **Foundation L'Oréal, UNESCO** and the **Ministry of Science and Higher Education of the Republic of Poland** through the **L'Oréal-UNESCO For Woman in Science Scholarship.**

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SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

High-Efficiency $CsPbBr_3$ Perovskite Quantum Dots Embedded in Polymer Matrices for Additive Manufacturing.

Emmanuel Reyes-Francis[1], Raul I. Sánchez-Alarcón[1], Álvaro De Armas Viera[1], Ismael Romero Ocaña[2], Míriam Herrera[2], Sergio I. Molina[2], Jose Marques-Hueso [1], Juan Pascual Martínez- Pastor[1]

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The combination of efficient emitting nanomaterials with the versatility of additive manufacturing promises to revolutionize the design of optoelectronic devices, with applications ranging from lighting to biosensors. In this work, we explore this frontier starting with an exceptional material: $CsPbBr_3$ perovskite quantum dots (QDs), which exhibit a photoluminescence quantum yield (PLQY) of nearly 97%, with a high-purity green emission centered at 508 nm and a narrow spectral width of just 16.5 nm. We achieved the successful integration of these QDs into a two-photon polymerization (2PP) resin, demonstrating the feasibility of fabricating intrinsically luminescent 3D microstructures. This advancement represents a crucial step towards creating custom photonic components. However, the integration process revealed challenges at both the processing and fundamental interaction levels. A non-homogeneous dispersion of the QDs within the matrix and an intense background luminescence from the resin itself were identified, complicating the analysis. At the interface, the interaction manifests as a red shift of the emission peak (to ~ 521 nm) and a notable broadening. More importantly, time-resolved photoluminescence (TRPL) analysis confirms a drastic alteration in the photoluminescence dynamics: The appearance of a new ultrafast decay component (≈ 0.75 ns) evidences the opening of non-radiative channels. We attribute this behavior to energy transfer mechanisms to the resin and to evidence of photodegradation, which directly translates into a loss of efficiency. Far from being an impediment, these findings are crucial as they provide a comprehensive understanding of the behavior of these complex systems. Based on this, a clear roadmap is established to overcome these obstacles, which includes the selection of alternative resins and the surface engineering of the QDs, in order to realize the full potential of 3D-printed photonics.

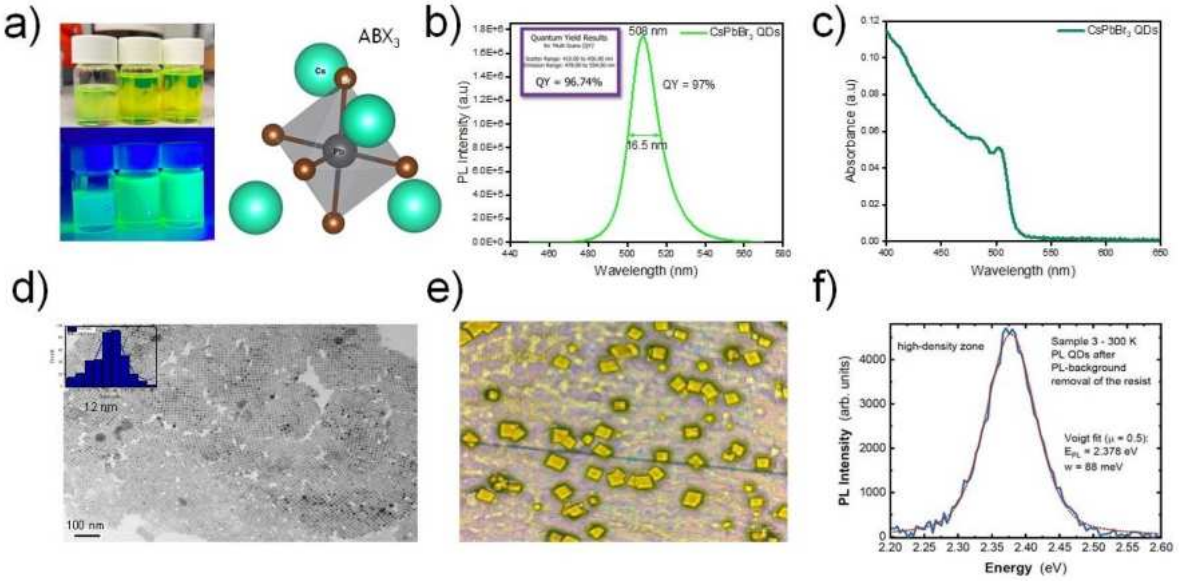

Figure 1. Comprehensive characterization of pristine $CsPbBr_3$ perovskite quantum dots (PQDs). (a) As-synthesized PQD solutions under visible (top) and UV light (bottom), highlighting green photoluminescence, alongside the crystal structural model (b) Photoluminescence (PL) emission spectrum, displaying high quantum yield (QY = 96.74%). (c) UV-Vis absorption spectrum. (d) Transmission electron microscopy (TEM) image of cubic PQDs with an inset showing the corresponding distribution histogram. (e) Optical micrograph showcasing the macroscopic morphology of the PQDs. (f) PL spectrum of a high-density region from at 300 K, after removal the background signal from the resist. The Voigt fit indicates a bandgap (*Eg*) of 2.378 eV.

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SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Single-to-donut-mode converter for coupling light into ring core fibre

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Please indicate preference: __Poster _x Oral
Specify Technical Area: __Biomedical x Energy and other Applications

The European Green Deal aims for climate neutrality by 2050, urging industries like chemicals—responsible for 7% of global industrial energy use and 5% of EU emissions—to adopt sustainable innovations. Current photochemical flow reactors, using polymer hoses and UV LEDs, suffer from poor light management, leading to high photon "costs" and low efficiency [1]. To address this, the EIC-funded reaCtor project proposes a fibre-based microreactor: a ring-core optical fibre with a 100 µm hollow channel for reactions. A beam converter shapes laser light into a donut mode guided by the ring core, while plasmonic nanorods on the inner surface scatter photons to reactants. Micromachined fluidic interfaces enable continuous flow. This design enhances photon-to-reaction efficiency, reducing energy waste and operational costs.

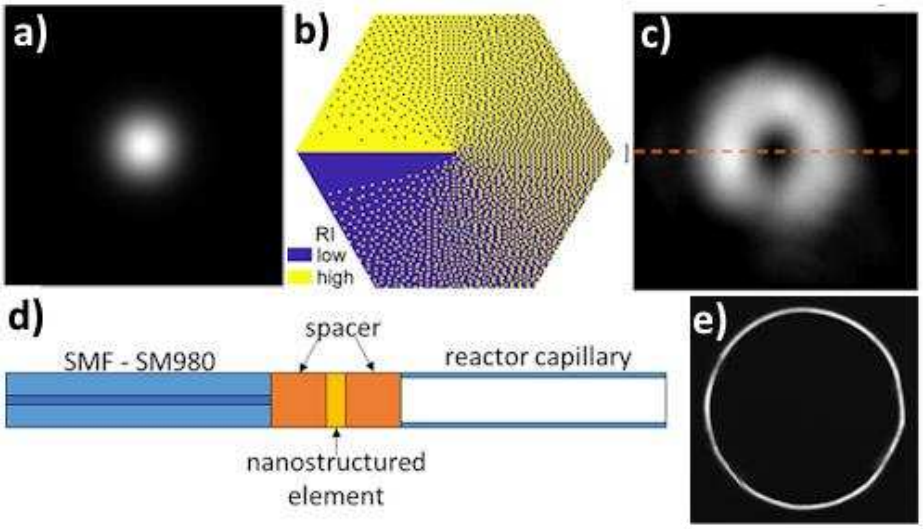

Fig. 1. (a) Light beam from input fibre, (b) structure of the nanostructured phase element, blue and yellow dots denote low and high refractive index rods respectively (c) output beam from the phase element, (d) schematic of the entire beam converter, (e) light propagating in the ring core

To achieve this goal a single-to-donut-mode converter for efficient light coupling into a microreactor core was developed. This converter transforms output of the standard fibre into a donut-shaped optical vortex using a nanostructured phase element [2]. This element, fabricated from sub-wavelength rods of low refractive index and high refractive index glasses, operates as an effective refractive index medium [3]. With more than 7651 rods arranged in a hexagonal structure 20 µm in diameter and 35 µm long, the phase element introduces angular phase shift equal to 2π at 870 nm operating wavelength. Nanostructured nature of the phase element allows it to work while maintaining flat entry and exit facets, enabling easy integration into an all-fibre setup. To optimize mode conversion, a coreless fibre spacer expands the beam from the input fibre to match the phase element's diameter, while a second optical element tailors the output mode to best align it with the 102 µm dimeter of the reactor fibre ring core. This allows to achieve light in the ring core with beam quality exceeding 0.78 across its cross-section.

Funding: The project reaCtor has received funding from the European Union's Horizon Europe research and innovation programme under grant agreement No. 101099405.

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SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Tracking Excited-State Processes in Plasmon–Chromophore Hybrids via Femtosecond Transient Absorption

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In this study, we introduce an innovative synthetic strategy for obtaining trimethoxysilylated azachalcones, donor–acceptor (D-A) chromophores exhibiting pronounced intramolecular charge-transfer characteristics. Detailed spectroscopic investigations combined with theoretical modeling confirm their unique optoelectronic behavior, underscoring their suitability for advanced functional applications. To harness and enhance their photophysical properties, these chromophores were covalently anchored onto plasmonic gold nanoshells (NSs)[1], forming hybrid nanostructures engineered to leverage molecule–plasmon coupling effects.

Femtosecond transient absorption spectroscopy demonstrated marked changes in excited-state dynamics between the isolated chromophores and their nanoshell-bound forms. Notably, all three components of the excited-state lifetime experienced significant prolongation upon integration with the NSs: from 700 fs, 1.93 ps, and 5.64 ps to 3.7 ps, 430.5 ps, and 15 ns, respectively. This enhancement is attributed to localized surface plasmon resonance (LSPR), which intensifies the local electromagnetic field, promotes hot-electron injection into the chromophore's LUMO, and reduces non-radiative decay through constrained molecular motion and strong electronic interactions at the metal–organic interface.

These results highlight the potential of plasmon-coupled hybrid systems in applications where controlled manipulation of excited-state processes is critical. Potential areas of use include photonic technologies, optical sensors, and light-activated biomedical platforms such as photodynamic therapy and high-resolution bioimaging, where prolonged excited-state lifetimes offer clear advantages in efficiency and sensitivity.

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Acknowledgments:
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Students Poster

SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Development of SiO_2@AuNRs-$LiLuF_4$:Ho^{3+},Yb^{3+} Hybrid Nanostructure for Simultaneous Near-Infrared Induced Heating and Optical Nanothermometry

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Please indicate preference: Poster
Specify Technical Area: Biomedical applications

In recent years, gold nanorods (AuNRs) have gained a lot of interest towards photothermal therapy (PTT) for treatment of cutaneous melanoma due to their tunable localized surface plasmon resonance (LSPR) falling within the biological windows (BWI: 700–950 nm and BWII: 1000–1350 nm). Upon excitation at their LSPR maxima, AuNRs generate heat that is dissipated to their surroundings resulting in cancer cell death.[1] Precise monitoring of local cellular temperature during PTT is crucial to avoid damage to surrounding healthy cells. Determining temperature changes at the nanoscale has been the focus of the field of luminescent based nanothermometers.[2] Combining both heating and temperature sensing functionalities in one single hybrid nanostructure offers a promising solution for real-time thermal feedback during treatment.[3]

Up to date, a diverse range of lanthanide-doped luminescent nanothermometers with well-defined excitation and emission regions has been developed. These nanothermometers provide high thermal sensitivity, spatial and spectral resolutions, and low uncertainty.[2] However, many of the current lanthanide based nanothermometers are limited by their excitation in the UV region or their emission is greatly reduced by tissue absorption. The application of NIR nanothermometers circumvents this problem by providing luminescence in the BWs.

In this work, a hybrid nanostructure consisting of a silica core serving as a platform decorated with AuNRs for light-to-heat conversion and $LiLuF_4$:Ho^{3+},Yb^{3+} nanothermometers for local temperature monitoring is presented.[4] Fluoride hosts are known to have low phonon energies enabling efficient radiative transitions. This hybrid nanostructure was examined for its morphology, cytotoxicity, and its local heating and temperature sensing properties. This hybrid material can provide local NIR photoinduced heating combined with simultaneous in situ optical nanothermometry. It demonstrates its potential to be used for advanced therapeutic strategies requiring localized thermal control.

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SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Yb^{3+}/Er^{3+} Upconversion Luminescence in Lithium Aluminosilicates

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Please indicate preference: Poster
Specify Technical Area: Biomedical

Lithium aluminosilicates ($LiAlSiO_4$) are recognized as versatile host matrices that can be doped with a wide range of ions, with lanthanides being a common choice. Although it has been well-documented that these materials can be doped with lanthanides for traditional luminescence applications, such as in LEDs, no reported work has focused on doping them with ions that exhibit up-conversion luminescence.[1] This research aimed to demonstrate that up-conversion luminescence can be achieved by doping the $LiAlSiO_4$ host matrix with a Yb^{3+}/Er^{3+} sensitiser/activator pair. This finding further broadens the potential applications of this material.

Samples of lithium aluminosilicate with the general formula $Li_{1-x-y}AlSiO_4$: xYb^{3+},yEr^{3+} were synthesised via a traditional high-temperature solid-state method. Samples were characterised by XRD and confirmed to be pure. The specific site that the dopants occupy within the host matrix was determined based on previously reported studies.[1]

Spectroscopic measurements indicated that upconversion was achieved when samples were excited with a 980 nm near-infrared (NIR) laser. Samples with a total dopant concentration below 2% ($Li_{0.98}AlSiO_4$:$0.02Ln^{3+}$) exhibited the strongest emission, while higher dopant concentrations led to reduced intensity due to concentration quenching. Although upconversion was observed, direct examination of the samples revealed inhomogeneities, with certain regions displaying significantly higher emission intensity than others (Figure 1).

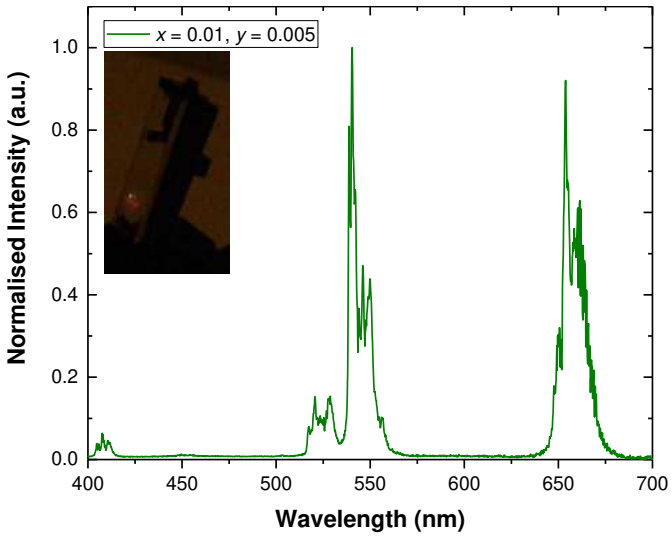

Figure 1: Emission spectrum and photo of a select sample of $Li_{1-x-y}AlSiO_4$: xYb^{3+},yEr^{3+} (x = 0.01, y=0.005) under 980 nm excitation.

This research paves the way for doping with other upconverting lanthanide ions, such as Tm^{3+}, whose emission, with further refinements to synthesis methods, could complement persistent luminescence phosphors to facilitate drug release in medical implants.

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SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Towards nanothermometers for inflammation detection in the NIR-III – Optimization of Er^{3+} emission in the near-infrared

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Please indicate preference: _X_Poster __ Oral
Specify Technical Area: _X_Biomedical __ Energy and other Applications

The increasing prevalence of chronic inflammatory diseases, driven largely by the aging of the world's population, represents a major public health challenge. Current diagnostic approaches, which include the detection of circulating inflammatory biomarkers and advanced imaging techniques, lack the sensitivity needed to detect inflammation at early stages or involve the use of ionizing radiation and expensive instrumentation. Consequently, there is a need to develop safer, more sensitive and cost-effective tools for such applications.

Developments in nanotechnology have made new approaches for diagnostics and treatment available to the biomedical community. We propose a diagnostic strategy based on the use of luminescent nanothermometers (LNTh) operating in the third biological window (NIR-III: 1550-1850 nm), where tissue optical properties favor deeper penetration and better spatial resolution. These nanothermometers are capable of detecting subtle temperature changes in tissues, one of the earliest physiological manifestations of inflammation, thus offering a non-invasive method for localized and early detection. Here we present the synthesis and characterization of $NaErF_4$ core/shell nanoparticles and their optimization to obtain an intense emission in the NIR-III at 1550 nm. NaErF4 core/shell was synthesized by the thermal decomposition method and an Yttrium (Y) based shell was used adapted from the literature.[1] Morphological characterization by TEM and X-ray diffraction (XRD) were performed, verifying the high cristalinity and β-phase (hexagonal) structure of the NPs. Subsequently, the optical emission properties were studied obtaining a band peaking at 1550 nm when the sample was excited with a wavelength of 800 nm.

Our nanoparticles will permit efficient *in vivo* imaging in combination with a novel pre-targeting strategy by integrating bioorthogonal click chemistry, targeting selectively distinct biomarkers of inflammation. Finally, we also tested the performance of these nanoparticles as LNTHs and performed the first preliminary experiments with biological and phantom tissues

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SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Design of core-multi-shell $NaGdF_4$:Yb^{III}, Tm^{III} upconversion nanoparticles decorated with luminescent $iridium^{III}$ complex: synthesis and photophysical insight

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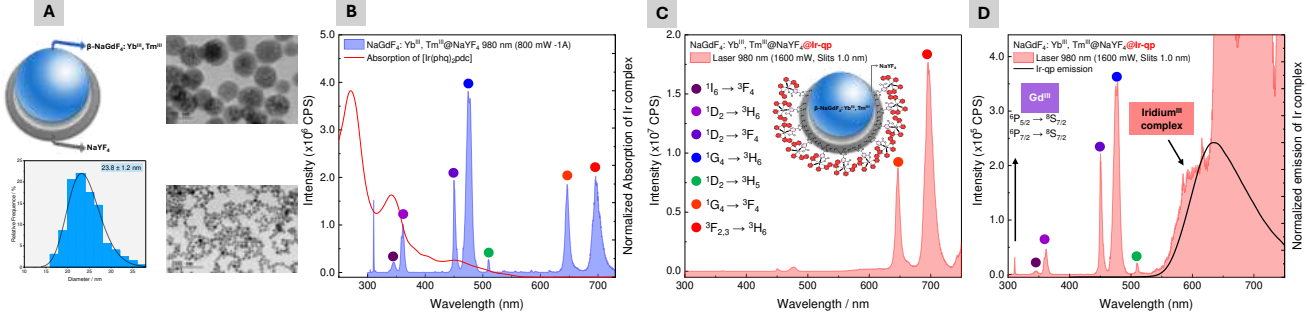
Please indicate preference: Poster
Specify Technical Area: Biomedical

Upconversion nanoparticles (UCNPs) doped with rare-earth ions (RE^{III}) are highly promising materials for nanomedicine applications. By engineering a core–shell layered structure, it is possible to fine-tune their physicochemical and biological properties, enabling the creation of multifunctional luminescent nanoplatforms for use as theranostic agents, combining luminescent sensing for diagnostics with treatment through reactive oxygen species (ROS).[1] RE^{III}-doped β-$NaGdF_4$ UCNPs have recently been recognized as one of the most efficient and attractive host materials for constructing multiphoton upconversion system.[2] In this context, we studied the functionalization of β-$NaGdF_4$: Yb^{III}, Tm^{III} with luminescent $iridium^{III}$ complexes in different core@shell architecture. Herein, three distinct architectures based on β-$NaGdF_4$ were synthesized via thermal decomposition method: (1) a doped-core structure composed of β-$NaGdF_4$ doped with 49 mol% Yb^{3+} and 1 mol% Tm^{3+}; (2) a doped-core@inert-shell structure, β-$NaGdF_4$:Yb^{III}, Tm^{III}@$NaYF_4$; and (3) a multilayer structure composed of an inert-core@doped-shell@inert-shell, β-$NaYF_4$@$NaGdF_4$: Yb^{III}, Tm^{III}@$NaYF_4$. Following synthesis, all UCNPs were functionalized with Ir^{III} complex [$Ir(phq)_2pdc$], where phq = 2-phenylquinoline and pdc = 2,4-pyridinedicarboxylic acid, abbreviated as **Ir-qp.** Upon 980 nm NIR excitation (Figure 1), $NaGdF_4$:Yb^{III}, Tm^{III} UCNPs displayed sharp emission peaks from the UV to NIR range. The UV-Vis absorption spectrum of the **Ir-qp** complex showed bands peaking at 271, 342, 400, and 453 nm, corresponding to LC and MLCT transitions, which overlap with the UV-blue emissions of Tm^{III}. This spectral overlap enabled energy transfer from Tm^{III} to Ir-complex, resulting in the quenching of $^1I_6 \rightarrow {}^3F_4$ (345), $^1D_2 \rightarrow {}^3H_6$ (362), $^1D_2 \rightarrow {}^3F_4$ (450), and $^1G_4 \rightarrow {}^3H_6$ (478 nm) transitions after surface functionalization. Concomitantly, an enhancement of red emissions at $^1G_4 \rightarrow {}^3F_4$ (647) and $^3F_{2,3} \rightarrow {}^3H_6$ (695) was observed, which can be attributed to back energy transfer from the Ir-complex emission (634 nm) to the red-emitting excited states of Tm^{III}. Preliminary results revealed non-radiative energy transfer from UCNPs to the **Ir-qp**, leading to suppressed UV-blue and enhanced red triplet emissions, indicating potential for biomedical applications.

Figure 1: Transmission electron microscopy (TEM) image of representative β-$NaGdF_4$:Yb^{III}, Tm^{III}@$NaYF_4$ UCNPs (A). Upconversion emission spectra (λ_{exc} = 980 nm, 298 K) of β-$NaGdF_4$:Yb^{III}, Tm^{III}@$NaYF_4$ (A) and β-$NaGdF_4$:Yb^{III}, Tm^{III}@$NaYF_4$@**Ir-qp** (C, D).



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SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Downshifting Tm^{3+} -Yb^{3+} doped $LiLuF_4$ nanoparticles for NIR thermometry. Examining the influence of core-shell structures and a 3rd Ln^{3+} ion on thermometry performance

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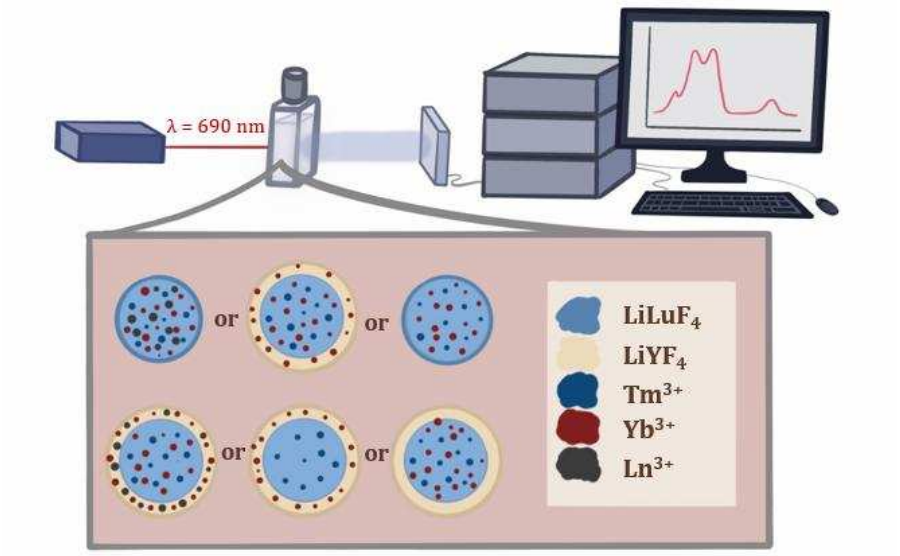
Specify Technical Area: x Biomedical __ Energy and other Applications

Lanthanide-doped nanoparticles (LnNPs) are excellent candidates for ultralocal temperature measurements in biological systems, as they offer reliable and minimally invasive readout[1]. To avoid tissues autofluorescence, such nanothermometers should operate within so-called biological windows (BWs), i.e. intervals within the near-infrared (NIR) range where absorption by lipids, water, and proteins is minimized[1]. While the commonly reported LnNP upconverting thermometers (e.g. Yb-Er [2]) are excited in the NIR, their emission is usually restricted to the visible range, limiting their applications in biomedicine. Here, we present our findings on a novel LnNP nanothermometer, $LiLuF_4$:Tm,Yb, fully operating in those BWs. The thermometer is excited at 690 nm through the Tm^{3+} $^3H_4 \leftarrow {}^3H_6$ transition, and the ratio between the $^2F_{5/2} \rightarrow {}^2F_{7/2}$ Yb^{3+} and $^3H_5 \rightarrow {}^3H_6$ Tm^{3+} emission peaks (at 998 nm and 1215 nm respectively) is used for the temperature assessment. Further, the impact of (un)doped $LiYF_4$ shells[3] and an introduction of a 3rd emissive ion, such as Nd^{3+}, on the thermometry performance is examined.



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SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Developing Hybrid Materials Based on Multifunctional Ag_2S Nanoparticles for Photothermal Therapy and Real-Time Temperature Sensing

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Please indicate preference: Poster
Specify Technical Area: Biomedical applications

Cutaneous melanoma is the most common and aggressive form of skin cancer. To date, various cancer therapies have been developed, including chemotherapy, radiotherapy, and surgery. Nonetheless, the treatment prognosis continues to be inadequate. Thus, there is an urgent need for a more effective therapy. Photothermal therapy (PTT) is an emerging approach for cancer treatment. The efficient skin penetration of near-infrared (NIR) light, along with the targeted and controlled nature of PTT, renders this approach particularly promising for melanoma treatment. For this purpose, numerous photothermal agents (PTAs) have been investigated, including metal-based, semiconductor-based, and carbon-based nanoparticles.[1] Ag_2S nanoparticles are highly interesting for biological applications due to their optical properties in the NIR region and their low cytotoxicity compared to many other semiconductor nanoparticles such as CdS and PbS.[2] The primary objective of PTT is to increase the local temperature of cancer cells to a cytotoxic level without damaging the adjacent healthy cells. Therefore, monitoring the local temperature during the therapy is of paramount importance.[1] This provides insights into the biological activities occurring within the cells and helps to enhance therapeutic efficacy. Ag_2S possesses temperature-dependent emission properties, making it an ideal candidate to be employed as a nanothermometer.[3] Upon excitation with an 808 nm laser, it emits around 1220 nm. With increasing temperature, the emission intensity reduces and redshifts. This renders it suitable as a ratiometric nanothermometer. An alternative approach to evaluate its thermometric properties is to study the luminescence lifetime. Moreover, Ag_2S can also be also used as a PTA, as the non-radiative relaxation processes leads to heat generation. The dual functionality of Ag_2S makes it an intriguing material for PTT, serving as a "self-monitored" PTA. This research addresses the thermometric properties of Ag_2S nanoparticles and different approaches to enhance their heating properties, with an attempt at combining them simultaneously in a hybrid material.

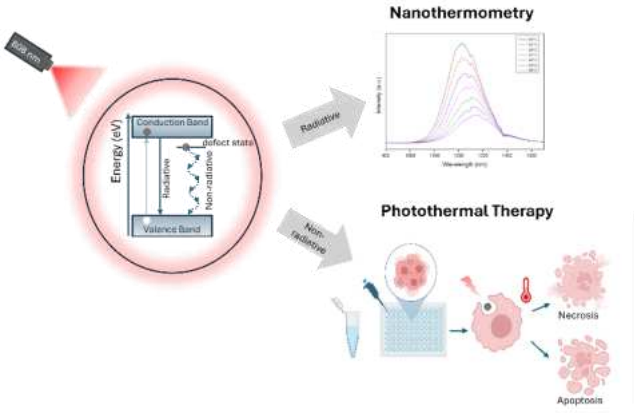

Figure 1: Schematic representation of the dual functionality of Ag_2S nanoparticles as a nanothermometer and a nanoheater.

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SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Lanthanide doped nanofluorides as optical probes for biomedical applications

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Please indicate preference: __Poster __ Oral
Specify Technical Area: _X_Biomedical __ Energy and other Applications

Novel nanomaterials as luminescent probes are urgently needed, as they are paramount for rapidly developing optical diagnostics in biomedical applications. Lanthanide-activated nanomaterials show strong luminescence in the UV, visible, and near-infrared optical range, and these emission properties, especially in the biological windows, are extremely useful for biomedical applications.
This work focuses on fluoride-based nanoparticles (NPs) doped with luminescent trivalent lanthanide ions (i.e, Eu^{3+}, $Tb^{3+,}$ and others). The nanomaterials have been prepared using a green chemistry, microwave-assisted, hydrothermal technique. Proper structural investigation by using X-ray powder diffraction highlighted that the obtained nanomaterials are single-phase. The size and morphology of the NPs have been analyzed by TEM characterization.

The emission of the NPs has been measured using laser radiation as a source to investigate the local structure of the lanthanide ions. Their thermometric efficiency has been studied exploiting a luminescence intensity ratiometric method, based on the emission intensities. In particular, we have investigated the $Tb^{3+} \rightarrow Eu^{3+}$ energy transfer process after excitation of the Tb^{3+} ion [1]. The Eu^{3+} emission spectra and decays have been monitored at different temperatures and then analyzed to study the dynamics of the lanthanides' excited states and confirm energy transfers in the NPs.

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SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Red/NIR emission in zinc gallogermanate: Cr^{3+} and Cr^{4+} active centers

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Please indicate preference: _x_Poster __ Oral

Specify Technical Area: _x_Biomedical __ Energy and other Applications

Persistent luminescence materials can store light energy and gradually release it after the excitation source is removed. They are particularly important for biomedical imaging [1]. Zinc gallogermanate is a suitable host for emitting ions like Cr^{3+} and Cr^{4+}, which produce red/NIR emission [2]. For persistent luminescence to occur, trapping centers are needed to store and transfer energy to the chromium ions—an aspect explored in detail in this work.

Cr-doped zinc gallogermanate ($Zn_{1+x}Ga_{2-2x}Ge_xO_4$:Cr) pellets with varying *x* concentrations were synthesized via solid-state reaction. Structural characterization was carried out using X-ray diffraction (XRD) and Raman spectroscopy. Optical properties were studied through photoluminescence (PL) and PL excitation (PLE) at room temperature (RT) in the visible and NIR range. Temperature dependence studies were also recorded from RT down to 70 K in both the visible and NIR ranges. Additionally, afterglow measurements were performed.

The goal of this work is to study the influence of *x* concentration on the optical properties of Cr-doped zinc gallogermanate. Structurally, all samples are monophasic except for the one with the *x* value of 0.5. All samples exhibit strong emission in the visible and NIR range, as shown in Figure 1. Moreover, persistent luminescence characteristics are also detected in all samples. Namely, *x*=0.1 sample presented the highest intensity and longest afterglow, observed during at least 10 h.

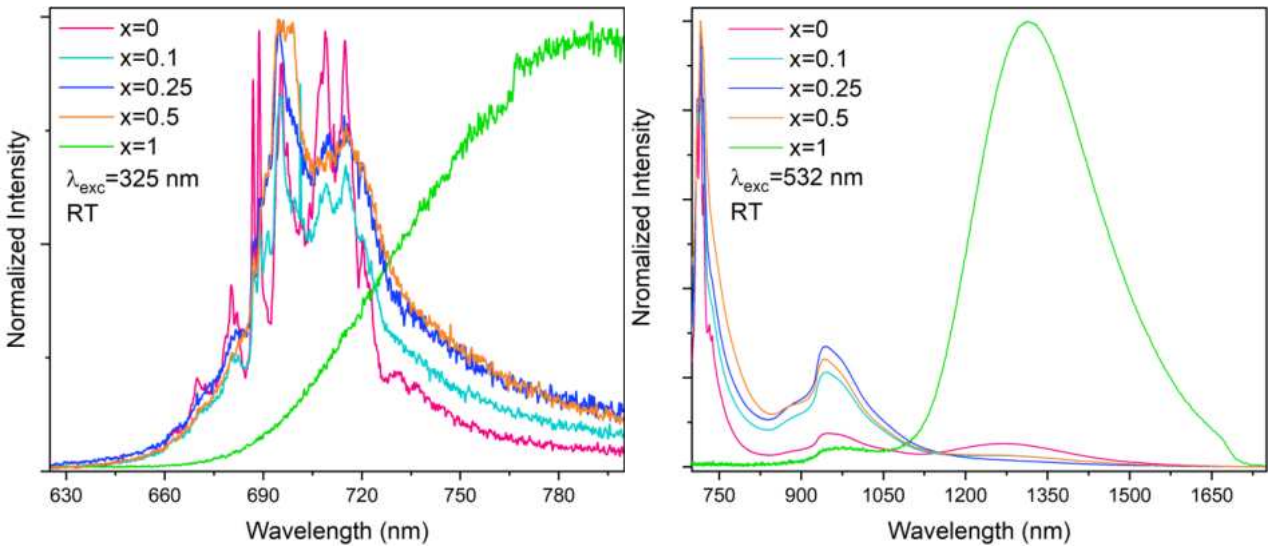

Figure 1: PL spectra for all samples in the visible (left) and NIR (right) spectral range.

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SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Use of biorthogonal click chemistry for the detection of inflammation-induced overexpression of VCAM-1 in mouse endothelial cells

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Specify Technical Area: X Biomedical __ Energy and other Applications

The global rise in chronic inflammatory diseases is closely linked to the ageing population, posing a growing challenge to healthcare systems. Current diagnostic approaches for inflammation-related conditions range from the detection of circulating inflammatory markers via biochemical assays to the detection of local inflammation using imaging techniques, such as X-ray, ultrasound, magnetic resonance imaging, computed tomography, or nuclear imaging. However, these techniques often lack the specificity to accurately localise inflamed areas and suffer from limited sensitivity in detecting inflammation at early stages. As such, there is a pressing need for innovative diagnostic technologies that are not only highly sensitive and specific but also safe, rapid, and cost-efficient.

Inflammation, whether acute or chronic, involves a complex cascade of biological processes aimed at eliminating harmful stimuli and restoring tissue homeostasis. A hallmark of this response is the upregulation of adhesion molecules such as vascular cell adhesion molecule-1 (VCAM-1), which is expressed on activated vascular endothelial cells. VCAM-1 plays a critical role in the recruitment of leukocytes to inflamed tissues through a multistep process involving tethering, rolling, activation, firm adhesion, and trans-endothelial migration.[1]

To exploit these molecular signatures for diagnostic imaging, bioorthogonal chemistry offers a powerful tool. This approach involves chemical reactions that can occur within biological environments without disrupting native biomolecules or interfering with physiological processes.[2]

In our project, we implemented a pretargeting strategy that combines the specificity of click chemistry with the selective overexpression of VCAM-1 in inflamed mouse aortic endothelial cells. We functionalised an anti-VCAM-1 antibody with trans-cyclooctene (TCO) and paired it with lanthanide-doped nanoparticles (LnNPs) functionalised with tetrazine (Tz), enabling rapid and highly selective TCO–Tz ligation. The LnNPs, co-doped with neodymium (Nd^{3+}) and ytterbium (Yb^{3+}), exhibit intense and well-defined luminescence in the near-infrared (NIR) range, making them exceptionally well-suited for deep-tissue, high-contrast imaging.

This targeted, bioorthogonal approach not only ensures precise localisation of inflammation but also demonstrates the potential of NIR-emitting LnNPs as a robust, non-invasive diagnostic platform for early-stage detection of inflammatory processes in vitro. Ultimately, this strategy lays the groundwork for next-generation imaging tools that can improve diagnostic accuracy and patient care in the management of inflammatory diseases.

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SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Photon Piling in Upconverting Lanthanide Clusters

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Please indicate preference: _X_Poster
Specify Technical Area: Energy and other Applications

Upconversion (UC) is a photophysical phenomenon wherein multiple low-energy photons are absorbed and subsequently re-emitted as a single higher-energy photon.[1] This process typically manifests as an anti-Stokes emission, offering significant advantages due to its minimal background interference from auto-fluorescence and light scattering, thus enhancing sensitivity. UC materials generally present ladder-like energy levels that facilitate a stepwise energy ascent towards the emitting state and possess long-lived intermediate excited states, which help prevent premature decay to the ground state. Lanthanide ions, with their favorable energy level structures and long excited state lifetimes,[2] are particularly well-suited for the design of UC materials.

Although the phenomenon of UC has being known since the 1960s,[3] its observation has been predominantly confined to solid-state materials and, more recently, nanoparticles. Molecular scale UC was first reported in 2011 by Piguet's group, who demonstrated trinuclear [Er2Cr] triple helicates exhibiting UC in organic solvents at low temperatures (30 K).[4] Despite this initial breakthrough, ensuing developments in new molecular UC devices have been sparse. With a notable advancement including our group's achievement of UC at the molecular scale in water at room temperature.[5]

This project aims to develop new supramolecular heteropolynuclear lanthanide-based clusters with enhanced UC efficiencies. Our focus being mainly the design of novel ligands to form discrete molecular entities with lanthanide ions, while thoroughly characterizing the cluster assembly processes to understand their kinetic and thermodynamic parameters, and optimizing the UC properties through strategic selection of lanthanide elements and optimization of ligands.

By improving the efficiency and control of UC at the molecular scale, this research aims to create innovative tools with potential applications across various fields, including bio-labeling, microscopy, photodynamic therapy, and NIR-to-visible conversion for photovoltaic cells.

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SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Transition metal oxides as a methane oxidation catalysts under Plasma conditions

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Poster
Energy and other Applications

Methane (CH_4) is the second largest contributor to global warming, accounting for approximately 30% of radiative forcing.[1] Currently, most methane is flared, converting it to carbon dioxide (CO_2), a greenhouse gas that remains in the atmosphere for thousands of years, with significant effects on the environment. To address this issue, innovative approaches have emerged aiming to mitigate methane emissions while simultaneously producing valuable chemicals through decarbonization strategies.[2] The use of plasma appears as a simple, powerful strategy to transform methane into a added value chemical. [3] In this context, we have studied the role of transiton metal oxides as catalysts in methane oxidation under Dielectric Barrier Discharge (DBD) plasma when generated within a tubular dielectric reactor. This low-temperature plasma is sufficient to activate methane enabling its conversion into high-value products such as ethanol, methanol, acetone, hydrogen and ethane.

Our results show how the presence of different transition metal oxides (i.e. , NiO, Fe_2O_3, MnO_2, CuO) in the reactior using pulsed DBD plasma under a He/CH_4 gas stream enhances CH_4 activation and tunes the selectivity of the process towards value-added, green products. Analysis of the reaction products confirmed a high selectivity for methanol when using iron oxide as catalysts in this plasma-mediated reaction.

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SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Photonic Materials for Neuromorphic Architectures

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Please indicate preference: Poster
Specify Technical Area: Energy and other Applications

Abstract

Nowadays, multiple areas of society generate large volumes of data, increasingly requiring fast and efficient processing. Artificial Intelligence (AI) has become crucial in addressing these advancements and needs. As the complexity of AI models grow along with data volumes, conventional computing encounters efficiency challenges [1]. Neuromorphic engineering appears as an alternative to computing hardware design inspired by the human brain and on its low power processing (20 Watts) [2]. The photonic domain enables the exploration of the unique properties of light for high speed, energy efficient and scalable computing [3]. In this work, we will address neuromorphic architectures based on luminescent materials implemented as photonic layers combined with digital Machine Learning (ML). The layers convert inputs into expanded versions based on their complex optical responses then used to feed the ML model, resulting in low-power hybrid AI architectures [4]. Neuromorphic hardware architectures are also explored based on the principles of reservoir computing. High-bandwidth optoelectronic components are combined with a Mach-Zehnder Interferometer as a nonlinear node and optical fibers as delay lines, to achieve an ultrafast and scalable processing [5]. The proposed approaches aim at highlighting optical neuromorphic computing as a promising and efficient alternative or enhancement over conventional computing paradigms.

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SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Direct insights into ligand exchange dynamics on $NaYF_4$ nanocrystals using ^{1}H-NMR

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Poster
Energy and other Applications

Lanthanide-doped $NaYF_4$ can be used in many applications such as bioimaging, luminescence thermometry, lighting, and increasing solar cell efficiency. For most of these, nanometer-scale crystals are needed for high spatial resolution, to benefit from solution processability, or to prevent light scattering. Generally, these nanocrystals (NCs) are synthesized using coprecipitation or thermal decomposition in the presence of molecules that function as stabilizing surface ligands. Oleic acid or oleyl amine are popular as these are practical in use and lead to high-quality NCs. However, other ligands are often necessary for applications. For instance in bioimaging, polar ligands are needed to disperse the NCs in aqueous environments. Ligand exchange is either a one-step process where post-synthesis ligands are displaced with a large excess of the desired ligand, or a two-step process where the post-synthesis ligand is stripped with an acid or nitrosonium tetrafluoroborate before introducing the desired ligand. The success of these strategies depends on the thermodynamics and kinetics of ligand binding and unbinding. These exchange dynamics are poorly understood and have not been studied directly on this material.

Here, we directly study the self-exchange of oleic acid on $NaYF_4$ NCs using simple ^{1}H-NMR. To this end, we investigate how exactly oleic acid is bound to the NC surface and gain insight into the exchange mechanism. We probe exchange dynamics and use this to explore how washing affects ligand density, which directly influences NC stability. Here, we exploit the dependence of NMR shift on the chemical environment by comparing peak positions of NMR signals from dispersed NCs to pure freely dissolved oleic acid to determine the amount of free and bound oleic acid in a specific system. This ratio informs us on the free-to-bound exchange rate of oleic acid on these NCs. With these results we aid the rational design of post-synthesis treatment of NCs to achieve desired ligand coverage.

SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Metal-organic frameworks (MOFs) based on lanthanides for molecular electronics

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Please indicate preference: Poster
Specify Technical Area: Energy and other Applications

In the early 1990s, de Silva *et al.* described the first general and practical approach to information processing and computing based on molecules able to perform logical operations, mimicking the conventional electronic logic gates.[1] The first AND molecular logic gate was based on organic molecules, applying cations as the logical inputs and a change in the emission intensity of the organic molecules as the logical output. However, the characteristic broadband emission and fast decay times of organic compounds, conjugated to the well-known photobleaching, precludes multiplexing using light as a logical input or output, making difficult its implementation in applications other than proof-of-concept molecular logic devices.

The use of trivalent lanthanide ions (Ln^{3+}) as luminescent optical active centers in molecular logic is particularly attractive as these ions typically emit in a wide wavelength range covering the UV–vis–NIR spectral regions, with characteristic line-like emission bands (<10 nm) and long-lived excited state lifetimes (>1 µs). Up to now, all the logical gates based on Ln^{3+} ions respond to chemical inputs, operating exclusively in wet conditions. If all both logical inputs and logical outputs are of physical nature (i.e., light, pressure, temperature), it will render advantages in the input-output homogeneity when the integration of distinct logical functions, no-contamination, and reuse of the device are demanded. [2,3]

In this poster we will report Ln^{3+}-based Metal-organic Frameworks (MOFs) and coordination polymers, which consist of Ln^{3+} ions or clusters coordinated with organic ligands for molecular logic applications. Some of Eu^{3+}/Tb^{3+} mixed MOFs are proven to exhibit thermometric properties, as their emission strongly depends on temperature. Moreover, the rigid and well-defined MOF crystal structure can protect the luminescent properties of lanthanide ions from environmental influences, preserving their optical characteristics. Lastly, the tuneability of MOFs enables precise control over the local environment surrounding Ln^{3+} ions, influencing their luminescent behavior and responsiveness to external stimuli. Consequently, Eu^{3+}/Tb^{3+} mixed MOFs are very attractive to develop molecular logic gates, exploiting temperature as logical input.

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SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Stable nano-YAG:Ce^{3+} phosphors for photonic applications

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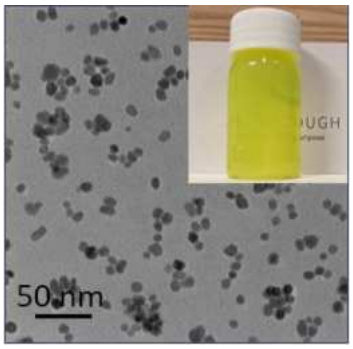
Please indicate preference: Poster
Specify Technical Area: Energy and other Applications

Over the last two and half decades, $Y_3Al_5O_{12}:Ce^{3+}$ (YAG:Ce) has served as a benchmark phosphor in lighting and display fields. Its intense green-yellow emission, extremely high robustness, strong absorption of blue light and outstanding stability makes it an ideal phosphor for a wide variety of applications. With recent miniaturization of semiconductor light emitting devices (LEDs), such as mini- and micro-LEDs, the search for stable and efficient down-converting materials with nano-to-submicron dimensions has intensified. Because of its many beneficial properties, YAG:Ce is an interesting candidate for these applications when available at the nanoscale. However, so far, efforts on the development of nano-YAG typically yield agglomerated and/or irregular particles, low absorption strengths, as well as a low energy conversion efficiency and stability issues. [1]

Here, we present an overview of our technologies on achieving stable, well-defined nano-YAG:Ce^{3+} phosphors with high energy conversion efficiencies (QY>90%). In this poster we discuss: 1) the different synthetic methods that we use, resulting in great control over the size of the nanoparticles, which can be tuned between few hundreds of nm to 10-20 nm; 2) the post-synthetic treatments and encapsulation technologies and how these influence the structural and optical properties of the materials, in particular how they improve the stability of nano-YAG:Ce^{3+} both under laser irradiation and on commercial LEDs.



Transmission electron microscopy image of nano-YAG:Ce^{3+} and (inset) digital photograph of a colloidal dispersion of YAG:Ce^{3+} nanoparticles

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SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Metal ions sensing with two-photon fluorescent probes based on cadmium-free colloidal quantum dots

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Please indicate preference: ✓ Poster __ Oral
Specify Technical Area: __Biomedical ✓ Energy and other Applications

Quantum dots (QDs) have gained broad attention across both scientific and industrial fields due to their tunable with size optical and electronic properties. Nevertheless, conventional QDs often contain cadmium – a toxic element associated with major health and environmental concerns - which limits their practical bio-related applications. Therefore, there is a strong demand for the development of non-toxic nanomaterials that would represent a less hazardous and more eco-friendly alternative. For instance, carbon nanodots (CNDs), sulfur quantum dots (SQDs) molybdenum disulfide quantum dots (MoS_2 QDs), indium phosphide/zinc sulfide core-shell quantum dots (InP/ZnS QDs) or silver sulfide quantum dots (Ag_2S QDs) not only offer excellent fluorescence performance but also exhibit low toxicity, good biocompatibility and water dispersibility, positioning them as promising candidates for wide array of uses [1,2].

One of the key phenomena in the field of fluorescent nanomaterials is two-photon absorption, which plays a vital role in cutting-edge developments in photonics, optical sensing, and biomedical applications such as bioimaging or theranostics. Utilizing femtosecond laser pulses, we investigate in detail the nonlinear optical behavior of cadmium-free QDs with a primary focus on their use as two-photon active nanosensors for metal ions detection. Through temperature dependence of luminescence measurements performed under near-infrared excitation, we offer deeper insight into the potential mechanisms responsible for the fluorescence quenching-based metal ions sensing in the two-photon regime. Characterizing the nonlinear optical properties of the studied nanomaterials in a quantitative manner enables precise evaluation of their performance in comparison to other fluorescent probes and optimization for applications in biomedicine, e.g. bioimaging. The results confirm the potential of non-toxic cadmium-free nanomaterials as sensitive and selective two-photon active optical sensors suitable for use in biological systems as well as interesting alternatives to currently employed markers for nonlinear microscopy.

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SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Electrocatalytic H_2O_2 Production via $2e^-$ Water Oxidation on Fluorine-Doped Tin Oxide Catalysts

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Please indicate preference: _X_Poster __ Oral
Specify Technical Area: __Biomedical _X_ Energy and other Applications

The selective electrochemical production of hydrogen peroxide (H_2O_2) via the two-electron water oxidation reaction ($2e^-$ WOR) has attracted growing interest as a sustainable alternative to the energy-intensive anthraquinone process. Recent studies have emphasized the importance of surface electronic properties and catalyst–support interactions in steering the WOR pathway toward H_2O_2 formation rather than oxygen (O_2) evolution [1,2].

In this work, we explore fluorine-doped tin oxide (FTO) as a cost-effective and stable catalyst system for $2e^-$ WOR. By systematically varying the fluorine concentration in tin oxide films through a spray pyrolysis technique, we aim to modulate the electronic structure and surface reactivity of the material. Our results show that the electronic and structural properties of the films are strongly dependent on the fluorine doping level. These properties were characterized using X-ray diffraction (XRD), electron microscopy, and optoelectronic measurements.
To evaluate catalytic performance, each FTO sample was deposited onto carbon paper as a current collector and tested in carbonate electrolyte. The preliminary results indicate H_2O_2 production with a Faradaic efficiency approaching 50%. Additionally, the electrodes suffer minimal degradation during long-term stability test. Post-mortem characterization confirmed the retention of the rutile phase, with no significant signs of structural degradation. This study provides valuable insights into fluorine doping as a strategy for enhancing WOR selectivity and underscores the importance of support engineering in optimizing electrocatalysts for decentralized H_2O_2 production.

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SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Modifying PTAA Wettability for Large Area Perovskite Sollar Cells

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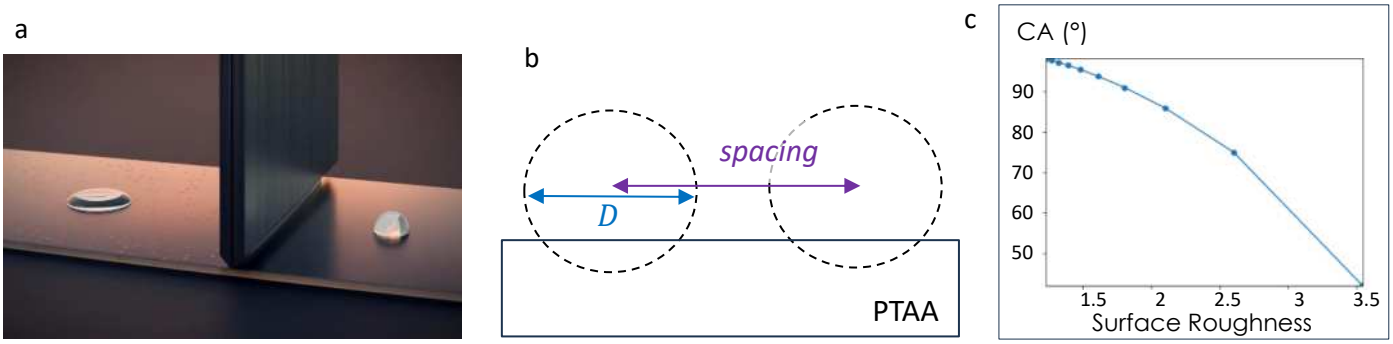
Please indicate preference: X Poster _ Oral
Specify Technical Area: _Biomedical X Energy and other Applications

Flexible perovskite solar cells are of great interest for the future's growing energy needs; this requires large scale manufacturing methods, including *roll-to-roll.* A favorable hole transporting material for this is PTAA: it is flexible, can be deposited quickly and at scale, and is hydrophobic [1]. The hydrophobicity is a double edged sword, promoting module stability but leading to incomplete perovskite coverage due to poor wetting.

Metal oxide nanoparticles have been shown to increase the wettability of hydrophobic substrates including PTAA [2]. Counter intuitively, partially blocking the contact area *increases* charge transfer by minimizing nonradiative recombination at the interface [3].

Metal oxide nano powders can be orders of magnitude cheaper than nanoparticles, but they are less studied because of their high agglomeration tendency, which hampers reproducibility. We hypothesize that by optimizing nano powder dispersion, and harnessing their agglomeration to improve wettability, a reasonable trade-off can be found.

Here we model the surface roughness factor and the effect thereof on the contact angle, using the Cassie wetting model corrected with a Wenzel roughness factor. We use nanoparticles and nano powders comparably to show a trade off in wetting modification (contact angle measurement), accounting for agglomeration (DLS) and the resulting roughness (AFM).



a: artist's illustration of the possible implementation of metal oxide nanomaterial layer, and the resulting change from high contact angle (right) to low contact angle (left). **b**: scheme of an idealized materials system of PTAA with spherical nanoparticles and **c**: the contact angle (CA) of this system with increased surface roughness for particle diameter D=50 nm.

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SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Optical Properties of Eu-Implanted Ga_2O_3 Thin Films: From α to β Polymorphs

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Please indicate preference: _x_Poster __ Oral
Specify Technical Area: __Biomedical _x_ Energy and other Applications

Gallium oxide thin films have garnered significant attention as a promising ultrawide-bandgap material for next-generation semiconductor devices [1]. The α to β polymorphs have been extensively studied due to their potential in diverse applications, including high-power electronics, deep UV optoelectronics, gas sensors, and transparent conductive films, among others. The β-phase of monoclinic Ga_2O_3 is the most stable form, characterized by a wide bandgap of 4.9 eV and a high breakdown electric field of 8 MV/cm. [1], making it well-suited for power electronics and optoelectronics in environments due to its excellent thermal stability, high dielectric strength, and resistance to radiation and chemical degradation. Its metastable counterpart, α-Ga_2O_3, offers an even larger bandgap (up to 5.2 eV) and a higher predicted breakdown field (around 10 MV/cm) [1]. Modifying Ga_2O_3 thin films with rare-earth ions enables tunable emission from the ultraviolet to the near-infrared. Europium (Eu) doping is particularly interesting for gallium oxide thin films due to its sharp, intense red luminescence, ideal for displays and phosphors. Ion implantation is a highly appealing doping method from an industrial standpoint, offering precise control over dopant concentration and spatial distribution. Numerous studies have investigated the luminescence of Eu-implanted β-Ga_2O_3 thin films [2,3]; however, research on Eu-implanted α-Ga2O3 thin films and their subsequent phase transformation to β remains limited. In this work, Eu ions were implanted in α-Ga_2O_3 thin films (grown by halide vapor phase epitaxy (HVPE) at 500 °C [4]) at RT with a fluence of 1×10^{15} cm^{-2}. A systematic study of the optical and structural characterization as a function of post-implant rapid thermal annealing (RTA) temperature, ranging from 400 °C to 1000 °C, was performed to evaluate the transformation of the α-phase into the β-phase and its implications for the optical activation of ions. The luminescence of Eu-implanted α/β Ga_2O_3 thin films was evaluated using optical spectroscopy, including Photoluminescence (PL) and PL Excitat ion (PLE) techniques. The structural characterization was performed using Rutherford Backscattering Spect rometry, X-ray diffraction, and μ-Raman spectroscopy. The PL results reveal that the trivalent was successfully activated for RTA temperatures above 700 °C; at the same time, the α-phase is completely transformed into the β-phase as confirmed by structural characterization.

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SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Stitching-Based Resolution Enhancement in Wavefront Phase Measurement of Silicon Wafer Surfaces

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Please indicate preference: Poster

Specify Technical Area: Energy and other Applications

The increasing demand for higher resolution and faster machinery in silicon wafer inspection is driven by the rapid rise in electronic device production and the continuous miniaturization of microchips. As feature sizes shrink and wafer sizes grow, there is a critical need for precise and efficient surface characterization tools. To address these challenges, this paper presents the design, development, and implementation of a novel measurement device capable of accurately characterizing the surface of silicon wafers through the stitching technique. We propose an advanced optical system architecture specifically optimized for evaluating the surface profile of silicon wafers, with particular emphasis on measuring roughness and nanotopography. The developed device achieves a lateral resolution of 7.56 µm and an axial resolution of 1 nm, enabling high-precision metrology. It is capable of scanning and analyzing an entire 300-mm wafer in approximately 60 minutes, while acquiring and processing approximately 400 million data points. The core methodology utilizes a wavefront phase sensor, which reconstructs the wafer's surface geometry by analyzing two images displaced at carefully determined distances from the conjugate plane within the image space of a 4f optical system. The study further details the comprehensive calibration procedure and introduces a robust algorithm for transforming local measurement coordinates into global wafer coordinates. Quantitative phase imaging is obtained through the application of a wavefront intensity image reconstruction algorithm. Experimental validation demonstrates the system's ability to differentiate between thinned dies bonded onto carrier wafers, detect variations in coplanarity, and identify bonding defects. Additionally, the residual stress in thin films deposited over the dies is quantified using the Stoney model, underscoring the system's potential for comprehensive wafer inspection and advanced process monitoring in semiconductor manufacturing.

SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Compact photocapacitors and photobatteries for direct light energy storage

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Preference: __Poster __
Technical Area: __ Energy and other Applications__

In recent years, the growing global energy demand has driven significant interest in the development of sustainable energy sources. It is possible to distinguish between different renewable powering technologies based on renewable sources. Among all different renewable energy sources such as solar, wind, biomass and ocean energy[1], sunlight stands out being the most promising one. However, it presents some important limitations, mostly related to its intermittency, due to the variability of solar irradiation along the day and the year. This leads to the necessity of highly efficient energy storage systems.[2] Nevertheless integration of a solar energy conversion system with a storage device implies, few drawbacks related for example, to electricity losses. To avoid this problem, new compact devices have been developed, which are able to combine the two main functionalities without the need for additional connections thanks to multifunctional materials.[3] Such devices can rely on different storage mechanisms: electrochemical, as in batteries, or electrical, as in supercapacitors.[4] Thus, it is possible to fabricate photo-batteries and photo-capacitors that can self-recharge preserving their good performance as storage systems. Today, there is an increasing interest in the study of efficient materials to be implemented in these systems, *e.g.* photo-rechargeable zinc-ion based capacitors[5] and photo-rechargeable lithium-ion based batteries[6], coupled with different electrode materials. The aim of this presentation is to highlight the newest technologies and materials with integrated and compact high performance energy conversion and storage solutions with careful considerations on the current limitations and a perspective on future scientific directions.

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SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Skin-inspired stretchable biogel enables high-performance moisture-electric generation and AI-enhanced closed-loop hydration regulation

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Please indicate preference: Poster. Specify Technical Area: Energy and other Applications

Abstract

Moisture-induced energy harvesters have shown promise for portable power supply[1] and self-powered on-skin sensing in non-invasive health monitoring[2]. However, current materials suffer from trade-offs between electrical and mechanical properties, limiting their energy output and operational stability under physiological conditions. Here, we report a skin-inspired stretchable biogel with bidirectional dual-ion transport highways and a dynamic interpenetrating network that mimics the ion-regulating function of sweat glands and the mechano-adaptive architecture of the dermis.

The biogel combines bidirectional dual-ion transport channels with a dynamic interpenetrating network, enhancing ionic mobility, mechanical adaptability, and structural integrity. Key properties include ultra-high stretchability (750% strain), skin-like Young's modulus (45 kPa), and high ionic conductivity (2.0 S/m at 25°C). Leveraging these, the MEG maintains stable performance over 50 days, delivering 1.3 V open-circuit voltage, 1.1 mA cm^{-2} short-circuit current density, and 114 μW cm^{-2} power density at 60% RH—tripling state-of-the-art systems. The biogel also features strong interfacial adhesion, thermal reversibility, biodegradability, and excellent cytocompatibility, ensuring biosafety and sustainability. Scalable fabrication enables large-area (4000 cm^2) 15 × 15 device arrays, with 120 units powering mobile phones outdoors. Integrated with deep learning skin patches, it achieves 94% accuracy in real-time exercise hydration monitoring via a BiLSTM network, supporting wireless prediction and advancing personalized health management.

Mechanistic studies show that charged functional groups ($–OSO_3^-$/$–COO^-$/$–NH_3^+$) form biomimetic dual-ion channels, enhancing ordered ion migration and suppressing adverse diffusion via a "triple synergistic mechanism" of electrostatic enrichment, directional transport, and disordered diffusion inhibition. Molecular dynamics simulations and in situ spectroscopy (FTIR, Raman) confirm these mechanisms reduce charge recombination, boosting energy output. This work resolves the critical trade-off between mechanical performance and energy efficiency, offering a versatile platform for flexible bioelectronics, sustainable energy harvesting, and AI-driven health monitoring.

Keywords: Hydrogel; Moisture-electric generators; Deep learning; Bionic.

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SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Superior Photodetection in Inverted Perovskite Architectures: Enhanced Responsivity and High Stability in p-i-n Triple-Cation Devices

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Poster-Energy

Abstract

Bulk organometal perovskite materials with single or double organic cations have been employed in photodetection applications due to their excellent optical properties, such as bandgap tunability, strong light absorption, and effective carrier transport. However, these materials are not stable under ambient conditions; hence, we used triple-cation perovskite materials, such as $Cs_xMA_yFA_{1-x-y}Pb(I_zBr_{1-z})_3$ (Cesium (Cs) Methylammonium (MA) Formamidinium (FA)) Lead (Pb) Iodiode (I) Bromide (Br)), and also encapsulated the final device, to not only preserve the promising properties of single- or double organic-cation perovskites, but also to mitigate the stability issue. In this study, we compare the photodetection capabilities of n-i-p (conventional) and p-i-n (inverted) triple-cation perovskite devices, focusing on key metrics such as dark current, photogenerated current, responsivity, and operational stability. The results demonstrate that the p-i-n configuration achieves superior performance, such as a high photogenerated current and low dark current of 100 µA at 0.1 mW and 1.2 nA, respectively. In addition, it exhibits an enhanced responsivity of 0.32 A/W at a wavelength of 450 nm. On the other hand, n-i-p configuration responsivity is 0.28 A/W at the same wavelength. However, it shows a lower photocurrent, 10 µA at 0.1 mW, and a comparable dark current of 0.8 nA. Detailed analysis demonstrates that such excellent performance originates from the good band alignment between perovskite and the 2PACz hole transport layer (HTL), which reduces the barrier height for holes, hence resulting in recombination reduction and more efficient charge extraction and collection. These findings establish p-i-n perovskite photodiodes as the preferred architecture for stable, high-sensitivity photodetection, with potential applications in imaging, sensing, and optical communications.

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SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Micropositioning NIR colloidal nanocrystals and measurement of their microluminiscence

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Abstract

Colloidal quantum dots (CQDs) and nanocrystals with tunable bandgaps in the NIR range are being researched for multitude of infrared applications including LiDAR, telecommunications, quantum technologies, photodetectors, cameras, as well as biosensing, deep-tissue imaging, or therapy.

In this work, an approach from the field of microelectronics is applied for the selective deposition of nanomaterials with micrometric resolution. The approach is based on the use of UV-patternable composites with Ag_2S nanocrystals, where the patterning is produced by photolithography, which is compatible with the electronics industry.

The Ag_2S nanocrystals have been synthesised by the coprecipitation method, and their morphology and optical properties have been characterised. Then, an optimal formulation for the lithographic process has been developed. Finally, the micro-luminescence of the patterns has been measured by using a confocal microscope coupled to a FLS1000 spectrofluorometer from Edinburgh Instruments.

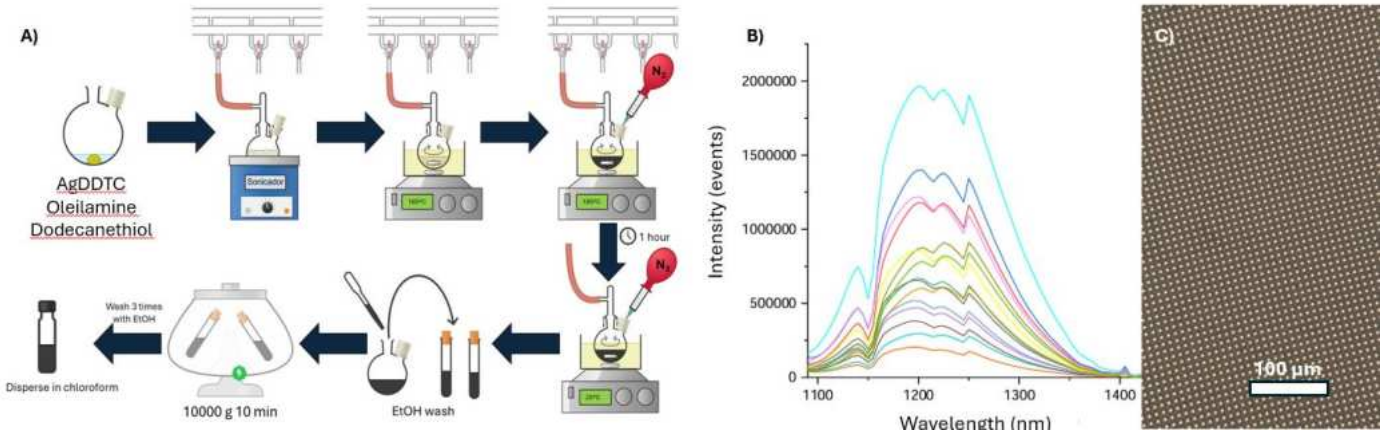

Figure. A) Synthesis of Ag_2S nanocrystals. B) Photoluminescence of the nanocrystals in suspension. C) Polymer array produced by photolithography with 10 µm pitch.

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SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Photoconductivity in ultrathin Indium Selenide nanosheets

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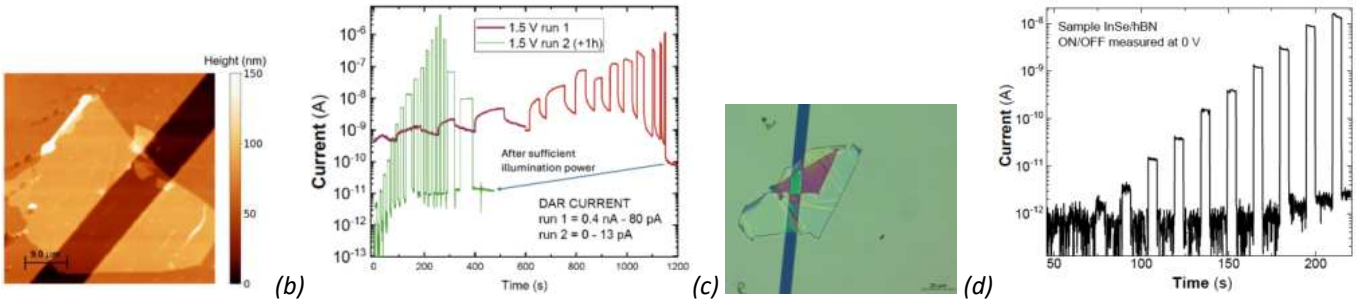
Please indicate preference: X Poster __Oral
Specify Technical Area: __Biomedical X Energy and other Applications

Indium Selenide (InSe) is a layered monochalcogenide semiconductor, which possesses a suitable bandgap energy for solar energy conversion and an exceptionally high electronic mobility at room temperature (> 1000 cm^2/Vs). While its absorption coefficient is relatively low at E_g (10^3 cm^{-1}), it significantly increases at energies above the E1 transition ($5x10^4$ cm^{-1} at 450 nm). These attributes make near-2D ultrathin InSe nanosheets an ideal semiconductor for micro-photodetectors, particularly self-powered devices. In the present work we have studied the photoconductivity of such ultrathin nanosheets with several lateral dimensions and thicknesses (see Fig. 1a for one of them 24 nm thick as measured by AFM) transferred onto prepatterned Pt electrodes (8-10 µm of channel lengths). Electrical measurements were performed in vacuum (≈ 10^{-6} mbar) at different temperatures (80-300 K) and compared to the case of ambient conditions. Our measurements demonstrate that pristine samples exhibit a trap sensitized photoconductivity: high responsivity at the lowest measured incident powers but limited by slow rise/decay times (red line in Fig. 1b). However, after sufficiently high illumination (> 0.1 W/cm^2), dark current is strongly reduced, and very fast operation is observed (green line in Fig. 1b) together with an increasing photocurrent nearly linear with the incident power. Such effect of trap passivation under illumination in vacuum conditions is not simple to elucidate. A plausible mechanism could involve a photo-passivation (local heating by light absorption, possibly) of Se vacancies at the InSe surface with remaining oxygen (and water vapor). This could change the Fermi level pining. This passivation effect is not observed in InSe nanosheets covered with h-BN, hence the phenomenon is mostly related to the top free surface in ultrathin nanosheets. For nanosheets with asymmetric area size touching the two Pt electrodes (Fig. 1c) self-powered operation (V = 0) is possible with a much faster operation (Fig. 2d), because in this case trap sensitized photoconductivity does not apply.



(a) (b) (c) (d)

Figure 1 – (a) AFM made on an ultrathin nanosheet 24 nm thick. (b) ON/OFF current measurements using a 450nm laser on the the nanosheet by increasing excitation power in each cycle (pristine: red line, run 2 after pristine measure: green line). (c) Visible microscope image of an InSe nanosheet (21.7 nm thick) capped with h-BN. (d) ON/OFF at 0V (450 nm laser).

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SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Red/Green tunable emission from $NaTbF_4$ nanoparticles under dual-mode UV/NIR excitation for anticounterfeiting applications

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Please indicate preference: X Poster __ Oral
Specify Technical Area: __Biomedical X Energy and other Applications

Counterfeiting is a growing challenge that demands innovative security solutions based on advanced luminescent materials. Among these, rare-earth-doped nanoparticles are particularly promising due to their tunable optical properties, which enable the generation of unique and distinct emission profiles.
In this work, $NaTbF_4$ un-doped and Eu^{3+} and/or Yb^{3+} doped nanoparticles were synthesized via solvothermal method and characterized by X-ray diffraction, transmission electron microscopy and energy-dispersive X-ray spectroscopy to confirm their structural and chemical composition. Spectroscopic analysis reveals that these materials exhibit tunable luminescence, with emissions that can be either green- or red-dominant, depending on the excitation wavelength (ultraviolet UV, or near-infrared NIR) and the dopant ions. This dual-mode luminescence is the result of efficient energy transfer between the Tb^{3+}, Eu^{3+}, and Yb^{3+} ions, involving down-shifting and up-conversion processes. Additionally, as a proof of concept, the nanoparticles were successfully integrated into commercial offset inks, allowing encrypted luminescent codes to be revealed under different excitation conditions.

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Shift'25 TENERIFE

Regular Poster

SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Advanced Photodynamic Therapy Using Laser-Generated X-Rays

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Poster
Specify Technical Area: Biomedical Applications

Since cancer remains the second leading cause of death worldwide, it is an urgent need for more effective and targeted treatments. Limitations of conventional treatments such us - systemic toxicity, drug resistance, and limited efficacy have driven interest in alternatives like photodynamic therapy (PDT), which offers a more targeted and promising approach [1].

PDT is minimally invasive and has low toxicity but suffers from poor tissue penetration [1]. To overcome this, scintillating nanoparticles (NPs) were utilized to convert ionizing radiation, such as X-rays, into visible light, activating nearby photosensitizers. NPs were synthesized by sol-gel method and conjugated with a porphyrin-based photosensitizer. To assess the X-PDT capabilities of our complexes, we have examined the use of high-power laser-induced Bremsstrahlung radiation. The study employed a 7.5 PW laser (~250 J energy before compressor, 25 femtosecond pulse) with a gas jet target (98% helium and 2% nitrogen) to produce relativistic electron beams, which were directed at a metal foil to generate photon beams with an energy cutoff of ~100 MeV and ~3 mrad divergence. To assess the effects of laser-driven radiation on biological samples we used various cell lines, including both healthy and cancerous types. These samples were exposed to several radiation shots to achieve a relevant accumulated dose. Following exposure to the secondary generated radiation, cellular responses were evaluated through multiple assays, including cell viability assessment using the MTT assay to determine the cytotoxic effects of the treatment and the comet assay to analyze the DNA damage induced by the therapy.

The results highlight the transformative potential of high-power laser systems for radiobiology and oncology. These methodologies provide a foundation for investigating radiobiological phenomena at ultra-high dose rates, with promising applications in understanding and leveraging FLASH effects. This campaign marks a key step in integrating advanced laser technologies into precision radiotherapy and radiobiological research.

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SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Scintillating Nanocomplexes for X-Ray Induced Photodynamic Therapy

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Poster
Specify Technical Area: Biomedical Applications

Photodynamic therapy (PDT) is a clinically approved treatment, which employs a photosensitizer (PS) exposed at a certain light wavelength to generate reactive oxygen species (ROS) in order to kill cancer cells. Although PDT is minimally invasive and has low toxicity, it still has some drawbacks, like shallow tissue penetration. As a solution for this problem, X-ray induced PDT (X-PDT) was developed as a new therapy approach which uses ionizing radiation instead of visible light [1,2].
In this study we report the synthesis and characterization of several lanthanide X-ray-excited luminescent nanoparticles (NPs). NPs have been successfully synthesized by doping several lanthanides into TiO_2 host matrices and were effectively employed in combination with several PSs. Ce and Eu doped TiO_2 NPs were synthesized by sol-gel method and conjugated with porphyrin-based PS. The nanocomplexes and their counterparts were photophysical and morphologically characterized by several techniques such as UV-Vis absorption spectroscopy, photoluminescence, oxygen singlet generation, DLS, XRD, XPS, and SEM.
To evaluate the X-PDT potential of our complexes, we have used of X-ray conventional source with 45 kV and 800 µA. Doses of 1Gy, 2Gy, and 4 Gy were applied for biological screening of PS-nanocomplexes for both normal and tumoral cell models. This setup utilized 48/96-well plates to enable simultaneous irradiation of multiple experimental conditions. Preliminary biological screening was accomplished by MTT/MTS assay, Live/Dead staining, and LDH cytotoxicity assay to demonstrate the performance of the experimental setup and preservation of cell viability. Additional protocols for biological testing including clonogenic assay, ROS generation analysis, cell cycle studies, and Comet assay were performed further. All tests were performed on MCF-12A normal cells and MDA-MB-231 triple-negative breast cancer cells.
The performed investigations revealed the potential of our synthetised nanocomplexes for X-PDT.

Aknowledgement: This research was funded by the Institute of Atomic Physics through the project ELI-RO/RDI/2024_022; the Romanian Ministry of Education and Research by Nucleu Program LAPLAS VII contract no. 30 N/2023.

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SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Engineering Core@Shell Upconverting Nanoparticles for High-Efficiency FRET-Based pH Sensing

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Please indicate preference: X Poster __ Oral
Specify Technical Area: __Biomedical X Energy and other Applications

Globally, pH is a frequently measured chemical parameter, with glass pH electrodes being a widely used benchmark for their reliability, precision, and broad pH range coverage. Despite their cost-effectiveness and rapid response, glass electrodes have drawbacks such as large size, rigidity, and susceptibility to external fields, limiting their suitability in certain applications. Optical methods offer effective alternatives to address pH measurement challenges, especially at nano-/micro-meter scales and for visualizing the pH distribution. FRET-based sensors, particularly those utilizing upconverting nanoparticles (UCNPs), show promise in measuring local variations of pH in critical biological parameters. UCNPs, capable of emitting higher-energy photons upon excitation with low-energy photons, offer advantages such as resistance to photobleaching and background-free detection. The unique multi-modal emission of UCNPs enables ratiometric sensing, reducing errors associated with fluctuations in excitation intensity or nanoparticle concentration. This makes UCNPs a robust and accurate candidate for various sensing applications. Nonetheless, FRET is not the exclusive process influencing the detected emissions. Unless individual UCNPs are measured directly, there's a notable possibility that a photon emitted by one UCNP could be absorbed by a dye molecule located on another nanoparticle. This phenomenon, known as photon reabsorption (PR), can lead to a reduction in the collected emission, potentially masking the genuine localized FRET response of the original nanoparticle. This issue arises due to the random distribution of emitting ions throughout the UCNP volume, with only a fraction of them present near the surface and participating in FRET. Current sensors often neglect this complexity, relying on less-sensitive reabsorption processes.

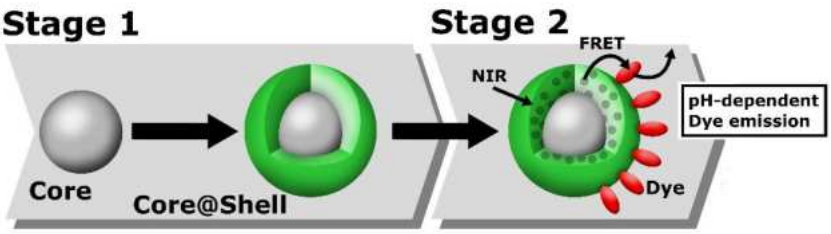

Figure 1. Schematic illustration of the idea leading to enhance the FRET efficiency

This study explores the design and optimization of core@shell UCNP architectures tailored to enhance FRET efficiency while mitigating PR effects. By positioning donor ions in a thin active shell and minimizing donor–acceptor distances, we demonstrate a significant improvement in FRET-based pH sensing performance.

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SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Evaluating the laser cooling potential of Yb^{3+} - doped CaF_2 microcrystals

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__Poster
Specify Technical Area: __Biomedical

Temperature is a key parameter that governs a wide spectrum of phenomena in physics, chemistry, and biology – from chemical reaction kinetics and phase transitions to metabolic processes. Comparing with localized heating, which is straightforward even at small scales, achieving effective microscale cooling remains a significant challenge. Laser-based refrigeration, relying on anti-Stokes photoluminescence, has emerged as a compelling strategy. In this process, materials absorb photons of lower energy and emit photons of higher energy, extracting vibrational energy (phonons) from the lattice and leading to a net cooling effect (Fig. 1a)) [1][2]. Ytterbium-doped materials are particularly well-suited for this approach due to their favorable energy level structure.

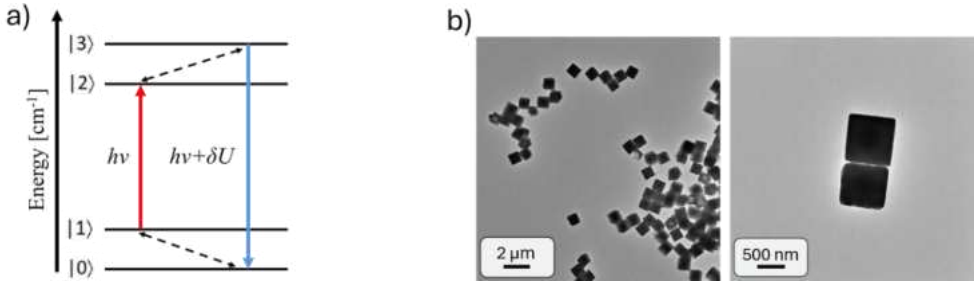

Fig. 1. a) Four-level energy model underlying optical cooling. b) Transmission electron microscopy (TEM) images of CaF_2 crystals synthesized over 12 hours with pluronic F127 at pH=4.

In this study, we evaluate Yb^{3+} doped calcium fluoride (CaF_2) microcrystals as a potential material for optical refrigeration. CaF_2 possess high optical transparency, though its relatively high phonon energies may constrain cooling efficiency. CaF_2:Yb^{3+} microcrystals were synthesized using hydrothermal approach, employing both conventional oven and heating as well as microwave-assisted techniques. We systematically varied synthesis parameters—including reaction duration, pH, and surfactant selection—to examine their influence on crystal morphology and size. Structural properties were confirmed using X-ray powder diffraction (XRD), while particle morphology was characterized using both optical microscopy and transmission electron microscopy (TEM) (Fig. 1b). Possibility of optical refrigeration in CaF_2: Yb^{3+} was evaluated using Raman spectroscopy by analyzing both the intensity ratio of Stokes to anti-Stokes scattering and the temperature-dependent softening of Raman modes. These investigations provide insight into the cooling dynamics and the potential of CaF_2:Yb^{3+} as a viable candidate for solid-state laser refrigeration.

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SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Adaptive Phase Engineering in Interferometric Scattering Microscopy

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High-resolution tracking of nanoscale objects is critical in both biomedical diagnostics and nanotechnology for energy systems. Interferometric scattering (iSCAT) microscopy, a label-free technique capable of sub-nanometer spatial resolution, provides a powerful platform for real-time imaging of weakly scattering particles such as proteins, viruses, or synthetic nanostructures. However, its practical deployment in complex 3D environments is hindered by rapid axial contrast oscillations and phase ambiguities.

To overcome these limitations, we integrate photothermal spatial light modulators (PT-SLMs) with programmable spiral phase masks for dynamic point spread function (PSF) engineering. This configuration enables fast, real-time modulation of the optical wavefront, stabilizing axial signal response and enhancing 3D localization performance without relying on exogenous labels. Unlike static phase masks, PT-SLMs allow adaptive switching between multiple PSF profiles, enabling context-specific imaging protocols.

This approach significantly improves depth sensitivity, signal robustness, and particle discrimination—capabilities essential for studying subcellular processes, tracking therapeutic nanoparticles, or characterizing nanostructured materials for energy harvesting and storage. Demonstrations include enhanced axial tracking of nanoparticles across extended focal volumes and rotational PSF multiplexing to extract morphological information.

By combining dynamic wavefront control with iSCAT's intrinsic sensitivity, this technique provides a flexible platform for non-invasive characterization of nanoscale systems, supporting advancements in next-generation diagnostic tools and material science.

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SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Highly Photostable UCNPs–Chlorin e6 Nanocomplex for Dual NIR-Activated Photodynamic Therapy

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Please indicate preference: Poster
Specify Technical Area: Biomedical Applications

Photodynamic therapy (PDT) has become a clinically accepted, minimally invasive cancer treatment strategy. It offers advantages such as precise tumor targeting, reduced systemic toxicity, affordability, and rapid patient recovery. However, the limited tissue penetration of excitation light in the visible spectrum region has hindered its full therapeutic potential. To address this limitation, we developed a nanocomplex that utilizes the deep-tissue penetration capabilities of near-infrared (NIR) light to activate a conventional photosensitizer, chlorin e6 (Ce6). In this approach, Ce6 was specifically incorporated into upconversion nanoparticles (UCNPs), which are designed to emit in the visible spectrum when excited by two NIR wavelengths. The emission profile of the UCNPs was tailored to align with Ce6 absorption, thereby enhancing effective luminescence resonance energy transfer (LRET). The UCNPs were modified with saturated phospholipids, facilitating the transfer from organic solvents into aqueous environments and allowing for a Ce6 loading capacity. The resulting UCNPs-Ce6 nanocomplexes exhibited outstanding cellular biocompatibility, achieving LRET efficiency surpassing 50%. Additionally, these complexes demonstrated effective singlet oxygen generation when irradiated with 808 nm or 980 nm NIR lasers. Ce6 demonstrated significantly enhanced photostability when encapsulated within the nanocomplex compared to its free form. Cellular uptake studies revealed endocytic internalization of the nanocomplex. Exposure to NIR light induced a significant, dose-dependent cytotoxic effect on both DLD1 and HCT116 colorectal cancer cell lines. Among the two excitation wavelengths tested, 808 nm emerged as the more advantageous option, yielding higher singlet oxygen production and minimizing thermal effects. Overall, our results underscore the potential of the UCNPs-Ce6 nanocomplex as a highly promising NIR-responsive candidate for the deep-tissue photodynamic cancer therapy.

Acknowledgements
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SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Before Going Intracellular: Exploring the Temperature-Dependent Emission Behaviour and Stability of a Genetically Encoded Probe in Intracellular-Mimicking Buffers

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Please indicate preference: Poster
Specify Technical Area: Biomedical

Temperature is more than just a number; within living cells, it's a dynamic biophysical parameter vital for regulating cellular function. Yet accurately estimating local heat production at subcellular resolution remains a considerable challenge. Luminescence thermometry has become a promising approach in this regard owing to its remote nature, high thermal sensitivity, spatial resolution, and rapid acquisition rates [1]. These luminescent thermometers can detect minor temperature variations by turning them into changes in fluorescence properties. Among the several luminescent probes reported in the literature, fluorescent protein-based thermometers have demonstrated excellent intracellular targeting capability [2].

In this work, we investigate the potential use of ELP-TEMP, a genetically encoded fluorescent thermometer, for detecting intracellular temperature variations. ELP-TEMP is composed of an elastin-like peptide fused with two fluorescent proteins (mVenus and mTurquoise2), which reached a maximum temperature sensitivity reported of 45.1% per °C [3]. When coupled with the appropriate localisation sequences, this fluorescent protein can also be used to target specific organelles.

Our present focus is on characterising the temperature-dependent emission behaviour and thermal stability of ELP-TEMP. Controlled heating and cooling cycles (0.5°C/min) were monitored to evaluate thermal response and calculate the melting temperature (T_m), defined as the point at which 50% of the protein is in its unfolded state. Emission spectra are acquired upon excitation with near-UV light with a wavelength of 405 nm in the 20–95 °C range and used to generate calibration curves in aqueous buffers such as PBS, phosphate-buffered saline. These tests will be extended to environments that mimic intracellular conditions to investigate the impact of media composition on the accuracy of thermal readout.

Although still in progress, this work aims to create highly sensitive probes suitable for biological use. Ultimately, this research will contribute to the development of accurate intracellular thermometry techniques, with a particular emphasis on monitoring mitochondrial temperature. Mitochondria are particularly interesting organelles due to their involvement in metabolism, thermogenesis, and disease.

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SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Infrared emitting lanthanide doped nanoparticles provide sensing capabilities to coronary implants

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Please indicate preference: ☑Poster __ Oral
Specify Technical Area: ☑Biomedical __ Energy and other Applications

Intracoronary stents have revolutionized the treatment of coronary obstructions, allowing for minimally invasive procedures and significantly enhancing both therapeutic efficacy and patient quality of life. Despite their clinical success, once implanted, stents act as passive elements, incapable of providing real-time data on the treated artery, thereby limiting early diagnosis of post-implantation complications such as inflammation, restenosis, or recurrence of atheromatous plaques. In this study, we introduce stents with deep tissue sensing capabilities through the incorporation of near-infrared emitting lanthanide-doped nanoparticles. Using 3D-printed stent prototypes, we demonstrate that the luminescence emitted by neodymium and ytterbium ions in core/shell/shell $NaYF_4$ nanoparticles facilitates both deep tissue visualization and tracking of the stent position. Additionally, the temperature-dependent fluorescence lifetime of Nd,Yb:$NaYF_4$ nanoparticles provides thermal sensitivity, allowing precise deep tissue thermal monitoring of catheter-induced heating with sub-degree accuracy. This work highlights the potential of infrared-emitting nanoparticles to drive the next generation of coronary stents, paving the way for advanced light-based diagnostics and therapeutic procedures.

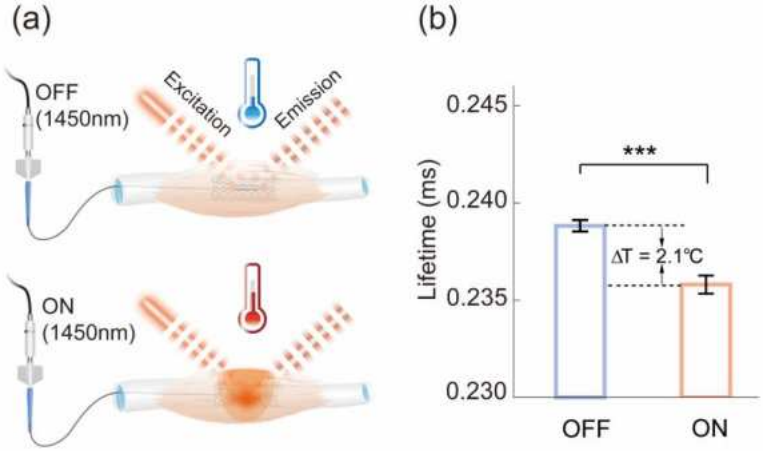

Figure. 3D printed luminescent stent for remote thermal monitoring of intracoronary hyperthermia treatment. (a) Schematic drawing of the experimental procedure used to evaluate the potential of our fluorescent stents for remote thermal monitoring of intracoronary hyperthermia treatment. Excitation and emission wavelengths were 800 nm and 980 nm, respectively. **(b)** Average fluorescence lifetime obtained in the absence and presence of 1450 nm radiation. The on-target 1450 nm laser power provided by the catheter was 20 mW.

SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Development of a multimodal laser-based system for intraoperative differentiation of head and neck cancer

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Please indicate preference: poster
Specify Technical Area: Biomedical

Head and neck cancer incidence and mortality are rising across Europe, with a projected 30% increase in cases by 2030. The accurate differentiation between malignant and normal tissue remains a critical challenge in oncological surgery. To address this, we propose the development of an experimental system that integrates laser-induced autofluorescence (LIF), time-resolved LIF, and Raman spectroscopy into a automated platform for *ex vivo* tissue analysis. Fluorescence spectroscopy offers insight into both morphological and biochemical properties, enabling real-time, single-point measurements and intraoperative application. Autofluorescence spectra reflect tissue composition and are useful in detecting cancer both *ex vivo* and *in vivo*. Raman spectroscopy complements this by detecting subtle biochemical changes preceding morphological transformations visible under the microscope.

The experimental setup integrates two diode lasers, a dual-spectrometer detection system, and an automated sample stage. Tissue samples are collected *ex vivo* from patients undergoing laryngectomy, sectioned using cryostat, and mounted on optical slides. The system performs point-by-point scanning of the samples, collecting both fluorescence and Raman spectra, which are analyzed to identify spectral markers indicative of malignancy.

Our findings reveal distinct spectral differences between normal and tumoral tissue, including variations in fluorescence intensity, emission wavelength, and characteristic Raman shifts. These optical markers are statistically validated and correlated with histopathological results to ensure diagnostic relevance. The integration of LIF and Raman techniques allows for a comprehensive biochemical and structural assessment of the tissue, improving the accuracy of cancer detection while minimizing the risk of false positives.

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SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Modeling proton-induced DNA damage in human fibroblasts using GEANT4-DNA simulations

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Please indicate preference: Poster

Specify Technical Area: Biomedical

Cancer remains a major global health challenge, with rising incidence and mortality rates underscoring the urgent need for advanced, effective treatment modalities. Proton beam therapy has emerged as a promising approach due to its ability to precisely target tumors while minimizing the damage to healthy tissues. Understanding the complex biological effects of proton irradiation on human cells is essential for optimizing treatment protocols and ensuring long-term patient outcomes.

This study investigates the impact of proton beams with energies ranging from 150 keV to 60 MeV on human fibroblast cells using the GEANT4-DNA Monte Carlo simulation toolkit. Fibroblasts, being abundant and structurally integral to human tissues, provide a relevant model for analyzing radiation response. The simulations incorporate detailed representations of the physical, physicochemical, and chemical stages following irradiation, including energy deposition and radiolytic processes leading to DNA damage.

The results quantify early DNA damage, particularly single-strand breaks (SSBs) and double-strand breaks (DSBs), caused by direct ionization and interaction with reactive oxygen species. Lower energy protons induce more localized and complex DNA damage, whereas higher energy protons result in deeper but more dispersed damage patterns. The DSB yields align well with experimental data and previously published simulations, and derived metrics such as γ-H2AX foci and cell survival curves facilitate direct experimental comparison.

In conclusion, this research underscores the critical role of GEANT4-DNA in elucidating proton-induced sub-cellular effects, revealing energy-dependent dose-response relationships and advancing our understanding of cellular damage mechanisms. These findings have implications for clinical proton therapy, radiation protection, and the development of biologically informed treatment planning.

Acknowledgement: This work was carried out under the contract PN 23.21.01.06 sponsored by the Romanian Ministry of Research, Innovation and Digitalization.

SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Upconversion nanoparticles coated with Ir^{3+}-Ln^{3+} bimetallic complex aiming for singlet oxygen ($^1O_2$) generation

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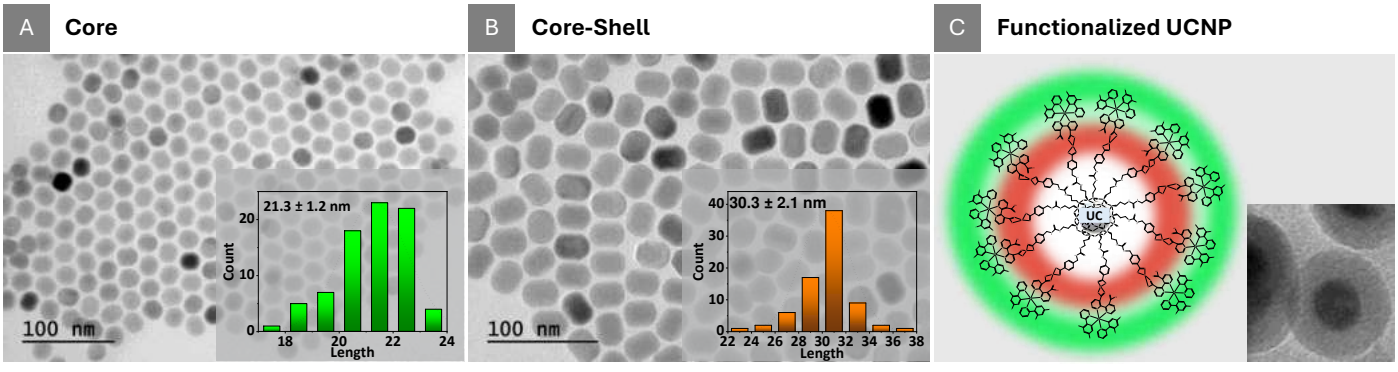
Please indicate preference: Poster
Specify Technical Area: Biomedical

There is currently a fast growth in the development of multifunctional luminescent materials with theranostic capabilities for cancer, driven by the fact that cancer remains the second leading cause of death worldwide, mainly due to diagnoses occurring at advanced stages. Cancer cells, similar to inflammatory diseases, cardiac ischemia, and brain disorders, can be detected by measuring the concentration of molecular oxygen ($^3O_2$) in tissues since hypoxic circumstances are a key sign of these pathological conditions [1]. Furthermore, the singlet oxygen ($^1O_2$) generation has been purposely employed as an effective strategy in cancer phototherapy [2]. In this work, $NaYF_4$:Yb^{3+},Nd^{3+},Er^{3+}@$NaYF_4$:Yb^{3+},Nd^{3+} upconversion nanoparticles (UCNPs) were successfully synthesized via the thermal decomposition method, and after that coated with SiO_2 (UCNPs@SiO_2). The $NaYF_4$:Yb^{3+},Nd^{3+},Er^{3+}@$NaYF_4$:Yb^{3+},Nd^{3+} core-shell nanoparticles displayed the hexagonal phase (β-phase), which was confirmed by comparison with the XRD pattern. The particle core was formed with great size and shape control, displaying an average diameter of about 21.3±1.2 nm, as determined by TEM analysis. Following the shell growth, the particles adopted an oblate spherical morphology with an average size of 30.3±2.1 nm. The SiO_2 coating was confirmed through TEM images, and the final UCNPs@SiO_2 nanoparticles were estimated to have a size of 54.6±5.8 nm, demonstrating remarkable stability in aqueous solutions. The $NaYF_4$:Yb^{3+},Nd^{3+},Er^{3+}@$NaYF_4$:Yb^{3+},Nd^{3+}@SiO_2 nanoparticles exhibited mainly the green emission bands under excitation at 808 and 980 nm, originating from the Er^{3+} ion. This green emission will be used to excite the deep-red-emitting Ir^{3+}-based complex [Ir(dfppy)$_2$(bqdc)], (dfppy: 3,5-difluoro-2-(2-pyridinyl)phenyl) and bqdc: 2,2′-biquinoline-4,4′-dicarboxylic acid), which is coordinated to Yb^{3+} and grafted onto the surface of UCNPs@SiO_2, to enable ratiometric oxygen ($^3O_2$) sensing as well as the singlet oxygen ($^1O_2$) generation.



$NaYF_4$:Yb^{3+},Nd^{3+},Er^{3+} | $NaYF_4$:Yb^{3+},Nd^{3+},Er^{3+} @$NaYF_4$:Yb^{3+}+,Nd^{3+} | UCNP@SiO_2-Ln^{3+}-Ir^{3+}

Acknowledgments
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SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Investigation of a nanoconstructed curcumin-loaded Eu(III)-silica system as nitric oxide photoreleasing for theranostic application

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Please indicate preference: Poster
Specify Technical Area: Biomedical

The development of materials capable of releasing therapeutic agents in a controlled manner in response to light stimuli to enhance therapeutic efficacy is a significant challenge in the healthcare field. Nitric oxide (NO) is among the most investigated molecules in the biomedical field, both for its essential function as a gaseous signaling molecule in the human body and for its great potential as an alternative therapeutic agent in several pathologies, including cancer, bacterial, and viral infections [1]. Because NO is an unstable molecule, its therapeutic application faces challenges arising from its short half-life and high reactivity, which limit its stability and biological range, especially in environments rich in reactive species, such as plasma and the intracellular environment. These limitations make it essential to develop strategies that allow greater control over its release and prolong its biological activity [2]. Such strategies include the use of NO photodonors, which are light-activatable precursors, enabling the precise and noninvasive release of NO. Additionally, the use of carrier molecules and their encapsulation in appropriate systems increase the half-life of NO, preserves its biological functions, contributing to safer and more effective therapeutic applications. Curcumin is a natural organic substance that has attracted attention for its medicinal properties [3], and when used as a carrier molecule for NO, curcuminoid nitrates can present a potentiated therapeutic action in the organism [4]. In this context, the approach based on the presence of luminescent complexes of rare earth ions in controlled release systems aims to enable their dual function of acting both as an imaging agent [5] and as a NO releaser as a therapeutic agent. Thus, this work aims to introduce a strategy for the preparation of bioactive compounds based on organic curcuminoid nitrates and lanthanide complexes nanoencapsulated in silica, which can be studied as controlled release systems of nitric oxide in biological media. The nanomaterial was prepared by the sol-gel method, incorporating a $[Eu(tta)_3(phen)]$ complex into silica, obtaining spheroidal particles with intense luminescence in the red region (612 nm). The nanoparticles were then functionalized with 3-aminopropyltriethoxysilane (APTES) for subsequent addition of curcumin nitrate (CurcNO), which was prepared from the nitration of pure curcumin. The materials were characterized by FTIR, thermal analysis, and Zeta Potential, indicating the effective grafting of NO transport molecules onto the silica surface. After the coating and functionalization steps, the material maintained a spheroidal shape and intense luminescence in the red, indicating its promising application as a marker in controlled release systems for bioactive molecules.

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SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Study on optical properties of K and Cs-doped g-C_3N_4 and their photoelectrochemical activity for reduction of CO_2

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Presentation preference: Poster
Technical Area: Energy Applications

Converting carbon dioxide and solar energy into useful fuels through artificial photosynthesis presents a promising avenue for mitigating the carbon footprint and addressing the escalating demand for renewable energy. A primary challenge in visible-light-driven CO_2 reduction is the limited photo-absorption and rapid electron-hole recombination. Doping photocatalysts with alkali metal elements offers an effective strategy to enhance CO_2 photoreduction efficiency by tailoring their electronic properties.[1] According to the literature, [2-4] an appealing material, graphitic carbon nitride (g-C_3N_4), exhibits a combination of beneficial properties: strong light response, environmental compatibility, impressive chemical stability, and ease of preparation. These features make it highly suitable as a photocatalyst for energy transformations, including environmental cleanup. In this study we will present the effect of potassium and cesium doping on g-C_3N_4 (Cs-C_3N_4, K-C_3N_4) for the photoelectrochemical reduction of CO_2 under visible light.
Our results show how K and Cs doping leads to a red shifted and blue shifted absorption from pure C_3N_4, respectively. In this way, the K-C_3N_4 sample is able to better use solar energy, producing more photogenerated carriers, enhancing the (electro)photocatalytic performance. In terms of selectivity, Cs-C_3N_4 achieves highly selective photoelectrochemical CO_2 reduction to yield formate with a formation rate of 1.8 mmol g^{-1} h^{-1} and a Faradaic efficiency of > 69%. Our research underscores the critical role of suppressing electron-hole recombination in boosting solar energy conversion efficiency and offers a promising direction to improve the performance of g-C_3N_4-based photocatalysts for the production of solar fuels and chemicals.

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SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Photodynamic Performance of Upconverting Nanoparticle–Protein Stabilized Gold Nanocluster–Chlorin e6 Hybrid Systems

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Photodynamic therapy (PDT) is a clinically approved method for cancer treatment that relies on light-activated photosensitizers (PS) to produce reactive oxygen species (ROS). However, the limited tissue penetration of visible light restricts its therapeutic depth. Near-infrared (NIR) light penetrates deeper into tissues but cannot efficiently excite conventional PS via single-photon absorption. While two-photon excitation is possible, it requires ultrafast lasers and introduces thermal risks due to the high-power densities involved.

Upconverting nanoparticles (UCNPs) offer a promising alternative by converting NIR light into higher-energy UV-VIS photons capable of activating traditional PS molecules. In this study, we developed a hybrid nanoplatform based on core–shell UCNPs ($NaGdF_4$:Yb^{3+},Er^{3+}@$NaGdF_4$:Yb^{3+},Nd^{3+}), functionalized with a protein corona composed of bovine serum albumin-stabilized gold nanoclusters (BSA-Au NCs) and chlorin e6 (Ce6). The BSA-Au NCs were synthesized via in situ reduction of chloroauric acid in protein-rich alkaline media, while the core–shell UCNPs were prepared using a thermal co-precipitation method. The ROS generation efficiency of the UCNP–BSA-Au NC–Ce6 complex under NIR irradiation was evaluated using Singlet Oxygen Sensor Green (SOSG).

Spectroscopic data confirmed complex formation between BSA-Au NCs and Ce6 at a molar ratio of 1:1. Interaction with UCNPs was assessed by monitoring photoluminescence decay at 656 nm, revealing an energy transfer efficiency of approximately 40%. No significant decay changes were observed with BSA-Au NCs alone, confirming Ce6 as the primary energy acceptor.

Singlet oxygen production was further verified using the SOSG probe under 808/980 nm NIR irradiation. Increased fluorescence upon light exposure confirmed successful ROS generation. These findings support the UCNP–BSA-Au NC–Ce6 complex as a viable NIR-activated photodynamic platform with potential for deeper-tissue applications.

To further evaluate the photodynamic effect of the UCNP–AuNC–Ce6 hybrid system, in vitro experiments were conducted using MDA-MB-231 human breast cancer cell line. The cells were incubated with the nanocomplex for 24 hours, followed by irradiation with 808 nm NIR light to activate the UCNPs and initiate PDT. Cell viability was assessed 24 hours post-irradiation based on fluorescence images of cells stained with calcein-AM and propidium iodide. A significant reduction in cell viability (~50%) was observed in the irradiated group treated with the hybrid complex, while no notable cytotoxicity was detected in control groups (irradiated without particles or treated with particles without irradiation).

These preliminary findings demonstrate that the UCNP–AuNC–Ce6 hybrid system can induce a pronounced photodynamic effect upon NIR activation. This supports its potential application in the development of donor-based UCNP nanoplatforms for targeted cancer PDT and warrants further investigation under biologically relevant conditions.

Acknowledgment: This work was supported by the Research Council of Lithuania (Grant No.S-MIP-23-5).

SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Label-free imaging of human cell models of neurodegenerative disorders using Quantitative Phase Imaging (QPI).

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Please indicate preference: X Poster __ Oral

Specify Technical Area: X Biomedical __ Energy and other Applications

Over 55 million people worldwide suffer from neurodegenerative diseases such as Alzheimer's and Parkinson's, and this number is expected to double by 2050 due to the aging global population[1]. Since these conditions are a major contributor to dependency and disability in the elderly, better prognostic and diagnostic methods are urgently needed to improve prevention and treatment. Accounting for an estimated 60–70% of dementia cases worldwide, Alzheimer's disease alone underscores the critical need to advance neurodegeneration research[2]. In this context, the human-derived neuroblastoma cell line SH-SY5Y has emerged as a valuable *in vitro* cell model for studies in neuroscience. These cells can be differentiated into mature human neurons through a range of mechanisms, and specific neuronal subtypes can be derived by employing distinct methods[3]. Differentiated SH-SY5Y cells provide a controlled and reproducible human neuronal cell model for studying disease-specific pathologies and for drug discovery screening assays, making them highly useful for preclinical studies in neurodegeneration research.

Quantitative phase imaging (QPI) is a powerful label-free and non-invasive technique that enables the study of cells by measuring their refractive index (RI), while also providing an objective assessment of morphology and dynamics that is free from variability introduced by contrast agents[4]. Cell refractive index (RI) represents a relevant optical property that correlates with intrinsic factors such as dry mass or water content, providing valuable information about cell composition. In the present study, phase maps were generated using paraformaldehyde-fixed SH-SY5Y cells, with an unknown RI, in combination with different immersion media with a well-known RI. The aim of this work was to optimize image acquisition conditions and metrics analysis for this cell type while accounting for their RI and to determine how the cells respond to different treatments. This work establishes a procedure to obtain specific statistical metrics for different morphological parameters, including volume and height, and how they are modified between control and treated cells.

Acknowledgements

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- Wooptix S.L.

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SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

ZnO Layer Optimization for Enhanced Performance of InAs Quantum Dot Photodetectors in Bioimaging

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Poster-Biomedical

Abstract

Colloidal quantum dots (CQDs) are ideal for designing tunable infrared photodetectors for non-invasive medical imaging. In order to replace toxic Pb-based CQDs, we explore photodetectors using commercial indium arsenide (InAs) CQDs. A key challenge is to improve their photodetection efficiency to match applications like biosensing and diagnostics[1]. Herein, we report an effective strategy to enhance InAs CQD performance by engineering the electron transport layer. We investigate zinc oxide (ZnO) thin films[2], annealed at various temperatures (200°C to 450°C) in an oxygen-rich atmosphere[3], to optimize their electronic properties for integration into a photodetector operating from visible to near infrared wavelengths. This optimized ZnO layer (Figure 1a) facilitates efficient charge extraction[4], yielding a device with a photocurrent response under 25 µW light intensity illumination (0.16 mW/cm²) at 450 nm (Figure 1b). Our results underscore the critical role of interfacial layers in crystallization-enhanced ZnO-based InAs photodetectors as a promising platform for future imaging technologies.

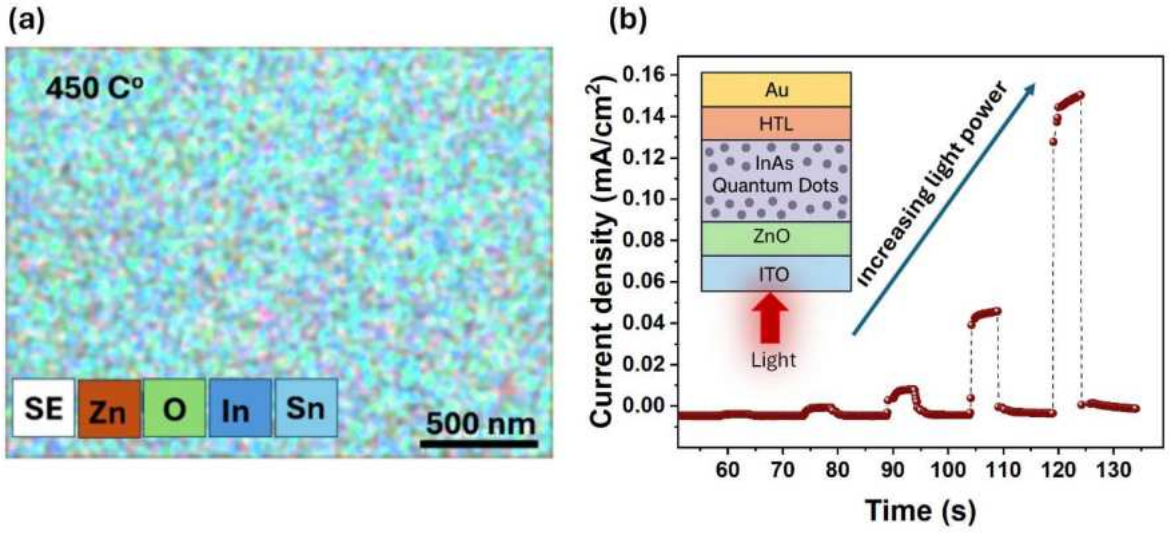

Figure1. (a) EDS mapping of the ZnO layer. (b) The photodetector current density as a function of optical power (8.3 to 25 mW). The inset shows the corresponding device structure.

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SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Bifunctional Eu^{3+}-doped layered double hydroxide on membrane support for luminescent sensing and adsorptive removal of tetracycline

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Please indicate preference: _X_Poster __ Oral
Specify Technical Area: __Biomedical _x_ Energy and other Applications

Pharmaceutical residues can remain in the environment even after wastewater treatment, representing a challenge for both detection and removal, and posing risks to ecosystems and human health [1,2]. In this work, Eu^{3+}-doped and undoped layered double hydroxides (LDH) were synthesized via the co-precipitation method. The Eu^{3+}-doped LDH was immobilized on membrane support. X-ray diffraction (XRD) patterns indicated enhanced crystallinity upon Eu^{3+} incorporation. Fourier-transform infrared spectroscopy revealed minimal spectral differences between the undoped and doped LDH samples. Scanning electron microscopy confirmed the characteristic platelet-like morphology and effective immobilization of the material on membrane support.

Photoluminescence measurements under UV excitation demonstrated that Eu^{3+}-centered emission occurred in the presence of tetracycline (TC) via an antenna effect. Moreover, the Eu^{3+} emission intensity increased proportionally with the TC concentration, indicating the material's potential as a luminescent probe (Fig. 1a). Approximately 93% of TC adsorption was observed on the surface of the Eu^{3+}-doped LDH after 90 min. Selectivity assays using TC, ciprofloxacin (CIP), and ofloxacin (OFX) showed a distinct luminescence response exclusively to TC (Fig. 1b), likely due to differences in energy transfer efficiencies among the analytes. These results demonstrate that the Eu^{3+}-doped LDH immobilized on membrane support is a promising platform for selective TC detection and removal in aqueous environments.

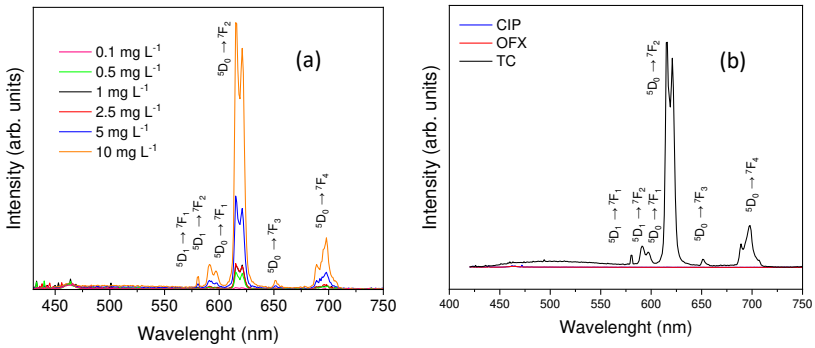

Fig. 1. Emission spectra of (a) Eu^{3+}-doped LDH at varying TC concentrations and (b) Eu^{3+}-doped LDH with TC, OFX and CIP.

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SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Making the Calibration of Power Dependence in Ratiometric Luminescent Nanothermometry superfluous

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Please indicate preference: __Poster x Oral
Specify Technical Area: __Biomedical x Energy and other Applications

Temperature is the most fundamental thermodynamic state variable. It is one of the few quantities that play a critical role in nearly all physical, chemical, and biological phenomena [1]. Ratiometric luminescence nanothermometry carries the potential to measure temperature in scenarios for which established methods are unsuitable. The precision of nanothermometry depends on the excitation power. Recently, Jia and co-workers found that the dependence of excitation power in lanthanide-based ratiometric nanothermometers is insensitive to temperature changes and, therefore, can be calibrated [2]. As a consequence, calibration and continuous monitoring of the optical power are mandatory to allow precise nanothermometry – a requirement that complicates optical setups and limits nanothermometry in scenarios where power control or measurement is impractical or unfeasible.

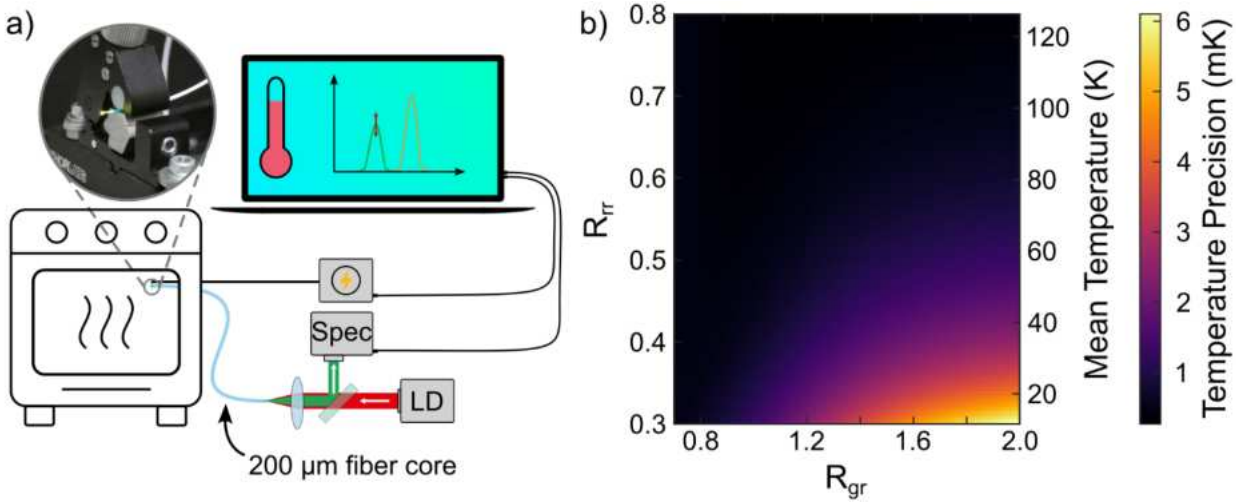

***Figure 1**: a) Optical setup of the calibration including the optical fiber with the nanothermometers attached to their facet (inset). b) The absolute temperature precision of the nanothermometers calculated from the symbolic regression results.*

Here, we use Er^{3+}-activated nanothermometers and, in addition to the well-known 525/545 nm ratio, define a second luminescence intensity ratio involving the emission at 660 nm. The intensity of this emission is strongly correlated with the power and is available when using standard spectroscopic instrumentation. We apply symbolic regression to find an unambiguous mathematical expression that describes the experimental data. From this mathematical expression, we determine the mean temperature deviation from the fitting error to be 0.16 K and a maximum temperature precision as small as 6 mK (Fig. 1b). In summary, our approach makes excitation power measurements in ratiometric luminescent nanothermometry superfluous.

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SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Exploring the Glass–Particle Interface in PersL Composites

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preference: Poster
Technical Area: Energy and other Applications

Optical glass-based composites have attracted attention for uniting the luminescence characteristics of crystalline materials with the chemical robustness and processability inherent to glass matrices. This combination allows for the integration of sensitive luminescent components into systems capable of operating under demanding environmental conditions. For instance, most parts of glow-in-the-dark emergency signals are composed of persistent luminescence (PersL) materials embedded in polymeric matrices, which can result in sensitive composites upon prolonged exposure to sunlight, for example. Glass, on the other hand, can provide superior stability and improve durability under harsh environments, thus broadening their applicability. However, fabricating glassy composites remains a challenge due to the high temperatures involved in melt-quenching techniques. A detailed understanding of the fabrication process is thus critical for advancing new material development. In this study, we explore the incorporation of $Sr_2MgSi_2O_7:Eu^{2+},Dy^{3+}$ (SMSO) PersL phosphors into a $NaPO_3–Ga_2O_3$ glass matrix. The composites were fully characterized and the photoluminescence (PL) properties were evaluated through PL spectroscopy and persistent luminescence decay analysis. Furthermore, synchrotron-based two-dimensional hyperspectral mapping was used to probe spatial variations in luminescence, elemental distribution, and ionic oxidation states within the SMSO domains. The findings elucidate the influence of melting temperature on the interface between the active phase and the glass host, contributing to the rational design of high-performance optical composites with customizable functionalities.

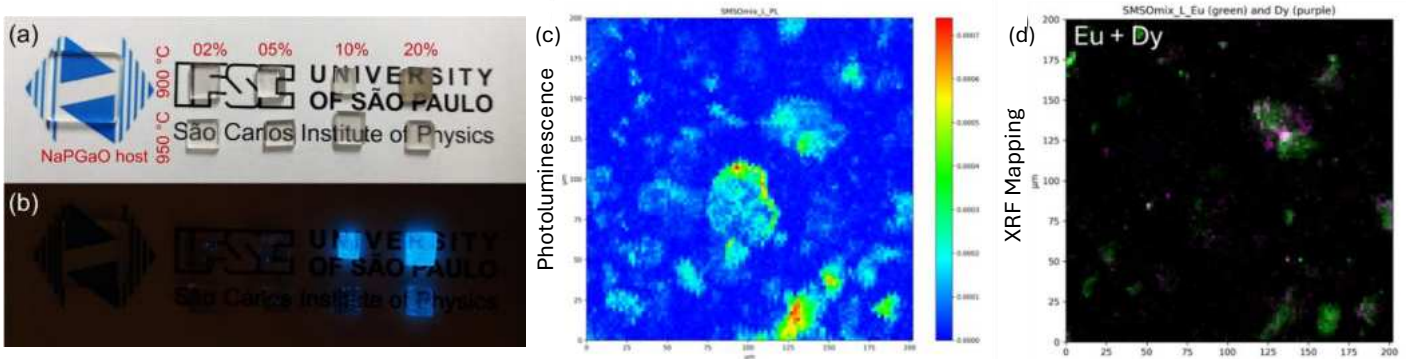

Figure 1. PersL glass composites samples (a) at ambient light and (b) 10 seconds after ceasing the 365 nm irradiation, (c) 2D μ-mapping of photoluminescence emission and (d) XRF of L_αEu (green) and L_βDy (purple) under synchrotron radiation.

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SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Photoluminescence Spectroscopy of Upconversion Nanoparticles Using a Compact Spectrofluorometer

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Please indicate preference: _x_Poster
Specify Technical Area: _x_ Energy and other Applications

Upconversion nanoparticles (UCNPs), typically composed of rare-earth dopants such as erbium and ytterbium embedded in a host matrix like $NaYF_4$, provide a unique optical mechanism for converting near-infrared (NIR) excitation into higher-energy visible or ultraviolet emission. This property underpins their increasing role in diverse fields ranging from photovoltaics to biophotonics.

In this study, we present a comprehensive photoluminescence characterisation of $NaYF_4$:Yb,Er UCNPs dispersed in aqueous media, carried out using a single compact spectrofluorometer. Spectral, time-resolved, and absolute quantum yield measurements were performed under identical excitation conditions using an integrated 980 nm laser source. This unified approach ensures experimental consistency while simplifying the characterisation workflow.

Our results highlight the significant impact of the solvent environment on upconversion performance, offering quantitative insights into the typically low upconversion efficiencies of such systems, with a quantum yield as low as 0.01% accurately quantified. The study further emphasises the importance of using highly sensitive instrumentation when probing weak upconversion signals. These findings are promising for researchers aiming to optimise UCNPs for energy conversion, bioimaging, and sensing applications, where tuning emission properties and enhancing efficiency remain ongoing challenges.

SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Green Synthesis of P-doped Carbon Nitride for Effective Light-driven Oxidation Reactions in Hypoxic Environments

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Poster - Energy and other Applications

In recent years, graphitic carbon nitride (g-C_3N_4) has increasingly achieved a remarkable role in the world of semiconductors owing to its chemical and thermal stability alongside its bandgap (~2.7 eV), which makes the material a well-established photocatalyst[1]. In particular, doping with non-metals such as B, S, and P has proven to be an efficient and environmentally friendly way to overcome charge recombination and extend the absorption interval of the semiconductor, while also avoiding the use of common— and often critical —metallic elements[2]. This contribution reports a simple and fast synthesis of P-doped carbon nitrides, where $(NH_4)_2HPO_3$ was chosen as a sustainable, cheap, and abundant phosphorus source (**Figure 1**). Elucidation on the structure and the composition is performed with a wide range of analytical methodologies, including microscopies (HR-SEM, TEM), spectroscopies (DRS UV-vis, FT-IR, EPR, TCSPC, EDS, XPS), XRD, and N_2 physisorption. Under blue LED light, the material is able to effectively catalyze the photodegradation of four different polluting dyes (Rhodamine B, Malachite Green, Indigo Carmine, and Congo Red) in water, as well as the oxidation of benzyl alcohol and benzyl amine in acetonitrile without the need of extra oxygen but the one already presents in the solvent. Thus, this represents one of the first examples of oxidation in O_2-poor environments reported in the literature for carbon nitride materials[3].

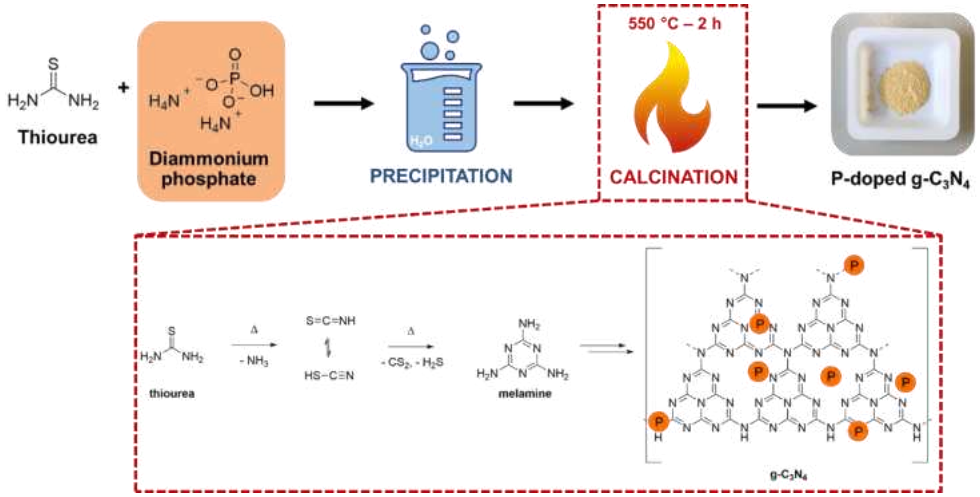

Figure 1. *Schematic illustration of the synthesis of P-doped carbon nitride. In the red dashed box, the mechanism of thermal condensation that leads to the final material.*

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SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

A New Approach to Remote Optical Current Sensing Using $NaYF_4:Yb^{3+},Er^{3+}$

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Poster
Energy and other Applications

This study introduces, to the best of our knowledge, the first development of an optical sensor specifically designed for accurate electric current measurement using a luminescent material that allows remote sensing. The system incorporates $NaYF_4$ doped with Yb^{3+} and Er^{3+}, embedded in a photocurable resin that coats the target component. As a proof of concept, the sensor was tested on a 0.68 Ω, 5 W ceramic resistor (5% tolerance). The device operates based on the relationship between the temperature rise in the resistor (induced by current flow) and the luminescent response of the material. By calibrating the luminescent signal against temperature, the current intensity can be determined precisely. The method was validated for currents ranging from 0 to 2.2 A, constrained by the thermal and electrical limits of the chosen resistor. Notably, the measurable current range depends on the specific resistive element used, necessitating dedicated calibration for each setup. Calibration was performed across a temperature range of 298 K to 328 K. The sensor achieved an estimated precision of 0.01 A. This high level of accuracy, combined with remote operation, positions the sensor as a promising tool for scenarios where traditional measurement approaches are impractical or invasive.

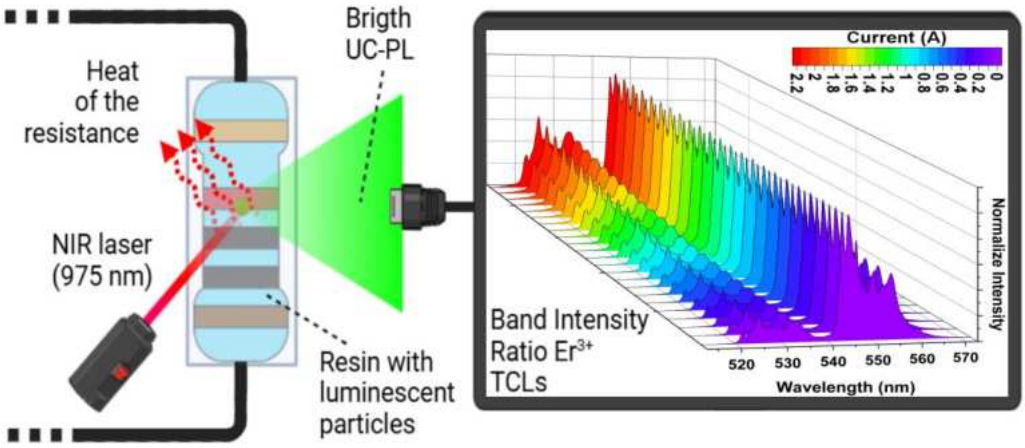

Fig. Scheme of the system used for the current intensity sensing, showing the sensor operating principle.

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SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Fiber-based Plasmonic Microreactor for Flow Chemistry

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The European Green Deal aims to reduce the net greenhouse gas emissions to zero by 2050. Consequently, the European Chemical Industry Council stated that we "[…] need to change how we produce […] while remaining globally competitive." [1]. Therefore, disruptive and innovative technologies are required. A promising example is flow chemistry driven by light in reactors based on polymer hoses, illuminated by UV LEDs [2]. However, the light management of such reactors is comparably poor compared to well-engineered optical systems. This results in high photon "costs" and low photon-to-reaction efficiencies.

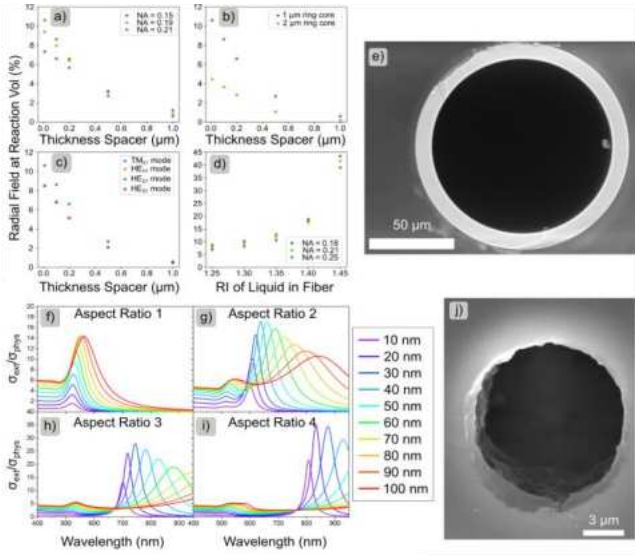

Figure 1: a) – d): Percentage of the radial field at the surface of the reaction volume depending on the thickness of the spacer layer for different numerical apertures (NAs) (a), ring thicknesses (b), modes (c), and depending on the refractive index in the reaction volume (d). e): SEM picture of the fiber. f) – i) Plasmon resonances for different side lengths of gold nanorods with an aspect ratio of 1 (f), 2 (g), 3 (h), and 4 (i). j) Close-up electron microscopy picture of the micromachined holes in the side of the reactor fiber.

To reduce the high photon "costs", we propose to drive photochemical reactions inside a specialty optical fiber. Our collaborative research is funded by the European Innovation Council (EIC) through the project reaCtor [3]. The developed specialty fiber is a ring-core fiber with a 100 µm hollow reaction volume. A fiber-based beam converter shapes the single-mode beam of a fiber-coupled laser into the donut mode guided by the ring-core of the fiber. Plasmonic nanorods on the inner fiber surface distribute the photon energy to the reactants. Micromachined in-/outlets yield microfluidic interfaces.

Here, we present the current status of our research. Based on an application-oriented assessment, we numerically design the optical and microfluidic properties of the fiber and fabricate it accordingly. We start the fabrication process with a modified chemical vapor deposition process and draw the a preform to a fiber with 125/100 µm outer/inner diameter. We decorate the inner fiber surface of the fiber with plasmonic nanoparticles and fabricate the microfluidic in-/outlets via laser selective etching. In the future, we will assemble an all-fiber microreactor and benchmark it for photo flow chemistry.

Funding: The project reaCtor has received funding from the European Union's Horizon Europe research and innovation programme under grant agreement No. 101099405.

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SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

Iron Prussian Blue as a water oxidation catalyst in (photo)electrochemical CO_2 reduction devices

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Poster
Energy and other Applications

Artificial photosynthesis which as inspired by natural photosynthesis has attracted growing attention due to its application in sustainable and green technology by converting CO_2 and water into valuable products [1-2]. Catalysis plays a key role in artificial photosynthesis by facilitating the transformation of solar energy into usable chemical energy [3]. In addition to the process able to transform CO_2 into fuels or added-value chemicals, there is a need for catalysts able to sustain the oxygen evolution reaction (OER) to extract electrons and protons from water. But the reaction conditions required by the CO_2 reduction to be efficient and highly selective impose very strict conditions (electrolyte) on the OER catalytic process. These are typically close to neutral pH where most transition metal oxides are unstable or inefficient.

In this study, we have revisited the series of Prussian blue analogues (PBAs) as anodic catalysts in an artificial leaf device. These catalysts are robust in a very wide pH range, and offered competitive OER performance in the Co-based PBA[4]. However, Co is identified as a critical raw material by the EU[5], so we decided to further explore the Mn, Fe, Ni and Cu PBAs in the search for non-CRM OER activity in CO_2-saturated $KHCO_3$ electrolyte, as preferred media for the CO2 electroreduction reaction. Our results revealed that among all the non-CRM analogues, the original all-Fe PB demonstrated excellent stability under OER conditions (> 8h), with a catalytic performance close to that found in the Co-PBA derivative. Our results indicate that electrodes based on this material offer a good anodic performance to be implemented in artificial photoelectrochemical devices.

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SHINING A LIGHT ON BIOMEDICAL AND ENERGY APPLICATIONS
Tenerife, Canary Islands, Spain, 13-17th October 2025

When photons snowball: Studying the photon-avalanching nanocrystals

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Poster
Energy and other Applications

Lanthanide-doped materials exhibit remarkable photophysical behaviors due to their unique electronic configurations, making them essential for a broad range of optical applications—from lighting and displays to communications and sensing. A particularly intriguing and nonlinear phenomenon is **photon avalanching (PA)**, where a weak initial absorption triggers a highly nonlinear, self-amplifying upconversion process (Fig. 1). Despite decades of research following its discovery in bulk materials in 1979[1], PA has only recently been observed in **nanocrystals (NCs) at room temperature**[2], marking a significant advancement in the field. This opens the path to novel methods in *e.g.*, **super-resolution microscopy** and **optical computing**.

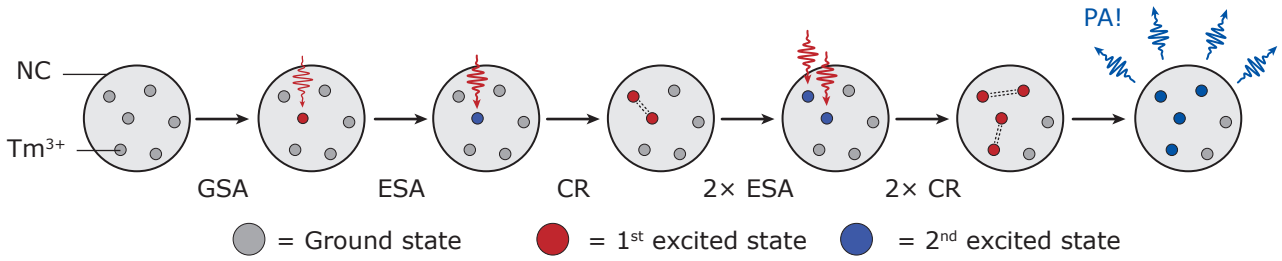

Fig. 1 – From left to right: PA in lanthanide-doped NCs is driven by excited-state absorption (ESA) and ion–ion interactions that facilitate cross-relaxation (CR), collectively leading to a sharp increase in the excited-state population once a critical excitation threshold is reached.

In this project, we investigate thulium-doped PA $NaYF_4$ NCs using customized spectroscopic techniques. Our findings reveal a previously unreported **non-binary blinking behavior** under high-intensity excitation, where emission fluctuates between multiple intensity plateaus rather than simple ON/OFF states. Additionally, we have investigated the possibility of **memory retention** by the ANPs, *i.e.,* enhanced emission intensity as a result of multiple stimuli compared to a single one. This phenomenon—where the output PA luminescence intensity depends on the "history" of photoexcitation—was previously found by Bednarkiewicz *et al.*[3]

By combining experimental observations with nonlinear models, we provide a deeper understanding of PA near its excitation threshold and uncover physical signatures—such as slow rise times, small emission spots, and large variance in emission intensity—that distinguish the avalanching regime. We anticipate that the ANPs studied in this work, with their strong nonlinear optical properties, blinking behavior, and memory retention capabilities, will prove valuable in microscopy and optical computing applications.

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