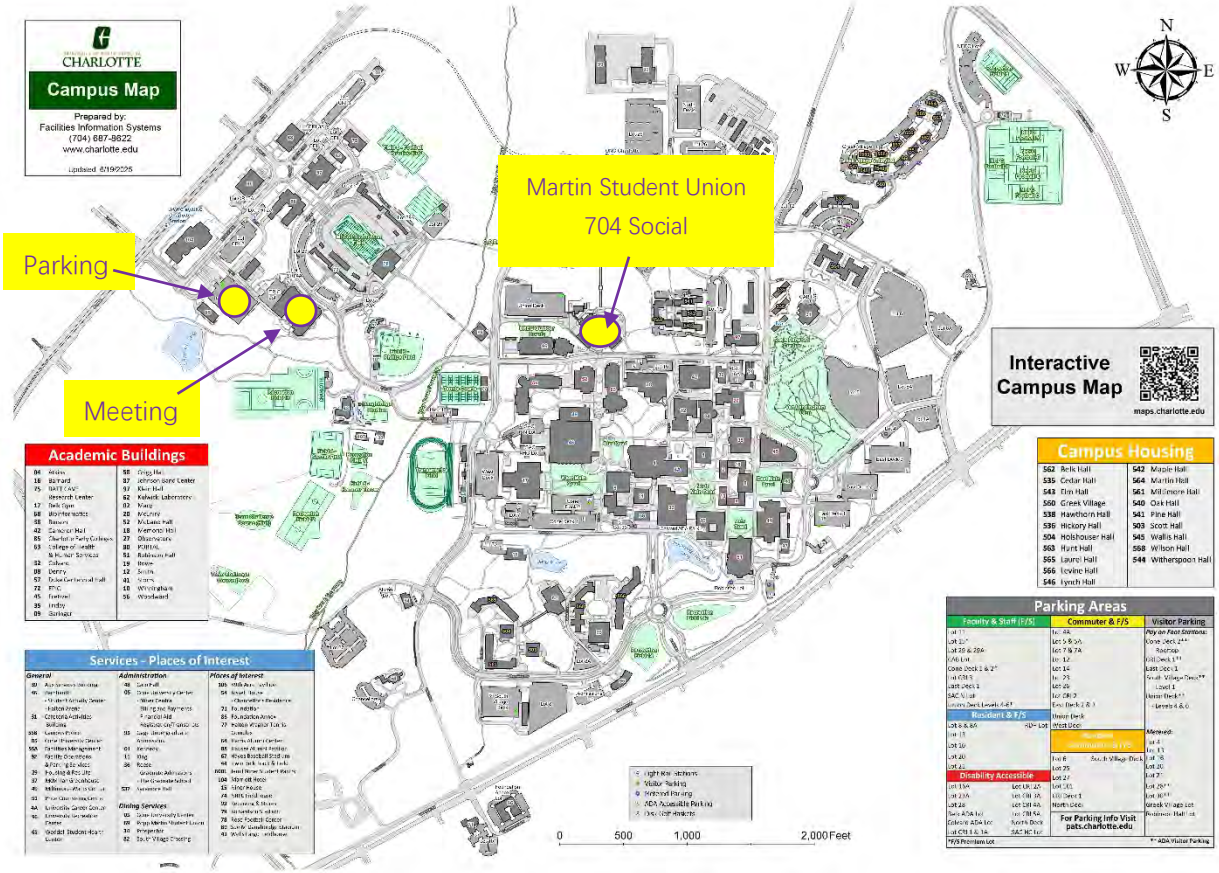
Welcome to DPC'25 on the campus of the University of North Carolina at Charlotte!

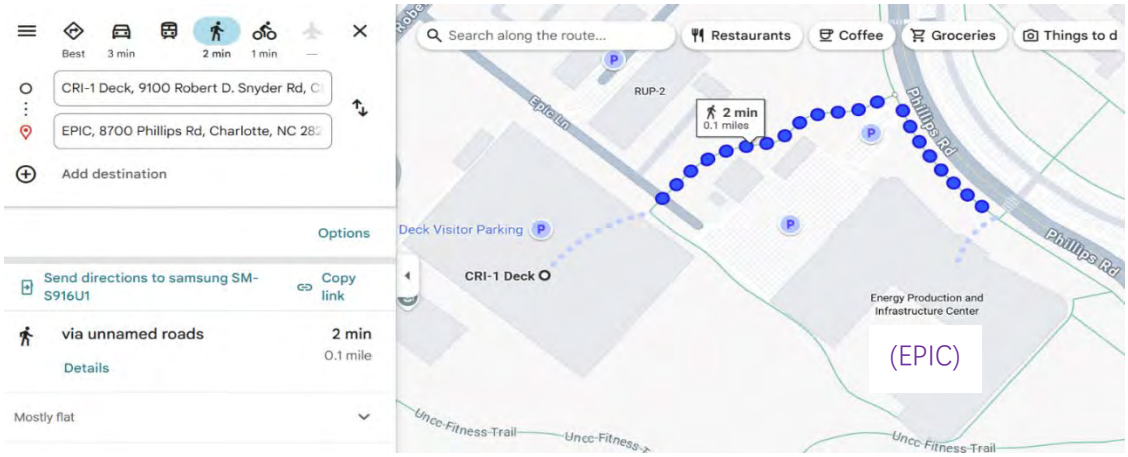
DPC is an international conference series held every three years alternately in North America, Europe and Asia with a program focused on theoretical and experimental aspects of excited states dynamics in condensed matter in physics, chemistry and material sciences. The previous three conferences were held in Wroclaw (Poland), Christchurch (New Zealand) and Paris (France), respectively, in 2022, 2019 and 2016 respectively. It was started in Athens, Georgia (USA) in 1978, and the last time held in the USA was in Argonne (USA) in 2010. We are excited to bring the conference back to the Carolina area in honor of the three early DPC key players Profs. William M. Yen, Richard S. Meltzer, and Michael D. Sturge.

Profs. Yong Zhang, Dan Boye, Xiaojun Wang
Chairs, Organizing Committee of DPC '25

1. Parking and Direction to the conference venue (Rm G256, EPIC Building)

Parking: CRI-1 Deck, cross street from Marriott Hotel (take a ticket when entering, pay with a coupon (provided by conference) when exiting. The conference site is 2-minute walk from the CRI-1 deck.





Entrance to the ground level (Rm G256)

Entrance to the first level (Atrium)

2. **Lunches**
   - Except for 8/6 (Wed), Buffet style lunch will be at “704 Social”, 2nd floor of Student Union (take Silver line bus from EPIC to Student Union or a 15-minute walk), using a coupon to enter (one coupon per person per day)
   - 8/6 (Wed): boxed lunch at EPIC (pick up from tables in the hallway of the conference room)
3. **8/4 (Mon, 6:30pm) Welcome Reception**
   EPIC Building atrium
4. **8/5 (Tue, 6:00pm) Poster setup AND 8/6 (Wed, 4:00pm) Poster viewing and rating**
   Hallway of EPIC ground floor, mounting boards will be provided. Dimension limits: 30”x40”
5. **8/6 (Wed, 6:30pm) Conference Banquet**
   Harris Alumni Center (bus from/to EPIC)
6. **8/7 (Thur, 2:30pm) Conference Excursion**
   NASCAR Hall of Fame (bus from/to EPIC)
7. **8/7 (Thur, after Excursion) Round of disc golf at nearby Reedy Creek course**
   contact Dan Boye daboye@davidson.edu) if interested.
8. UNC Charlotte Botanical Gardens (free), https://gardens.charlotte.edu/, Silver line bus to Klein Hall

Registration：

August 3 (Sunday)

Time: 14:00-18:00

Location: Atrium of EPIC Building (8700 Phillips Road, Charlotte, NC 28223)

(you could use the parking lot in front of EPIC. Usually parking permit is not enforced during weekends.)

August 4 (Monday) - August 6 (Tuesday)

Time: 8:00-10:00

Location: Atrium of EPIC Building (8700 Phillips Road, Charlotte, NC 28223)

Other time

Come to the conference site (EPIC G256)

Conference program:

"I" – Invited Talks

"O" – Contributed Talks

"P" - Posters

August 4 (Monday)

OPENING CEREMONY

08:30-09:00, Conference venue: Rm G256, ground floor of EPIC Building (8700 Phillips Road, Charlotte, NC 28223)

Organizing Committee: Yong Zhang, Dan Boye, and Xiao-Jun Wang

International Advisory Committee: Philippe Goldner

Welcome speech: Dr. Deborah (Deb) Thomas, Associate Vice Chancellor, UNC Charlotte

SPECIAL SESSION: Announcement and invited talk of the Sturge Prize Recipient

Presider: Mike Reid

09:00-09:30, Tian Zhong, University of Chicago, USA

Epitaxially grown rare-earth ion doped thin films for scalable quantum technology

Session 1, Presider: **Philippe Goldner**		
Time	Speaker	Title
09:30-10:00	Rose Ahlefeldt, Australian National University, Australia	**I01**: Optical studies of stoichiometric Er crystals for quantum information application
10:00-10:30	Philippe Goldner, Institute de Recherche de Chimie Paris, France	**I02**: Thin film based structures for optical quantum technologies
10:30 – 11:00	Coffee Break	
Session 2, Presider: **Rose Ahlefeldt**		
11:00-11:30	Xiao-Jun Wang, The Georgia Southern University, USA	**I03**: Unlocking the Potential of Up-Conversion Charging for Information Storage in Phosphors
11:30-11:45	Victor Castaing, Ecole Polytechnique-Institut Polytechnique de Paris, France	O1: Tuning key characteristics of storage phosphor thin coatings
11:45-12:00	Neilo M. Trindade, Universidade de São Paulo, Brazil	O2: A custom-built integrated system for measuring stimulated luminescence in materials
12:00-12:15	Sangeetha Balabhadra, Fayetteville State University, USA	O3: A-site doped zirconates ($A_2Zr_2O_7$) as a frontier in thermal sensing technology
12:15-12:30	Wanseok Oh, University of North Carolina at Charlotte, USA	O4: Electronic structure and properties of β-$ZnTe(en)_{0.5}$
12:30-14:00	Lunch Time ("704 Social", Student Union)	
Session 3, Presider: Angelo Mascarenhas		

14:00-14:30	Mike Reid, University of Canterbury, New Zealand	**I04:** Rare-earth ions in CaF_2 nanoparticles for scalable quantum technologies
14:30-15:00	Chih-Kang Shih, University of Texas at Austin, USA	**I05:** Quantum tiling of 2D electronic materials
15:00-15:30	John Bartholomew, University of Sydney, Australia	**I06:** Single erbium ion site engineering and hybrid microwave-optical entanglement generation.
15:30-16:00	Coffee Break	
Session 4, Presider: John Bartholomew		
16:00-16:30	Rongying Jin, University of South Carolina, USA	**I07:** Hidden anomalies in topological materials probed by second harmonic generation
16:30-16:45		O5:
16:45-17:00	Xiaoxiao Sun, Peking University Shenzhen Graduate School, China	O6: Spatially resolved long-term ionic oscillations in mixed halide perovskites
17:00-17:15	Natalia Majewska, Adam Mickiewicz University, Poland	O7: Photoelectric studies as the key to understanding the nonradiative processes in chromium activated NIR materials
17:15-17:30	Tang Ye, University of North Carolina at Charlotte, USA	O8: Degradation kinetics of organic-inorganic hybrid superlattice β-$ZnTe(en)_{0.5}$ from micro-raman spectroscopy and density-functional theory
17:30-17:45	Group Photo (Location: the front steps of EPIC)	
18:30-21:00	Welcome Reception (Location: EPIC Building atrium)	

August 5 (Tuesday)

Session 5, Presider: Yiping Zhao		
Time	Speaker	Title
09:00-09:30	Angelo Mascarenhas, National Renewable Energy Laboratory, USA	**I08**: Percolation of N cluster states and the birth of the dilute $GaAs_{1-x}N_x$ alloy
09:30-10:00	Yong Zhang, University of North Carolina at Charlotte, USA	**I09:** Comparative studies of prominent PV materials: halide perovskite, GaAs and CdTe
10:00-10:30	Jinsong Huang, University of North Carolina at Chapel Hill, USA	**I10:** FLIM to understand the transport and charge recombination in metal halide perovskites
10:30 – 11:00	Coffee Break	
Session 6, Presider: Michael Walter		
11:00-11:30	Yiping Zhao, University of Georgia, USA	**I11:** Al-enhanced surface-enhanced raman spectroscopy
11:30-11:45	Tim Gfroerer, Davidson College, USA	O9: Dynamic calibration of the photoexcited lifetime in a GaAs double heterostructure
11:45-12:00	Sampath Gamage, University of North Carolina at Greensboro, USA	O10: Manipulation of proton dynamics in perovskite nickelate devices
12:00-12:15	John Krebs, Franklin & Marshal College, USA	O11: Europium phosphorescence in lanthanum aluminium perovskite
12:15-12:30		O12:
12:30-14:00	Lunch Time (“704 Social”, Student Union)	
12:30-14:00	International Advisory Committee (IAC) Meeting (EPIC xxx)	
Session 7, Presider: Tsing-Hua Her		
14:00-14:30	Michael Walter, University of North Carolina at Charlotte, USA	**I12:** Innovating fluorescent molecular dyes for photocatalysis, photochromism, and biosensing applications
14:30-15:00	Chun-Che Lin, National Taipei University of Technology, Taiwan	**I13:** Breakthrough refinement of SWIR emission phosphors: advancing imaging and material identification
15:00-15:30	Dan Boye, Davidson College, USA	**I14:** The sulfur anion $(S2)^-$ as a fluorescent quantum harmonic oscillator
15:30-16:00	Coffee Break	
Session 8, Presider: Chun-Che Lin,		
16:00-16:30	Tsing-Hua Her, University of North Carolina at Charlotte, USA	**I15:** Carrier generation in monolayer two-dimensional dielectrics under strong-field excitation
16:30-16:45	Rosangliana, Govt. Zirtiri Residential Science College, India	O13: Theoretical analysis of photo-assisted field emission near the metal surface using transfer Hamiltonian method
16:45-17:00	Jiyu Xu, Chinese	O14: Photoinduced ultrafast phase transitions in strongly

	Academy of Sciences, China	correlated materials
17:00-17:15	Guillaume Lague, Sorbonne Université, France	O15: Pump-probe investigation of charge carrier spin dynamics and dynamic nuclear polarization in lead halide perovskites
17:15-17:30	Carlos Gonzales Lorenzo, Universidade de São Paulo, Brazil	O16: Investigation of luminescent, structural, EPR, and optical properties of undoped and Eu-, Ce-, Tb-, Sm-, Cu-, Mn-, and Li-doped $MgSiO_3$ phosphors, synthesized by sol-gel combustion technique
18:00-20:00	Setting up posters (poster sizes up to 30”x40” or 76cmx102cm)	

August 6 (Wednesday)

Session 9, Presider: Andries Meijerink		
Time	Speaker	Title
09:00-09:30	María Chamarro, Paris Institute of Nanoscience, France	**I16**: Exciton dynamics in $FAPbBr_3$ nanocrystals embedded in transparent nanoporous film: signatures of Forster resonance energy transfer
09:30-10:00	Markus Suta, Heinrich Heine University Düsseldorf, Germany	**I17**: Experimental evidence for selection rules of nonradiative transitions–fundamentals and consequences for luminescent materials
10:00-10:30	Vladislav Klepov, University of Georgia, USA	**I18:** Intermolecular interactions in hybrid halide compounds and their influence on the optical properties
10:30 – 11:00	Coffee Break	
Session 10, Presider: María Chamarro		
11:00-11:30	Andries Meijerink, Utrecht University, Netherlands	**I19**: Cooperative processes in lanthanide luminescence
11:30-11:45	Yuuki Kitagawa, National Institute of Advanced Industrial Science and Technology, Japan	O17: Charge transfer excited states in Eu^{3+}-doped mixed-anion compounds
11:45-12:00		O18:
12:00-12:15	Mathieu Mivelle, Sorbonne Université, France	O19: Tailoring photon-avalanche via quantum emission manipulation in Tm^{3+}-doped nanoparticles
12:15-12:30	Mikolaj Kaminski, University of Gdansk, Poland	O20: Exploring near-infrared luminescence of nickel in $LiGa_{5(1-x)}Al_{5x}O_8:0.05Ni^{2+}$ via mechanical and chemical pressure
12:30-14:00	Lunch Time (Atrium of EPIC Building)	
Session 11, Presider: Markus Suta		
14:00-14:30	Lingdong Sun, Peking University, China	**I20:** Nano/microcavity coupled rare earth upconversion emission
14:30-15:00	Guanying Chen, Harbin Institute of Technology, China	**I21:** Upconversion nanoparticles: size-dependent luminescence quantum yields
15:00-15:30	Shuang Fang Lim, North Carolina State University, USA	**I22**: Selective excitation of directional super- and sub-fluorescence in single upconverting nanocrystals at room temperature
15:30 – 16:00	Coffee Break	
16:00-18:00 **Poster Session, Presider: Xiao-Jun Wang** (presenter list given at the end of the program) **Location**: EPIC ground floor hallway (next to the conference room)		
18:30-21:00 **Conference Banquet** Announcement of the next DPC city, and a brief address by the host of the next DPC **Location:** UNC Charlotte, Harris Alumni Center (8688 Johnson, Johnson Alumni Way, Charlotte, NC 28262). 15-minute walk from EPIC Building		

August 7 (Thursday)

Session 12, Presider: Amitava Patra		
Time	Speaker	Title
09:00-09:30	Feng Wang, City University of Hong Kong, Hong Kong	**I23:** Doping inorganic crystals for photonic applications
09:30-10:00	Peihong Zhang, University of Buffalo, USA	**I24:** Large-scale calculations of quasiparticle and excitonic properties of 3D and 2D solids
10:00-10:30	Thomas A. Schmedake, University of North Carolina at Charlotte, USA	**I25:** Exciton and charge management in silicon pincer complexes
10:30 – 11:00	Coffee Break	
Session 13, Presider: Feng Wang		
11:00-11:30	Amitava Patra, Indian Association for the Cultivation of Science, Indian	**I26:** Insights of ultrafast carrier dynamics of light-harvesting nanomaterials
11:30-11:45	Masanori Koshimizu, Shizuoka University, Japan	O21: Contribution of triplet excited states to photoluminescence of plastic scintillators excited at vacuum ultraviolet light
11:45-12:00		O22:
12:00-12:15	Oksana Chukova, University of Kyiv, Ukraine	O23: Spectroscopy and excited state dynamics of the RE-doped lanthanum vanadate nanoparticles with different crystal structures
12:15-12:30	Hongyu Lu, Hainan University, China	O24: Mn^{5+}-based luminescent thermometer in near-infrared region
12:30-14:00	Lunch Time ("704 Social", Student Union)	
14:30-17:30	**Conference Excursion** (NASCAR Hall of Fame)	

August 8 (Friday)

Session 14, Presider: Dan Boye		
Time	Speaker	Title
09:00-09:30	Luiz Jacobsohn, Clemson University, USA	**I27:** Controlled UV emission through Gd doping of $MgAl_2O_4$
09:30-10:00	Yanjie Liang, Shandong University, China	**I28:** Ultraviolet persistent luminescence materials
10:00-10:15	Naoki Kawano, Akita University, Japan	O25: Radiation response of ErF_3-doped strontium fluoride transparent ceramics
10:15-10:30		O26:
10:30-11:00	Coffee Break	
Closing Ceremony, **Presider**: **Yong Zhang**		
11:00-12:30	Announcement of poster award winners (photo) International Advisory Committee: Philippe Goldner Safe travels to all delegates — see you at the next DPC!	
12:30-14:00	Lunch Time ("704 Social", Student Union)	

Posters:

1. Isabela Alves Ferreira (Universidade Estadual Paulista (UNESP), Brasil), Luminescence Property of Lunar Simulant Sample.
2. Bingbing Yang (Northeast Normal University, China), Harnessing up-conversion luminescence in NaYF4:Nd3+ for optical anti-counterfeiting under white light excitation.
3. Pranamita Chakraborti (University of North Carolina at Charlotte, USA), Mechanistic Basis of the Voltage-Sensitivity of Thiazolothiazole Dyes.
4. Yuma Takahashi (Shizuoka University, Japan), Development of Eu-Doped TAGG Nanoparticle Scintillators.
5. Thomas Perrell (University of North Carolina at Charlotte, USA), Developments and Applications Thiazolothiazole Dyes for Photoredox Catalysis.
6. Naz F. Tumpa (University of North Carolina at Charlotte, USA), Photochemical Sensor Platform for Rapid, Non-Invasive Detection of Illicit Drugs.
7. Yizhou Wang (University of North Carolina at Charlotte, USA), Self-limiting Surface Oxidation Ensuring the Long-term Stability of II-VI Organic-Inorganic Hybrid Nanostructures
8. Javad Babaki (University of North Carolina at Charlotte, USA), IR Transmission and Reflection Spectra of Organic-Inorganic Hybrid Material β-$ZnTe(en)_{0.5}$.
9. Hasan Mahmud (University of North Carolina at Charlotte, USA), Photo-Induced Ion displacement in organic inorganic mixed halide perovskites: Turning stability concerns into functional opportunities.
10. Arpit Dave (University of North Carolina at Charlotte, USA), Enhanced material removal rate of glass enabled by an ultrathin layer of gold.
11. Ahmed Adel A. Abdelazeez (University of North Carolina at Charlotte, USA), Controlled Growth of Tellurium Network Structures for Multi-Spectral Photodetector Applications.
12. Matheus Nunes (Universidade Estadual Paulista, Brasil), Development of Al_2O_3-Based Radiation Detectors via Hydrothermal Synthesis.

Epitaxially grown rare-earth ion doped thin films for scalable quantum technology

Tian Zhong[1,*]

[1] *Pritzker School of Molecular Engineering, University of Chicago, Chicago IL, 60637, USA*

**E-mail: tzh@uchicago.edu*

Optically active solid-state spin qubits thrive as an appealing technology for quantum interconnects and quantum networking, owing to their atomic size, scalable creation, long-lived coherence, and ability to coherently interface with flying qubits. Trivalent erbium dopants, in particular, emerge as an attractive candidate due to their emission in the telecom C band and shielded 4f intra-shell spin-optical transitions. However, prevailing top-down architecture for rare-earth qubits and devices has not yet to achieve simultaneous long optical and spin coherence necessary for long-distance quantum networks. Here, we demonstrate dual Er^{3+} telecom spin-photon interfaces in two distinct lattice symmetry sites in an epitaxial thin-film platform. Harnessing high matrix crystallinity, control over dopants' proximity to surfaces, and exploiting symmetry of the host lattice, we simultaneously achieve kilohertz-level optical dephasing rate in a strongly symmetry-protected site and longer than 10 millisecond erbium spin coherence times. Additionally, we realize high-fidelity single-shot readout and microwave coherent control of these erbium spin-photon interfaces in a fiber-integrated package, enabling rapid scaling up. These results demonstrate a significant prospect for high-quality rare-earth qubits and quantum memories assembled using a bottom-up method and pave the way for the large-scale development of quantum light-matter interfaces for telecommunication quantum networks.

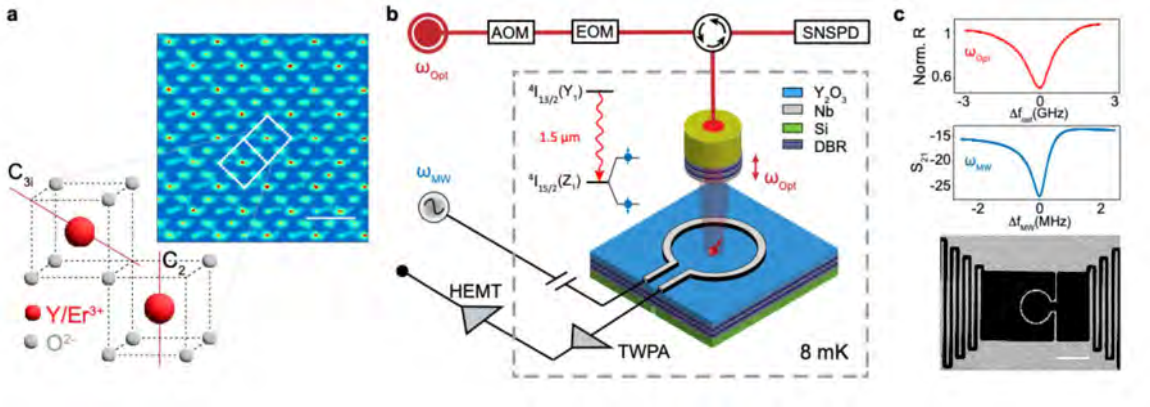


Figure Schematic of the Er^{3+} qubit device and experiment setup. (a). lattice image of the cubic-phase epitaxial Y_2O_3 films grown on silicon. The scale bar is 1 nm. (b). The device consists of a tunable cryogenic fiber Fabry-Perot cavity coupled to the optical transition of Er^{3+} and a low-impedance superconducting microwave resonator coupled to the Er^{3+} spin transition at 5.8 GHz. (c). (Top) the reflection spectrum of the fiber Fabry-Perot cavity. (Middle) spectrum of the microwave resonator. (Bottom) SEM image of a co-planar superconducting microwave resonator based on niobium The scale bar is 20 μm.

References

[1] S. Gupta, Y. Huang, S. Liu, Y. Pei, G. Giang, S-L. Yang, N. Tomm, R. Warburton, T. Zhong, arXiv:2310.07120, *manuscript under review*.

Dr. Tian Zhong obtained his Ph.D in electrical engineering from MIT, and then completed a postdoc at Caltech from 2014-2017. He joined faculty at University of Chicago Pritzker School of Molecular Engineering since 2018. He is a recipient of NSF CAREER award and DOD ARO young investigator program award.

I1. Optical studies of stoichiometric Er crystals for quantum information applications

Rose Ahlefeldt[1], Lara Gillan[1], Toby Hardcastle[1], Matt Berrington[2], Jevon Longdell[3], Matt Sellars[1]

[1] Research School of Physics and Engineering, Australian National University, Canberra, Australia
[2] School of Electrical Engineering & Telecommunications, University of New South Wales, Sydney, Australia
[3] Department of Physics, University of Otago, Dunedin, New Zealand
Rose.ahlefeldt@anu.edu.au

Erbium in crystals has been well studied in the dilute limit for quantum information applications, including quantum memories and quantum light sources. At typical concentrations <<0.1%, the large separations between Er ions mean the interactions between them are a weak perturbation on the single-ion optical spectrum and properties. The opposite limit, where Er is fully concentrated in the crystal, also has interest for applications like quantum transduction[1] and quantum processing[2]. However, the incredibly high optical density in such concentrated materials makes them difficult to study with standard spectroscopy. As a result, we know comparatively little about the optical energy level structure, linewidths, and coherence properties of this class of crystals.

We have completed detailed optical studies of one transducer candidate, ErLiF4, which showed good performance for this application. This material magnetically orders below 370 mK, in which regime it has narrow optical transitions of a few hundred MHz. The resulting exceptionally high optical density of 5.3×10^4 cm^{-1}, combined with the hybrid electric-magnetic transition dipole, substantially modifies the crystal's refractive index with the possibility of reaching the negative refractive index regime for the first time in a natural material[3]. Optical transitions in the crystal are excitonic rather than the single-ion excitations seen in dilute crystals, generating extra structure in the spectrum with optical linewidths as low as 18 MHz.

At the same time, the material host Er ions near defects whose frequencies are detuned from the excitonic lines by ~10 GHz and which have properties similar to dilute crystals. In particular, these defect lines show coherence times similar to Er:YLiF4, indicating a complete decoupling from the excitonic structure of the crystal, and, indeed, a degree of protection from fluctuating magnetic fields provided by the ordered magnetic state. These defect lines could be used in quantum processing applications, and this work is the first evidence that the coherence required for processing is feasible in fully concentrated, magnetically interacting crystals.

1. J. R. Everts, M. C. Berrington, R. L. Ahlefeldt, and J. J. Longdell, *Microwave to optical photon conversion via fully concentrated rare-earth-ion crystals*, **Physical Review A 99**, 063830 (2019).
2. R. L. Ahlefeldt, M. J. Pearce, M. R. Hush, and M. J. Sellars, *Quantum processing with ensembles of rare-earth ions in a stoichiometric crystal*, **Physical Review A 101**, 012309 (2020).
3. M. C. Berrington, M. J. Sellars, J. J. Longdell, H. M. Rønnow, H. H. Vallabhapurapu, C. Adambukulam, A. Laucht, and R. L. Ahlefeldt, *Negative Refractive Index in Dielectric Crystals Containing Stoichiometric Rare-Earth Ions*, **Advanced Optical Materials 11**, 2301167 (2023).

I2. Thin Film Based Structures for Optical Quantum Technologies

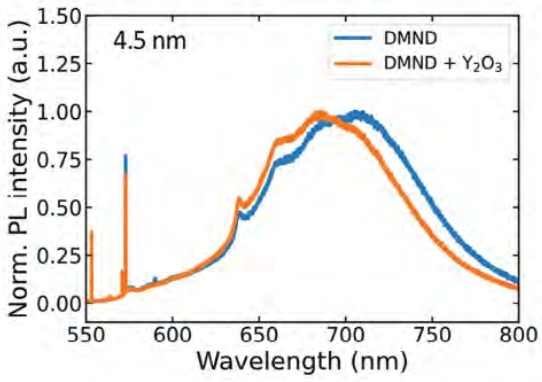
Philippe Goldner

[1] *Institut de Recherche de Chimie Paris, Chimie ParisTech, PSL University, CNRS, Paris, France*

**E-mail: philippe.goldner@chimieparistech.psl.eu*

Thin films offer exciting prospects for scalable quantum technologies, integration in photonic and electric circuits, as well as enhanced coupling e.g. of emitters to photonic structures. Moreover, associating distinct quantum centers in a hybrid structure can achieve new functionalities providing that the underlying properties of each component are preserved. In this work, we will discuss recent results on two systems with outstanding optical and spin properties that have been broadly used for quantum applications such as sensing and communications: NV^- color centers in diamond [1] and rare earth (RE) doped crystals [1,2].

The hybrid structure consists of a rare earth doped Y_2O_3 thin film deposited by direct liquid injection chemical vapor deposition (CVD) on a single crystalline diamond substrate in which shallow NV^- were implanted [3]. We investigated in detail the structure of the films and the optical and spin properties of rare earth ions and NV^- centers. Photoluminescence decays of the Er^{3+} telecom wavelength $^4I_{13/2}$-$^4I_{15/2}$ transition measured at room and low temperatures indicate a low concentration of defects in the films, with lifetimes up to 16 ms, whereas high-resolution spectroscopy reveals inhomogeneous broadening comparable to that reported on films deposited on other substrates like silicon. In addition, optical and spin properties of the NV^- before and after Y_2O_3 thin film deposition show they are not strongly affected by the film deposition. These promising results [4] suggest that the proposed structure can be useful for integrating the rare-earth ions with NV^- centers at the nanoscale level for developing hybrid solid state quantum systems.



Emission spectrum of NV^- centers implanted at a depth of 4.5 nm in diamond (blue). Deposition of a Y_2O_3 thin film preserves emission properties (orange).

[1] D. D. Awschalom, R. Hanson, J. Wrachtrup, and B. B. Zhou, Quantum technologies with optically interfaced solid-state spins, Nat. Photonics **12**, 516 (2018).

[2] N. Harada et al., Chemically vapor deposited Eu^{3+}:Y_2O_3 thin films as a material platform for quantum technologies, J. Appl. Phys. **128**, 055304 (2020).

[3] M. W. Ngandeu Ngambou et al., Hot ion implantation to create dense NV center ensembles in diamond, Applied Physics Letters **124**, 134002 (2024).

[4] I. G. Balaşa et al., Rare Earth-Diamond Hybrid Structures for Optical Quantum Technologies, Advanced Optical Materials 2401487 (2024).

I3. Unlocking the Potential of Up-Conversion Charging for Information Storage in Phosphors

Xiao-Jun Wang,[1] Feng Liu,[2] and Yichun Liu[2]

[1] *Department of Physics, Georgia Southern University, Statesboro, Georgia, USA*
[2] *School of Physics, Northesat Normal University, Changchun, Jilin, China*

**E-mail: xwang@georgiasouthern.edu*

Current optical storage technologies using phosphor media struggle to achieve fast, precise data recording due to limitations of traditional charging methods. We present an up-conversion charging (UCC) approach that enables rapid, high-resolution data storage in $Gd_3Ga_5O_{12}:Cr^{3+}$ phosphors. UCC employs two-step ionization and nonlinear charging, allowing data writing with only 0.01 s exposure per bit using a portable diode-laser engraver. This method improves recording efficiency, provides long-term data retention, and offers excellent rewritability.

Professor Xiaojun Wang received his Bachelor's degree from Jilin University, his Master's degrees from the Chinese Academy of Sciences, and his PhD in Physics from The University of Georgia, USA. He worked as a Postdoctoral Associate at Oklahoma State University and as an NIH Postdoctoral Fellow at UC-Irvine. Since 1995, he has been a Professor of Physics at Georgia Southern University, USA. Professor Wang serves as Editor-in-Chief for the Materials Research Bulletin, and an Editor for Light: Science & Applications. He is also a Fellow of the American Physical Society.

O1. Tuning key characteristics of storage phosphor thin coatings

V. Castaing,[1,*] M. Romero,[2] G. Lozano[2] and T. Gacoin[1]

[1] *Laboratoire de Physique de la Matière Condensée (PMC), CNRS, Ecole Polytechnique-Institut Polytechnique de Paris, 91120 Palaiseau, France.*

[2] *Institute of Materials Science of Seville, Spanish National Research Council – University of Seville, C/ Américo Vespucio 49, 41092 Seville, Spain.*

**E-mail: victor.castaing@polytechnique.edu*

From ancient torches to LED lighting, the quest to harness light has transformed societies, initially to extend social and labor activities beyond daylight hours. The growing world energy consumption, partially due to lighting, has shifted the focus towards capturing solar light to generate energy. In this context, persistent and storage phosphors, often referred to as 'light batteries', are promising candidates towards solar energy storage and conversion technologies. Indeed, these materials, typically oxides doped with rare-earth or transition metal cations, have the unique ability to store part of the absorbed optical energy at structural defects. The stored energy can then be released by thermal, optical or mechanical stimulation. Up to now, bulk storage phosphors are mainly used for applications like design, night signalization or radiation monitoring. In contrast, nanophosphors featuring this unique property have emerged only recently, although offering exciting opportunities for *in vivo* imaging, anticounterfeiting, photocatalysis, and 3D imaging displays.[1] To tackle the challenges of nano light battery design, we developed new synthetic strategies, combining two opposite worlds: soft chemistry and high temperature annealing, allowing to obtain bright transparent coatings. The unique opportunity offered by transparent coatings to tune their properties by optical environment design has been explored, by modifying their refractive index and optical path.[2] Finally, novel optical characterization tools were developped and coupled to rate equation modelling to assess light storage and release in a quantitative manner, allowing strict comparisons among different storage phosphor designs.[3]

References

[1] V. Castaing, E. Arroyo, A. I. Becerro, M. Ocaña, G. Lozano, et H. Míguez, *Journal of Applied Physics*, 130, 8, 080902 (2021).
[2] V. Castaing, M. Romero, J. Torres, G. Lozano, et H. Míguez, *Advanced Optical Materials*, 12, 3, 2301565 (2024).
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O2. A Custom-Built Integrated System for Measuring Stimulated Luminescence in Materials

M. C. S. Nunes[1], F. R. Kobata[2], F. S. Costa[2], P. M. Dantas[2], T. A. P. Salvador[2], A. O. Silva[2], Nancy K. Umisedo[2], E. M. Yoshimura[2] and N. M. Trindade[2*]

[1] *Programa de Graduação em Ciências e Tecnologia dos Materiais, Universidade Estadual Paulista, Sorocaba, SP, Brasil*

[2] *Instituto de Física, Universidade de São Paulo, São Paulo, Brasil*

**E-mail: neilotrindade@usp.br*

The development of integrated luminescence measurement systems is essential for dosimetry and radiation detection applications. In this context, we present LUMI-22, a custom-built, modular system designed for Thermoluminescence (TL), TL spectroscopy, Radioluminescence (RL), RL as a function of temperature, and the implementation of Optically Stimulated Luminescence (OSL). The system incorporates a heating unit based on Kanthal® A1 alloy (FeCrAl), controlled via a microcontroller that regulates temperature ramps (1–5 ºC/s). The RL excitation is provided by an X-ray tube (Moxtek 50 kV, 50 µA), with a sample dose rate of 0.43 Gy/min, while light detection relies on a photomultiplier tube (Hamamatsu H10493-012:HA, 185–850 nm) and a fiber optic spectrometer (Ocean Optics QE65000, 200–1100 nm) coupled with a 1000 µm fiber (QP1000-2-UV-VIS) for TL and RL spectroscopy.

To extend its capabilities, an OSL stimulation system was integrated, employing a 450 nm blue LED (90 mW, 5 mm diameter), controlled via an Arduino UNO and interfaced with LABVIEW software. This enhancement allows for the investigation of luminescence properties in simulated lunar and Martian minerals, provided by NASA, as well as natural minerals such as olivine ($(Mg^{2+}, Fe^{2+})_2SiO_4$), which is found on Earth, Mars, and the Moon and has been studied for luminescence dating.

The system's performance was evaluated using Al_2O_3:C, Al_2O_3:C,Mg, and TLD-100 phosphors, well-established materials in dosimetry, with results consistent with literature data. Additionally, natural Brazilian olivines were irradiated under controlled conditions to assess their potential as radiation detectors for future space missions. The successful integration of OSL further expands LUMI-22's applications in radiation dosimetry and extraterrestrial material analysis.

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O3. A-site Doped Zirconates ($A_2Zr_2O_7$) As A Frontier In Thermal Sensing Technology

Sangeetha Balabhadra[1*], Lukusa M. Tiffany[1], Nila S. James[2], Carol Cui[2], Zhiping Luo[1]

[1] *Department of Chemistry, Physics, and Materials Science, Lloyd College of Health, Science and Technology, Fayetteville State University, North Carolina, 28301, USA*

[2] *Jack Britt High School, Fayetteville, North Carolina, 28306, USA*

**E-mail: Sbalabhadra@uncfsu.edu*

$A_2B_2O_7$ compounds, particularly zirconates, have garnered significant attention due to their exceptional mechanical, chemical, and thermal properties, coupled with high structural flexibility and ionic conductivity. These materials exhibit two prominent structures, fluorite and pyrochlore, which enable their multifunctionality in diverse fields such as optoelectronics, catalysis, and nuclear waste immobilization [1,2]. Their adaptability to incorporate a wide range of dopant ions further enhances their potential, making them vital candidates for advanced technological applications.

State-of-the-art research highlights that the zirconates have been successfully implemented for the above-stated applications with a focus on stability, durability, and resistance to extreme conditions. However, current major setback of these materials is considered as its thermal performance under varying operational environments. Addressing its limitations remains crucial to fully harness their capabilities for high-performance applications.

In this study, $A_2B_2O_7$-type (A= Ga, Y, and In/Tb) zirconates were synthesized by dissolving the reactants at room temperature followed by a high temperature calcination step at 800°C for three hours [3]. The as-synthesized material was analyzed for its phase identification and phase purity using X-ray diffraction (XRD) equipment. Data from the energy dispersive x-ray spectroscopy confirmed the nominal elemental composition of the materials. The scanning electron microscope (SEM) was used to obtain magnified images of the synthesized materials. The SEM images recorded show the mixture of plate and sphere-type particles. The zirconates were further investigated for their photo/cathodoluminescence and thermal properties. Further thermogravimetric analysis, differential scanning calorimetry, precision and hardness measurements were also performed. This work aims to overcome existing shortcomings by enhancing thermal and structural performance, thereby paving the way for broader functional applications of $A_2B_2O_7$ ceramics.

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O4. Electronic Structure and Properties of β-ZnTe(en)$_{0.5}$

Wanseok Oh[1], Yizhou Wang[2], Carrie Donley[3], Alexis Harvey[4], Joanna Atkin[4], Thomas A. Schmedake[2] and Yong Zhang[1*]

[1] *Department of Electrical and Computer Engineering, University of North Carolina at Charlotte, Charlotte, 28223, USA*

[2] *Nanoscale Science and Department of Chemistry, University of North Carolina at Charlotte, Charlotte, 28223, USA*

[3] *Chapel Hill Analytical and Nanofabrication Laboratory, University of North Carolina, Chapel Hill, North Carolina 27599, USA*

[4] *Department of Chemistry, University of North Carolina, Chapel Hill, North Carolina 27599, USA*

**E-mail: yong.zhang@charlotte.edu*

β-ZnTe(en)$_{0.5}$ stands out as a II-VI organic-inorganic hybrid nanostructure featuring a perfectly ordered, defect-free, short-period superlattice. Its inorganic ZnTe layers are atomically thin (two monolayers) and interconnected by ethylenediamine (en) molecules, resembling 2D materials. This unique structure, where zinc and en's nitrogen atoms form covalent like bonding, creates a subnano scale hybrid superlattice. This specific design, with its precise thickness, stacking ability, and quantum confinement, makes β-ZnTe(en)$_{0.5}$ similar to 2D superlattice heterostructures, ideal for (opto)electronic applications. Its excellent long-term stability further enhances its potential in these fields [1].

While X-ray Photoelectron Spectroscopy (XPS) is widely recognized for its ability to identify the chemical states of elements, it is also a powerful tool for understanding a material's band structure [2]. By analyzing the low binding energy region of the XPS spectrum, which corresponds to the start of valence band emission, we can accurately pinpoint the valence band maximum (E_v). For β-ZnTe(en)$_{0.5}$, XPS revealed that Ev was approximately 0.80 eV below the Fermi level (E_F). This finding strongly indicates p-type conductivity, meaning the material's primary charge carriers are holes.

To directly measure the work function, Kelvin Probe Force Microscopy (KPFM) was utilized [3]. KPFM works by detecting the contact potential difference between a conductive atomic force microscope tip and the sample surface, providing a local measurement of the work function. For β-ZnTe(en)$_{0.5}$, KPFM yielded an average work function of 4.59 ± 0.03 eV. This result remarkably aligned with estimates from Ultraviolet Photoelectron Spectroscopy (UPS) (which estimated a range of 4.49 eV to 4.71 eV), bolstering confidence in the work function determination. Additionally, hot probe measurements independently confirmed the p-type conductivity of β-ZnTe(en)$_{0.5}$, validating the nature of its majority charge carriers.

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I4. Rare-Earth ions in CaF_2 nanoparticles for scalable quantum technologies

M. D. Moull[1,2], M. F. Reid[1,2]*, J.-P. R. Wells[1,2]

[1] *The School of Physical and Chemical Sciences, University of Canterbury, Christchurch, New Zealand*
[2] *The Dodd-Walls Centre for Photonic and Quantum Technologies, New Zealand*

**E-mail: mike.reid@canterbury.ac.nz*

Rare-earth doped crystals and nanocrystals are promising candidate materials for quantum information technologies that interface between light and matter, such as quantum memories, repeaters, and transducers. Coherent storage and single-ion detection in both bulk crystals and nanoparticles have been demonstrated [1]. Single-ion detection typically employs waveguides or cavities to enhance light-matter interactions via the Purcell effect.

The $^7F_0$-$^5D_0$ transition of Eu^{3+} has been widely investigated for its potential in quantum memory applications [2]. Unfortunately, the $^7F_0$-$^5D_0$ transition is usually very weak, making single-ion detection challenging.

The $C_{3v}(O^{2-})$ centre in oxygenated rare-earth doped calcium fluoride has an extremely large dipole moment, due to the replacement of one of the eight nearest-neighbour F^- ions by O^{2-} [3]. The high symmetry of this centre makes it straightforward to obtain not only crystal-field parameters but also transition intensity parameters [4].

In this talk, we will present results for the $C_{3v}(O^{2-})$ Eu^{3+} centre that significantly extend previous analyses [5]. We will discuss how our measurements and calculations give insight into the charge-transfer and crystal-field mixing mechanisms that contribute to the enhanced dipole moment for the $^7F_0$-$^5D_0$ transition. We will also discuss proposed coherent and single-ion detection experiments using Eu-doped nanocrystals.

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Prof. Michael F. Reid

University of Canterbury, Christchurch, New Zealand

Mike Reid graduated from University of Canterbury in 1981. He spent three years as a Postdoc at University of Virginia and seven years as a Lecturer at The University of Hong Kong. He returned to New Zealand in 1993. His research area is optical properties of rare-earth (lanthanide) doped materials, with a particular emphasis on modelling electronic structure and dynamical properties. His current focus is on electronic structure and dynamical properties of rare-earth doped materials that have potential for quantum-information applications and rare-earth doped nanoparticles that have potential sensing applications.

I5. Quantum Tiling of 2D Electronic Materials

C.K. Shih

Department of Physics, The University of Texas at Austin

**E-mail: shih@physics.utexas.edu*

Twisting two atomically thin layers of 2D electronic materials creates moiré patterns that unlock entirely new quantum phenomena—ushering in the era of *quantum tiling*. Much like artistic tiling fills a surface with intricate patterns, scientists can now design moiré superlattices to engineer exotic electronic states. In this talk, I will present three recent examples from our lab using twisted bilayer WSe_2 to illustrate the power of this approach.

First, at small twist angles, long-wavelength moiré superlattices form, where the presence of oppositely charged atomic layers induces swirling patterns of interlayer polarization—pseudospin skyrmions—that impart quantum geometric phases and enable topological band engineering. Scanning tunneling microscopy and spectroscopy reveal both the pseudospin textures and associated moiré band topology. [1]

Second, at a 30° twist, the moiré pattern becomes incommensurate with the atomic lattice, giving rise to a *moiré quasicrystal* that lacks translational symmetry but preserves long-range order through tiling rules. Despite the breakdown of Bloch's theorem, quasi-Bragg planes emerge, leading to fractal-like mini-gaps. [2]

Third, for twist angles slightly offset from commensurate values, the system self-organizes into a periodic array of three distinct rotational domains—called a *supermoiré* lattice. This superstructure generates a dense set of flatbands, offering a novel platform for exploring strongly correlated moiré quantum phases. [3]

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Short bio:

Professor Shih received his Bachelor's Degree in Physics at the National Tsing Hua University in 1977 and his Ph.D. in Applied Physics at Stanford University in 1988. After finishing his postdoctoral research at the IBM T.J. Watson Research Center, he joined the Physics Department of the University of Texas as a faculty member in 1990. Since then, he has mentored 35 Ph.D. students and 16 postdocs. He is now a full professor and holds the Arnold Romberg Endowed Chair in Physics at the University of Texas at Austin. Professor Shih's research activities have centered around controlling and investigating low-dimensional quantum materials at nanometer scales. Professor Shih is a fellow of the American Physical Society and has received the Distinguished Alumni Award from the National Tsing-Hwa University, Taiwan. He also received the Yushan Scholar Award from the ministry of education, Taiwan, ROC. He has been serving on the advisory board of CNMS, Oak Ridge National Laboratory in the US, and the advisory board of the Institute of Physics, Academia Sinica, Taiwan, and several research centers in the US and abroad.

I6. Towards crystal field engineering for single erbium ions

T.G.M. Newman[1,2,3], A.L. Jeffery[1], M.D. Moull[4,5], M.F. Reid[4,5], J.G. Bartholomew[1,2,*]

[1] *Centre of Excellence for Engineered Quantum Systems, The University of Sydney, NSW 2006, Australia*
[2] *University of Sydney Nano Institute, The University of Sydney, NSW 2006, Australia*
[3] *Sydney Quantum Academy, Sydney NSW Australia*
[4] *Dodd-Walls Centre for Photonic and Quantum Technologies, University of Canterbury, New Zealand*
[5] *The School of Physical & Chemical Sciences, University of Canterbury, Christchurch 8140, New Zealand*

**E-mail: john.bartholomew@sydney.edu.au*

Distributing entanglement efficiently over photonic networks is a critical challenge to increase quantum computing and communication capabilities toward utility scale. An appealing hardware system for solving this quantum networking challenge is crystals containing erbium ions [1]. The infrared $^4I_{15/2} \leftrightarrow {}^4I_{13/2}$ transition of Er^{3+} is ideal for low loss photon distribution in optical fibers and can exhibit high coherence and low spectral diffusion. However, Er^{3+} interactions with light are very weak and the infrared transition strengths are not well understood. In this paper, I will discuss our atomic-scale testbed for understanding and engineering Er^{3+} transition properties using the crystal field interaction in the host lattice.

We have grown Er^{3+}:CaF_2 single crystals and introduced O^{2-} into the lattice through controlled annealing [2]. Using emission spectroscopy and high resolution transmission studies of the $^4I_{15/2} \leftrightarrow {}^4I_{13/2}$ transition, we have characterized the crystal field interaction and compared the crystal field impact on the infrared transition dipole moment of Er^{3+} ions in various sites (see Figure 1). Although the excited state (Y_1) lifetimes are all longer than 10 ms, largely due to the low refractive index of CaF_2, we measured dipole moments of the order of 2×10^{-32} Cm, which is relatively strong for Er^{3+}. We have also studied the coherence times of the sites of interest and explored ways to minimize the impact of the magnetic field fluctuations arising from the F^- nuclear spin bath. Finally, we will report on our recent work coupling Er^{3+} ions to the high quality factor modes of sub-mm diameter CaF_2 whispering gallery mode resonators.

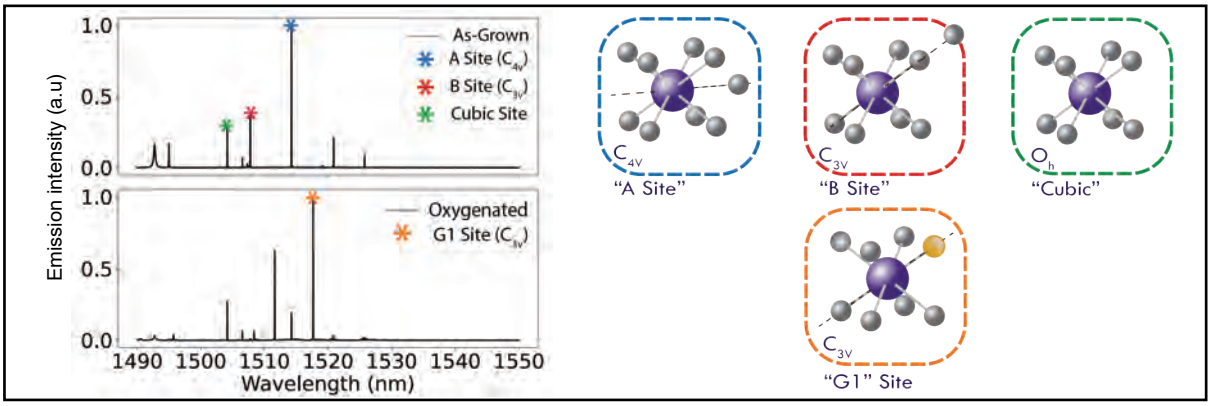

Figure 1: Emission spectra of the spectrally resolved sites in as-grown and oxygenated Er^{3+}:CaF_2.

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I7. Hidden anomalies in topological materials probed by second harmonic generation

Rongying Jin
SmartState Center for Experimental Nanoscale Physics, Department of Physics and Astronomy, University of South Carolina, Columbia, South Carolina 29208, USA
Email: rjin@mailbox.sc.edu

The discovery of topological properties in quantum materials has generated a new subfield, namely topological physics, which is to study the microscopic geometries and symmetries that lead to particular phenomena. The complexity can be induced by broken crystallographic and/or time-reversal symmetry. The broken crystallographic symmetry results in the noncentrosymmetry (NCS) of a material, while broken time-reversal (TR) symmetry can result from the intrinsic magnetism or the external magnetic field. Second harmonic generation (SHG) is a nonlinear optical response that is sensitive to NCS and TR symmetry breaking. We study the topology-related physical properties via second harmonic generation (SHG) measurements. Two examples will be given: one is Weyl semimetal $PtBi_2$ with NCS and another is $BaMnSb_2$ with NCS and magnetic ordering at $T_N \sim 286$ K. In both cases, nonzero SHG signal is detected. Combined with single crystal x-ray diffraction refinement and magnetic susceptibility measurements, the variation of the SHG intensity with temperature may be explained in terms of materials' unique symmetries. Our work illustrates that SHG is a powerful technique for probing NCS and TR symmetry-broken contributions, which are directly related to the topological properties.

O6. Spatially Resolved Long-Term Ionic Oscillations in Mixed Halide Perovskites

Xiaoxiao Sun[1,*], Weikun Ge[2], Yong Zhang[3,*]

[1] *School of Electronic and Computer Engineering, Peking University Shenzhen Graduate School, Shenzhen 518055, China*

[2] *Department of Physics, Tsinghua University, Beijing 10084, People's Republic of China*

[3] *Department of Electrical and Computer Engineering, The University of North Carolina at Charlotte, Charlotte, NC 28223, USA*

**E-mail: cook.s@pku.edu.cn, yong.zhang@charlotte.edu*

Photo-induced ion dynamics in mixed-halide perovskites, particularly halide segregation, are critical to their performance and stability. Our prior work[1] revealed that under illumination, halide ions are expelled from the illuminated area, forming a macro/mesoscopic halide-rich region outside the illuminated area, manifesting as an enhanced photoluminescent ring (Figure 1a). This nonlocal ion displacement creates a built-in voltage between the ring and central region, and, upon removal of illumination, leads to ultra-low-frequency ionic plasma oscillations as ions redistribute.

Here we present a detailed spatial analysis of these oscillations, focusing on the evolution of real space distributions of the PL intensity at 670 nm and 790 nm over 100 hours. The 790 nm PL spatial profiles (Figure 1b) offer a direct visualization of the halide ion oscillatory movement. From an initial state (0 hr illumination) with a depleted center, halide ions are observed to migrate back towards the central region. Subsequently, the intensity around the ring emerges at around 25 hours as the ions are moving back to the center again, followed by another central area recovery at 54 hours. Complementary dynamics are revealed by the 670 nm PL spatial profiles. This real space analysis provides further evidence of propagating ionic fronts and oscillatory waves, offering more insight to the wave-like ion dynamics than the time-domain analysis alone.

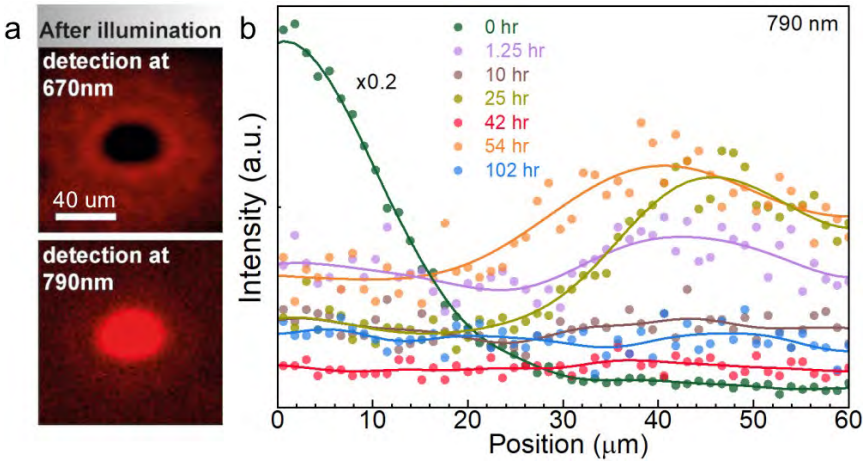

Figure 1. **a** PL mapping after local illumination by a 12 μm size 639 nm laser beam. **b** real space PL intensity at the selected recovery time for 790 nm.

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O7. Photoelectric Studies as the Key to Understanding the Nonradiative Processes in Chromium Activated NIR Materials

N. Majewska,[1,2*] M.-H. Fang,[3] S. Mahlik[2]

[1]*Faculty of Chemistry, Adam Mickiewicz University, Uniwersytetu Poznańskiego 8, 61-614 Poznań, Poland*

[2]*Institute of Experimental Physics, Faculty of Mathematic, Physics, and Informatics, University of Gdańsk, Wita Stwosza 57, 80-308 Gdańsk, Poland*

[3]*Research Center for Applied Sciences, Academia Sinica, Taipei 11529, Taiwan* (*10.5 pt, Italic*)

**E-mail: natalia.majewska@ug.edu.pl*

Due to their potential applications in biology, Cr^{3+}-activated luminescent materials have recently gained significant attention worldwide. These materials, capable of producing either sharp-line or broadband spectra, are promising candidates for phosphor-converted infrared light-emitting diodes (pc-NIR LEDs) and have been used in food freshness, quality, and composition analysis. One of the primary objectives is to identify materials exhibiting efficient broadband near-infrared (NIR) luminescence. Understanding quenching phenomena, which may be related to the crossing point between the ground and excited states or to autoionization, is crucial for designing efficient NIR materials.

Ga_2O_3 activated by Cr^{3+} ions is a promising material for NIR sources, characterized by efficient NIR luminescence in the 650–900 nm range. Here, we present luminescence and photoelectric studies of Cr^{3+}-activated Ga_2O_3 modified with In^{3+}, focusing on quenching mechanisms. Photocurrent excitation spectra closely followed the absorption spectra, confirming that charge carrier generation involves not only valence-to-conduction band transitions but also Cr^{3+}-related states. Specifically, transitions from $^4A_2$ to $^4T_1$ and $^4T_2$ of Cr^{3+} play a significant role in promoting carriers into the band structure. A notable increase in photocurrent with rising temperature, accompanied by a simultaneous decrease in photoluminescence intensity, suggests a thermally activated ionization process. Contrary to conventional models attributing luminescence quenching in Cr^{3+}-doped oxides to nonradiative relaxation from $^4T_2$ to $^4A_2$, our analysis reveals that quenching originates from hole-type thermal ionization. Rather than electron transfer from Cr^{3+} to the conduction band, this process involves hole formation in the valence band, fundamentally altering the understanding of thermal quenching in these materials. These findings not only provide novel insights into Cr^{3+}-doped systems but also suggest broader applicability to other transition metal-doped oxides.

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O8. Degradation Kinetics of Organic–Inorganic Hybrid Superlattice β-ZnTe(en)$_{0.5}$ from Micro-Raman Spectroscopy and Density-Functional Theory

*~~T. Ye~~[1,2], Y.-Y. Sun[3], T.A. Schmedake[1,4], and Y. Zhang[1,5]**

[1] *Nanoscale Science, University of North Carolina at Charlotte, Charlotte, NC 28223, USA*
[2] *Department of Physics, Norwich University, Northfield, VT05663, USA*
[3] *State Key Laboratory of High-Performance Ceramics and Superfine Microstructure, Shanghai Institute of Ceramics, Chinese Academy of Sciences, Shanghai 201899, China*
[4] *Department of Chemistry, University of North Carolina at Charlotte, Charlotte, NC 28223, USA*
[5] *Department of Electrical and Computer Engineering, University of North Carolina at Charlotte, Charlotte, NC 28223, USA*

* *E-mail: yong.zhang@uncc.edu*

Organic-inorganic hybrid halide perovskites have shown unprecedent potential for a wide range of applications but face a pressing stability challenge. A reliable accelerated aging technique is much needed for predicting the long-term stability of an organic-inorganic hybrid material. Here we take β-ZnTe(en)$_{0.5}$, which uniquely has real-time degradation data over one and a half decade,[1] as a prototype structure to validate an approach for this purpose. We use micro-Raman spectroscopy to investigate the thermal degradation of β-ZnTe(en)$_{0.5}$ in a protected condition and in air by monitoring the temperature dependences of the Raman modes of both the hybrid structure and degradation product.[2] We identify the transition state of intrinsic degradation and calculate the energy barrier using DFT to be 1.70 eV, in excellent agreement with the measured thermal degradation barrier of 1.62 eV in N_2 environment. Under ambient conditions, oxidation lowers the barrier to 0.92 eV, projecting a 40-year half-life at room temperature, in general agreement with the experimental observation of no apparent degradation over 15 years.

This study demonstrates an accelerated method for assessing the intrinsic and ambient-condition long-term stability of a material, especially for organic-inorganic hybrid materials. Furthermore, it highlights a key mechanism, conformation distortion enhanced stability, as critical to the exceptional longevity of β-ZnTe(en)$_{0.5}$. This mechanism should be considered in designing new superstructures.

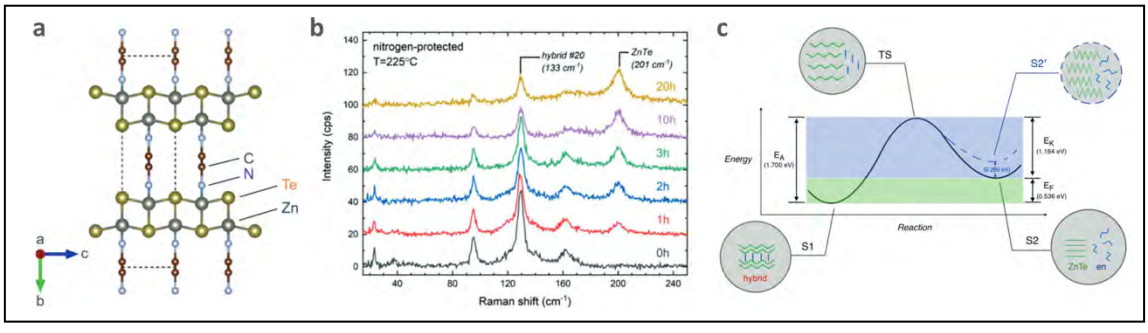

FIG: (a) Crystal structure of β-ZnTe(en)$_{0.5}$. (b) Time-resolved Raman spectra showing thermal degradation of β-ZnTe(en)$_{0.5}$ under nitrogen protection at 225 °C. (c) Degradation kinetics of β-ZnTe(en)$_{0.5}$.

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I8. Percolation of N cluster states and the birth of the dilute $GaAs_{1-x}N_x$ alloy

Angelo Mascarenhas[1]

[1]*University of Colorado Boulder, CO*

* *E-mail: ajmascar@gmail.com*

In the ideal case of a dilute alloy, electronic property adjustments result from bandstructure modifications generated by the random distribution of isolated substituent atoms. However, in the case of the substitutional alloy GaAsN, the addition of N to GaAs is known to result in a giant bandgap bowing as well as a severe degradation in the electron mobility. As such it can be categorized as an abnormal or non-ideal alloy. Here, the cation substituent Nitrogen has a propensity to form clusters, which generate stationary bound states just below the GaAs conduction band edge. Experimental results reveal that the alloy optical properties are profoundly altered when the localized cluster states overlap and percolate into a fully extended infinite supercluster, which hybridizes with the host conduction band states. PL spectroscopy under a magnetic field was used to identify the existence of Nitrogen superclusters that percolate into an impurity band. At very high magnetic fields, the individual Nitrogen clusters comprising the superclusters get decoupled, restoring their localized nature. Fragmentation of the supercluster back into individual clusters at high magnetic fields is revealed by the emergence of narrow, well defined PL peaks. This talk will discuss the use of a high magnetic field to eject resonant N cluster states out from the conduction band, to tailor the spatial overlap of cluster exciton wavefunctions thus revealing the evolution of N superclusters through the onset of the percolation threshold and providing a snapshot of the birth of the dilute $GaAs_{1-x}N_x$ alloy.

I9. Comparative studies of prominent PV materials: halide perovskite, GaAs and CdTe

Yong Zhang*

Electrical and Computer Engineering Department, University of North Carolina at Charlotte, Charlotte, 28223, USA

**E-mail: yong.zhang@charlotte.edu*

The extraordinary performance of organic-inorganic hybrid halide perovskites in photovoltacis is often attributed to their resembalce to the well-known high-performance inorganic PV materials in material properties such as carrier diffusion length and crystallinity. We compare three prominent PV materials: halide perovskite MAPbI3, GaAs, and CdTe in terms of photoluminescence (PL) efficiency, PL lineshape, carrier diffusion, and surface recombination and passivation, over multiple orders of photo-excitation density or carrier density appropriate for different applications [1]. We also compare the photostability trend from Si, III-V's, II-VI's , I-III-VI's (e.g., , CuInGaSe), I-II-IV-VI's (e.g., CuZnSnSe), and halide perovskite (e.g., $MAPbI_3$) [2-6].

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Dr. Yong Zhang is the Bissell Distinguished Professor in the Department of Electrical and Computer Engineering at UNC Charlotte since 2009. Prior to joining UNC Charlotte, he was a Senior Scientist at NREL. He earned his B.S. and M.S. degrees in Physics from Xiamen University, followed by a Ph.D. in Physics from Dartmouth College. His research spans electronic and optical properties of semiconductors and related nanostructures, organic-inorganic hybrid materials, impurity and defects in semiconductors, and innovative materials and device architectures for applications in optoelectronics, energy, and electronic-photonic integrated circuits. He has over 270 publications, 6 patents, and more than 11,000 citations. He is a Fellow of American Physical Society.

I10. FLIM to understand the transport and charge recombination in metal halide perovskites

Jinsong Huang

Department of Applied Physical Science, University of North Carolina, Chapel Hill
Email: jhuang@unc.edu

Electronic defects within the band gap of semiconductor materials play critical roles in determining the efficiency and stability of their photovoltaic devices. Eliminating deleterious defects in semiconductors or passivating them during the fabrication process of solar cells has become one of the most fundamental tasks for the solar cell society. This scenario is also prevailing in the metal halide perovskite solar cell community which has witnessed a rapid increase of the power conversion efficiency (PCE) of perovskite solar cells from 3.8% to nearly 27% with overwhelming reported progress on defect passivation strategies which also enhance the stability of perovskite solar cells. Any further improvement of the efficiency or stability of perovskite solar cells toward their Shockley-Queisser limitations have to rely on deeper understandings on the nature of defects in perovskite to squeeze out all non-radiative charge recombination paths by eliminating or passivating them. Among several limited tools that are shown to be effective in characterizing defects in perovskites,

Fluorescence Lifetime Imaging Microscopy (FLIM) allows direct vision the impact of defects on material physical property. Here I will present several studies using combination of FLIM and capacitance-based measurements. I will show how these measurements can answer the critical questions such as how high the density of defects, what are their chemical nature, is grain boundary as benign as bulk defects?

Jinsong Huang is currently Louis D. Rubin, Jr. Distinguished Professor at University of North Carolina at Chapel Hill. He received his PhD degree in Material Science and Engineering from the University of California-Los Angeles in 2007. His current research interests include solution processed electronic materials for applications in energy, sensing, and consumer electronics. He has authored ~300 publications, >30 patents, >10 books and book chapters.

I11. AI-Enhanced Surface-Enhanced Raman Spectroscopy for Rapid, Multiplexed Virus Detection and Quantification

Yanjun Yang[1], Jiaheng Cui[2], Amit Kumar[1], Jackelyn Murray[3], Les Jones[3], Xianyan Chen[4], Sebastian Hülck[5], Ralph A. Tripp[3], Yiping Zhao [1,*]

[1] *Department of Physics and Astronomy, Franklin College of Arts and Sciences, The University of Georgia, Athens, Georgia 30602, United States*

[2] *School of Electrical and Computer Engineering, College of Engineering, The University of Georgia, Athens, Georgia 30602, United States*

[3]*Department of Infectious Diseases, College of Veterinary Medicine, The University of Georgia, Athens, Georgia 30602, United States.*

[4]*Department of Epidemiology & Biostatistics, College of Public Health, The University of Georgia, Athens, GA 30602, United States*

[5]*Tec5USA Inc., Plainview, NY 11803, United States.*

**E-mail: zhaoy@uga.edu*

Accurate and rapid diagnosis of respiratory viral infections, particularly SARS-CoV-2, is critical for disease intervention, control, and management. Although real-time reverse transcriptase-polymerase chain reaction (RT-PCR) is the gold standard for virus detection, it is limited by long turnaround times, high costs, and the need for specialized personnel. Fast alternatives, such as antibody-based lateral flow assays, suffer from reduced sensitivity and specificity. To address these challenges, we developed a suite of rapid, label-free, and cost-effective diagnostic platforms integrating surface-enhanced Raman spectroscopy (SERS) with advanced deep learning algorithms. Three complementary SERS-based approaches—RNA hybridization, ACE2-capture, and direct viral detection—were demonstrated for the analysis of human nasopharyngeal swab specimens, achieving >99% classification accuracy between positive and negative cases within 30 minutes. These methods enabled sensitive detection with a limit of detection as low as 1000 copies/mL, variant differentiation, and accurate prediction of RT-PCR cycle threshold (Ct) values with a diagnostic accuracy of 99.04% in blind tests. Expanding on these foundations, large-scale SERS datasets encompassing virus coinfections and SARS-CoV-2 variants were acquired and analyzed using tailored deep learning models, including MultiplexCR, CoVari, and SFNet, achieving >98% classification accuracy and strong quantification performance (mean absolute errors below 0.03, RMSE $\approx$ 1). This work demonstrates the powerful synergy of SERS and AI for rapid, multiplexed virus detection, variant identification, and viral load quantification, positioning these platforms as promising candidates for point-of-care diagnostics, infection control, and broader applications in food safety and environmental monitoring.

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Yiping Zhao received the Ph.D. degree in physics from Rensselaer Polytechnic Institute, Troy, NY, USA, in 1999. He is currently a Distinguished Research Professor in the Department of Physics and Astronomy at the University of Georgia (UGA), Athens, GA, USA. Since joining UGA in 2002, he has authored more than 340 journal publications, numerous book chapters, and three books, including *Use of Smartphones in Optical Experimentation* (SPIE Press, 2022). His current research interests include surface-enhanced Raman spectroscopy, plasmonics, nanofabrication, biosensing, and AI applications in spectroscopy.

Prof. Zhao is a Fellow of SPIE, AVS, and IAAM, and a member of the APS, IEEE, and AAAS. His honors include the SPIE Nano-Engineering Pioneer Award, the Creative Research Medal from UGA, and multiple graduate mentorship awards. He serves on editorial and advisory boards for journals such as *Nanomaterials*, *Targets*, and *Chemical Society Reviews*.

O9. Dynamic calibration of the photoexcited lifetime in a GaAs double heterostructure

T.H. Gfroerer,[1,*] Olivia Guarinello,[1] B.R. Votaw,[1] Daniel Friedman,[2] and Yong Zhang[3]

[1] *Davidson College, Davidson, NC USA*
[2] *National Renewable Energy Laboratory, Golden, CO USA*
[3] *University of North Carolina at Charlotte, Charlotte, NC USA*

**E-mail: tigfroerer@davidson.edu*

We have recently demonstrated an all-optical method, relying primarily on steady-state photoluminescence measurements, to extract the quantitative parameters that describe the rates of radiative and nonradiative recombination in semiconductors. [1] The approach uses a band-to-defect level coupling model that treats the inter-band radiative recombination and defect-related trapping and recombination on equal footing for any defect center occupation fraction. In order to test this model, we are now employing a dynamic calibration technique, [2] which uses a combination of quasi-steady state and transient measurements, to obtain the lifetime as a function of charge carrier density in a GaAs/GaInP double heterostructure (see Fig. 1).

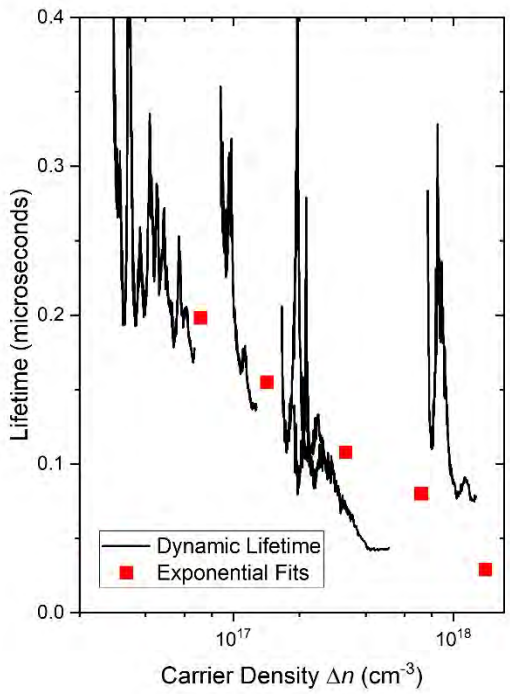

Fig. 1. Dynamic lifetime vs. photoexcited carrier density in GaAs. Also shown in red are lifetimes deduced from exponential fits to the PL decay, plotted at the initial quasi-steady-state carrier density.

In the laser power density regime studied here (approximately 10 – 1000 W/cm^2), our prior analysis of this structure indicated majority carrier densities near 10^{17} cm^{-3} and minority carrier densities ranging from 10^{13} to 10^{17} cm^{-3}. Our dynamic densities are consistent with the predicted majority densities. When we compare our measured lifetimes, which are on the order of 10^{-7} s, with the predicted radiative recombination rates (~10^8 s^{-1}), we observe an order of magnitude disagreement. This discrepancy may be related to photon recycling, which will occur more frequently in the larger illumination area of the transient experiment, reducing the measured rate. More work will be required to fully interpret our transient results in the context of the prior model.

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O10. Manipulation of proton dynamics in perovskite nickelate devices

S. Gamage[1] and Y. Abate[2,*]

[1]*Department of Nanoscience, Joint School of Nanoscience and Nanoengineering, University of North Carolina at Greensboro, Greensboro, NC 27401*

[2]*Department of Physics and Astronomy, University of Georgia, Athens, GA 30606*

**E-mail: yohannes.abate@uga.edu*

Perovskite nickelates, exemplified by $NdNiO_3$, are pivotal strongly correlated oxides valued for their tunable metal-insulator transitions (MITs) and promise in neuromorphic and optoelectronic devices. Understanding the elementary mechanisms governing their functional responses, particularly at the nanoscale, remains a significant challenge. This work focuses on the precise manipulation of proton distribution within these materials to dynamically control their electronic and structural properties. We have utilized a combination of cutting-edge experimental techniques, including nanoscale infrared nanoimaging and nanospectroscopy and in situ high-resolution X-ray diffraction (HRXRD) together with molecular dynamics calculation and FDTD simuilations, to observe and track the simultaneous structural and local conductivity modulation in hydrogen-doped $NdNiO_3$ (H-$NdNiO_3$). We demonstrate that these hydrogen dopants induce a dynamic reconfiguration of the material's electronic and structural states, which can be actively controlled by applying external electric fields.

O11. Europium phosphorescence in lanthanum aluminium perovskite

J. K. Krebs,[1*] Songhang Li,[1] Dragos I. Georgescu,[1] Tan Dung Pham,[1] and Katherine E. Plass[2]

[1] *Department of Physics and Astronomy, Franklin & Marshall College, Lancaster PA, 17604, USA*
[2] *Department of Chemistry, Franklin & Marshall College, Lancaster PA, 17604, USA*

**E-mail: kkrebs@fandm.edu*

Europium-doped $LaAlO_3$ (LAP) is an intriguing phosphor with a perovskite structure. When excited by ultraviolet light, it can exhibit both fluorescence and phosphorescence, with lifetimes differing by several orders of magnitude. The fluorescence decay (2.2 ± 0.3 ms), attributed to relaxation from the $^5D_0$ state to the ^7F_j ground state manifold, shows minimal temperature dependence [1]. In contrast, the slower decay results from repopulation of the $^5D_0$ state by charges trapped in energy states associated with the host material [2]. Charge migration, and consequently phosphorescence, is strongly temperature-dependent.

Lanthanide impurities in $LaAlO_3$ occupy the lanthanum cation site with slight distortions due to differences in ionic radii. Density functional theory (DFT) calculations have been performed to optimize the geometry of these distorted impurity sites. Using the optimized site geometry, we calculate the energy levels of Eu^{3+} in $LaAlO_3$ using Ligand Field-DFT within the Amsterdam Modeling Suite, employing the Average Over Configuration (AOC) approach to account for the partially filled 4f shell [3]. Calculated results will be compared to the measured emission spectrum under UV excitation.

We report experimental results on combustion synthesized samples (< 100 nm) with europium concentrations from 0.01-0.5 atomic percent. The decay dynamics of the excited europium population after 226 nm and 337 nm excitation reveal distinct behaviors, with the higher-energy excitation populating host traps, whereas lower-energy excitation does not. The temperature dependence of phosphorescent lifetimes shows the expected strong effect, with a 35% increase in the trap-to-$^5D_0$ transfer rate over the 78–255 K range. These results will also be presented within the framework of a rate equation model.

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I12. Innovating Fluorescent Molecular Dyes for Photocatalysis, Photochromism, and Biosensing Applications

Michael G. Walter[1]
[1]Department of Chemistry - University of North Carolina at Charlotte

*E-mail: mwalte33@charlotte.edu

Thiazolo[5,4-d]thiazoles (TTzs) are attractive materials for a variety of photochemical and electrochemical applications due to their simple syntheses, strong fluorescence, and high chemical stability. The unique fused, bicyclic TTz molecular structure enables multifunctional properties, high-performance fluorescence sensing, anolyte materials for redox-flow batteries, and as efficient photocatalysts. Dipyridinium, extended-viologen TTz derivatives exhibit high fluorescent quantum yields (> 90%) and reversible electrochromic properties. Simple TTz chromogenic hydrogel devices display electrochromism, electrofluorochromism, and photochromism and exhibit excellent reversibility and stable fluorescence cycling. We have also shown the ability of alkylated dipyridinium TTzs to drive the formal addition of potassium organotrifluoroborates (alkyl-BF_3K) to imines with good efficiencies (isolated yields ~ 80-90%) and turnover numbers (TON, 400-700), using surprisingly low mol% (0.05-0.1) photocatalyst. Newly designed, asymmetrically substituted, push-pull TTz materials show strong solvatofluorochromism and are being evaluated as voltage-sensitive dyes for cell membrane potential sensing. Asymmetric TTzs can be used as a cell membrane VSD and have shown good cell membrane localization, insignificant cytotoxicity, and photostabilities that are 4 times higher than comparable dyes. Presented is the recent work covering these high-performance applications and current studies of TTz chromophores for efficient for solid-state fluorescence sensing, photoinduced electron transfer, photochromism, and related solar applications.

Michael Walter earned a B.S. degree in chemistry from the University of Dayton in 2001 and as an undergraduate worked on conductive polymer syntheses at the Air Force Research Laboratory at Wright Patterson Air Force Base. He completed an M.S. degree in 2004 and Ph.D. degree in 2008 at Portland State University and joined Caltech as a postdoc in 2008. He was an NSF-ACCF postdoctoral fellow (2009-2011) studying the electrical characteristics of inorganic semiconductors in contact with conductive polymers. He joined the chemistry faculty as an assistant professor at UNC Charlotte in the fall of 2011. His research program includes the study of molecular semiconductors for solar energy conversion, porphyrin macrocycles for optoelectronic applications, and thiazolothiazole molecular photocatalysts. He is also a strong advocate for STEM outreach education and has developed several materials science related, hands-on education kits for high school science teachers and students.

I13. Breakthrough Refinement of SWIR Emission Phosphors: Advancing Imaging and Material Identification

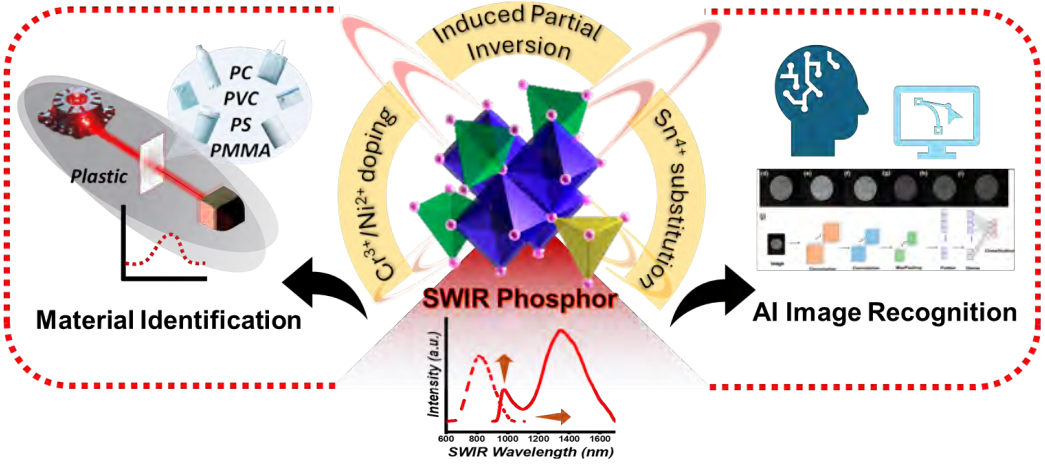
Chun Che Lin[1,2,*]

[1] *Institute of Organic and Polymeric Materials, National Taipei University of Technology, Taipei, 106334, Taiwan*

[2] *Research and Development Center for Smart Textile Technology, National Taipei University of Technology, Taipei, 106334, Taiwan*

**E-mail: cclin0530@mail.ntut.edu.tw*

The modification of short-wave infrared (SWIR) phosphors plays a crucial role in improving their performance for various optical applications. Two techniques for improving SWIR light emission: cation substitution in spinel structures and energy transfer in codoped phosphors are investigated in this work. The lattice parameters were changed by substituting Ga^{3+} with Sn^{4+} in $MgGa_2O_4$, consequently boosting SWIR emission and energy transfer efficiency and thereby improving performance in imaging systems using artificial intelligence (AI) system. Additionally, through energy transfer from Cr^{3+} to Ni^{2+}, Cr^{3+}/Ni^{2+} codoping in $Mg_3Ga_2GeO_8$ phosphors greatly improved their luminescent characteristics, producing broad SWIR emissions. These modified phosphors were successfully incorporated into SWIR light-emitting devices, demonstrating their potential in a range of applications, from optical sensing to material identification. This research highlights the importance of phosphor modification in advancing the capabilities of SWIR-based technologies.



SWIR phosphor modifications for high performance material identification and AI image recognition.

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Chun Che Lin

Chun Che Lin is an Associate Professor at the Institute of Organic and Polymeric Materials, National Taipei University of Technology (NTUT). He completed his Ph.D. in chemistry at National Taiwan University (NTU) and subsequently held a postdoctoral position at Utrecht University. He later served as an Assistant Professor at the Graduate Institute of Nanomedicine and Medical Engineering, Taipei Medical University, from August 2018 to July 2019. Prof. Lin's research is centered on the synthesis of quantum dots and near-infrared phosphors for optoelectronic applications. His interests extend to multifunctional hydrogels, which exhibit remarkable conductivity, antibacterial properties, and self-healing capabilities. To date, he has authored over 50 SCI-indexed journal articles in renowned publications such as Advanced Functional Materials,Journal of the American Chemical Society, Angewandte Chemie International Edition, Small, and Journal of Materials Chemistry A, achieving over 5,000 citations and an h-index of 34. Additionally, he holds three patents and has contributed two book chapters during his academic career.

I14. The sulfur anion $(S_2)^-$ as a fluorescent quantum harmonic oscillator

D. M. Boye[1*], Laurence Cain[1], Mario Belloni[1], Sarah Friedensen[1], Nancy Pruett[1], Henry Brooks[1]

[1] *Department of Physics, Davidson College, Davidson, NC 28035, USA*

**E-mail: daboye@davidson.edu*

The Quantum Harmonic Oscillator (QHO) is examined with differing levels of rigor in physics and chemistry curricula. Experiments investigating vibrational spectroscopy have not found broad use in classroom demonstration and laboratory instruction due to difficulties in implementation. We present a QHO exercise that is rock solid, inexpensive and easily performed. The QHO system studied is the sulfur anion $(S_2)^-$, modeled as two sulfur atoms and a bound electron [1-3] and is an activator found in over a dozen minerals worldwide. Typically, the crystal structures are formed from open aluminosilicate cages containing a mixture of Na^+, Ca^{2+}, Cl^- and CO_3^{2-} ions. Depending on the presence of sulfur at the time of formation, the cages may contain sulfur in the form of SO_3^{2-}, SO_4^{2-} and $(S_2)^-$ as well as other fluorescing species such as Mn^{2+} and Fe^{3+}.

A 405nm diode laser illuminates the sample immersed in liquid nitrogen and spectra containing lines seemingly evenly spaced in energy are collected. These lines result from transitions from the zero-phonon level of the excited electron state to vibrational levels coupled to the ground electronic state. At first look, the energy spacing and effective spring constant for the electronic ground state QHO levels is inferred. Upon further examination, nonlinear contributions to the quadratic harmonic potential can be determined.

Undergraduate students seek relevance in the samples they study. For example, an emerald sodalite sample from Greenland was found on the ground after recent glacial melting. Most recently we have been studying the sulfur-rich mineral lapis lazuli that has profound cultural and artistic significance. We show that thermal treatment or UV optical exposure can convert a non-fluorescing sample to one exhibiting $(S_2)^-$ emission.

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Dan Boye, a BS graduate of Emory and Henry College, holds a PhD from the University of Georgia where he was mentored by Richard Meltzer and John Rives. He is currently the Paul B. Freeland Professor of Physics at Davidson College. He maintains an active research program in the development of new optical and luminescent materials, and in 3D volumetric x-ray imaging applied to art and artifact. Dedicated to bringing together the visual arts, the performing arts, and science, he has taught a broad range of physics courses including 3 courses for non-science majors of which most currently is Music: Sound with Impact. He has provided educational opportunities for thousands of public school students and adults of all ages, musical and scientific backgrounds through programs, workshops and lectures. With a rich and strong bass-baritone voice, he has been widely featured as an operatic and musical theater performer and as an oratorio soloist. A veteran of over 40 Opera Carolina productions in Charlotte, his most recent roles include Zuniga in *Carmen*, Baron Duphol in *La Traviata*, and J. Edgar Hoover in *I Dream*. Appearances with Piedmont Opera in Winston-Salem include the French General in *Silent Night*, Cecil in *Maria Stuarda*, and Father Julien in *Joan of Arc: Trial at Rouen*.

I15. Carrier generation in monolayer two-dimensional dielectrics under strong-field excitation

Tsing-Hua Her[1]
[1]Physics and Optical Science, University of North Carolina at Charlotte
*E-mail: ther@charlotte.edu

Dynamic processes in the excited states of two-dimensional dielectrics can lead to interesting phenomena such as high harmonic generation and dielectric breakdown. It is therefore important to understand carrier generation processes in two-dimensional materials under strong-field excitation with sub-bandgap photon energy. In this talk, we present two-dimensional Keldysh theory to show a more efficient multiphoton and tunneling ionizations in monolayer 2D materials, compared to a single layer of multilayered bulk materials, due to higher electronic density of states. We also demonstrate that impact ionization in 2D materials is also substantially enhanced due to reduced dielectric screening. Together these lead to 10× more efficient high harmonic generation and dielectric breakdown in monolayer 2D materials.

Tsing-Hua Her is an associate professor in Physics and Optical Science at the University of North Carolina at Charlotte. He received the B.S. degree in physics from National Tsing Hua University in Taiwan in 1990, and the M.S. and Ph.D. degrees in applied physics from Harvard University in 1996 and 1998. After two years postdoctoral research in Physics at the University of California, Berkeley, he joined the Fiber Research Department at Bell Laboratories, Lucent Technologies (which later became OFS laboratories) as a Member of Technical Staff. He joined UNCC in 2003 as an assistant professor. His research activities cover a broad range of topics in light-matter interaction, ultrafast optics, optical sensing and metrology, and waveguide optics. His current research interests include strong-field physics of 2D materials and dielectric metamaterials. He has published 90 technical papers, 3 book chapters, and 5 patents. He received DARPA Young Faculty Award in 2008.

O13. Theoretical analysis of Photoassisted field emission near the metal surface using transfer hamiltonian method

Rosangliana[1*] and R.K.Thapa[2]

[1] *Department of Physics, Govt. Zirtiri Residential Science College, Aizawl 796001, Mizoram, India*
[2] *Department of Physics, Mizoram University, Aizawl 796001, Mizoram, India*

**E-mail: rslct7@gmail.com*

A model calculation of photoassisted field emission current (PFEC) by using transfer Hamiltonian method will be present here. When the photon energy is incident on the surface of the metals, such that the energy of photon is usually less than the workfunction of the metal under investigation. The incident radiation photo excites the electrons to a final state which lies below the vacuum level; the electrons are confined within the metal surface. A strong static electric field is then applied to the surface of the metal which causes the photoexcited electrons to tunnel through the surface potential barrier into the vacuum region and constitutes the considerable current called photoassisted field emission current. The incident radiation is usually a laser beam, causes the transition of electrons from the initial state to the final state and the matrix element for this transition will be written. For the calculation of PFEC, transfer Hamiltonian method is used. The initial state wavefunction is calculated by using Kronig-Penney potential model. The effect of the matrix element will also be studied. An appropriate dielectric model for the surface region of the metal will be used for the evaluation of vector potential. FORTRAN programme is used for the calculation of PFEC. The results will be checked with experimental data and the theoretical results.

Keywords—Photoassisted field emission, transfer Hamiltonian, vector potential, wavefunction.

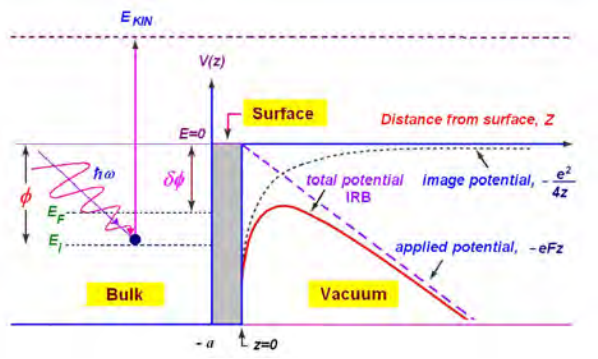

Figure: Model potential used for photoassisted field emission calculations for describing the band states with a surface of width a.

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O14. Photoinduced ultrafast phase transitions in strongly correlated materials

Jiyu Xu[1,2*], Daqiang Chen[2], Sheng Meng[1,2*]

1. Songshan Lake Materials Laboratory, Dongguan, Guangdong 523808, China

2. Institute of Physics, Chinese Academy of Sciences, Beijing 100190, China

**E-mail: xujiyu@sslab.org.cn, smeng@iphy.ac.cn*

The charge, lattice, orbital, and spin degrees of freedom are strongly coupled together in strongly correlated materials, leading to a variety of insulator-metal transition pathways in strongly correlated materials [1-2]. Using real-time time-dependent density functional theory (rt-TDDFT) simulations, we found that laser pulses can excite electrons at the valence band to the conduction band of M_1-VO_2 and triggers the ultrafast structural and electronic phase transitions in photoexcited M_1-VO_2 [3]. The structural and electronic phase transitions have the same threshold of laser intensities. The electronic phase transition is instantaneously generated, while the structural phase transitions have time constants of 100 to 300 fs, leading to the isostructural electronic phase transitions in M_1-VO_2 configuration.

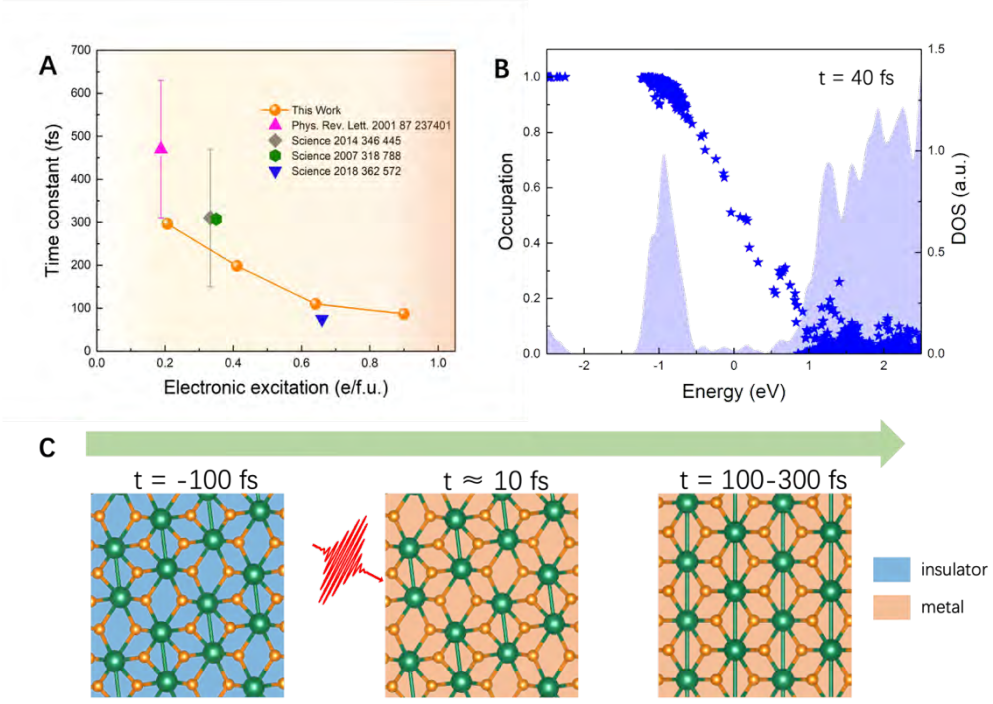

Figure. Photoinduced decoupled ultrafast electronic and structural phase transitions in photoexcited M_1-VO_2.

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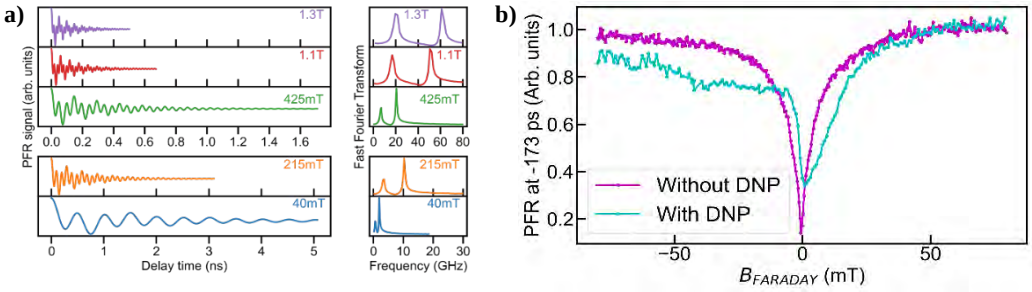
O15. Pump-probe investigation of charge carrier spin dynamics and dynamic nuclear polarization in Lead Halide perovskites polycrystalline films

G. Lagüe,[1,*], F. Bernardot [1], V. Guilloux [1], L. Legrand [1], T. Barisien [1], J. Sánchez-Diaz [2], S. Galve-Lahoz [2], C. Testelin [1], I. Mora-Seró [2], , C. Romero-Perez [3], M. Calvo Roggiani [3] , H. Miguez [3] and M. Chamarro [1]

[1] *Sorbonne Université, CNRS, Institut des NanoSciences de Paris, Paris, France.*
[2] *Institute of Advanced Materials (INAM), Universitat Jaume I, Castelló de la Plana, Spain. .*
[4] *ICMS, Instituto de Ciencias de Materiales, Sevilla, Spain.*

**E-mail: guillaume.lague@insp.jussieu.fr*

For more than a decade, interest in metal-halide perovskites has grown due to their remarkable optoelectronic and photovoltaic properties, making them promising for solar cells and light emitting devices applications. Furthermore, lead-halide perovskites, like $MAPbI_3$ or $FAPbI_3$, exhibit a strong spin-orbit coupling and spin-selective optical transitions for potential spintronics applications.
We investigated the coherent spin dynamics of charge carriers in $MAPbI_3$ and $FAPbI_3$ polycrystalline films using time-resolved pump-probe Faraday Rotation (PFR) under a transverse applied magnetic field (Fig.1a). These PFR measurements allowed to determine both electron and hole g-factors and spin dephasing times. The measured g-factors align with previous studies [1] and k.p theory calculations [2]. The dephasing times are comparable to those found in single-crystal halide perovskites such as $CsPbBr_3$ [3], $FA_{0.9}Cs_{0.1}PbI_{2.8}Br_{0.2}$ [4] and $MAPbI_3$ [1].
In a longitudinal magnetic field, we showed that the hyperfine interaction induces a transfer of the charge carrier spin polarization to the nuclear spin system, creating a dynamic nuclear polarization (DNP). Spin polarization measurements as a function of the magnetic field reveal an asymmetric curve (Fig.1b), indicating that the nuclear spin polarization acts back on the charge carrier spins as an effective magnetic field adding up to the applied field. Its magnitude increases with excitation density and we obtain a maximum $B_n = 40mT$ for an excitation of $100mW/cm^2$.



a) PFR signal decay in Voigt geometry, b) PFR signal in Faraday geometry as a function of the applied magnetic field : the asymmetry of the blue curve is an evidence of a dynamic nuclear polarization effect

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O16. Investigation of luminescent, structural, EPR, and optical properties of undoped and Eu-, Ce-, Tb-, Sm-, Cu-, Mn-, and Li-doped MgSiO3 phosphors, synthesized by sol-gel combustion technique

Carlos D. Gonzales-Lorenzo[1,2,*], Alberto A. Ccollque-Quispe[1], Gianni Giron-Asto[1], T.K. Gundu Rao[1], Klinton V. Turpo-Huahuasoncco[1], F. F. H. Aragón[1], L. Villegas-Lelovsky[1,3], Shigueo Watanabe[2], Jorge S. Ayala Arenas[1]

[1] *Nacional de San Agustín de Arequipa, Av. Independencia S/N, Arequipa, Peru*
[2] *Instituto de Física, Universidade de São Paulo, São Paulo, SP, Brazil*
[3] *Physics Department, IGCE, Paulista State University, CEP 13506-900, Rio Claro, SP, Brazil.*

E-mail: cgonzaleslo@unsa.edu.pe

Polycrystalline $MgSiO^3$ samples, undoped or doped with rare earth- (Eu, Tb, Ce, Li, Sm), transition- (Mn and Cu), and alkali metal- (Li) elements, were prepared by the sol-gel combustion method [1] and characterized by structural, luminescence, electron spin resonance, and optical properties. Fig. 1 illustrates the variation in unit cell volume for the metal-doped phase to ionic radii. Enstatite and protoenstatite phases are observed in undoped and doped MgSiO3. Better TL results have been observed for phosphors doped with Tb, Ce, and Li (0.5% mol). Fading experiments and the GCD method have been performed. EPR signals of gamma-irradiated phosphors indicate the formation of radiation-induced defect centers. Cu-doped MgSiO3 shows an unusual feature of the $Cu2^+$ ion. The Cu^{2+} ion occupies a tetragonally compressed octahedral site, presenting an unconventional attribute. The optical bandgap value Eg is higher for the Ce, Mn, and Tb-doped MgSiO3 phosphors. Ce, Li, and Tb dopant ions were found suitable for the MgSiO3 sample regarding its thermoluminescent response and possible application in radiation dosimetry.

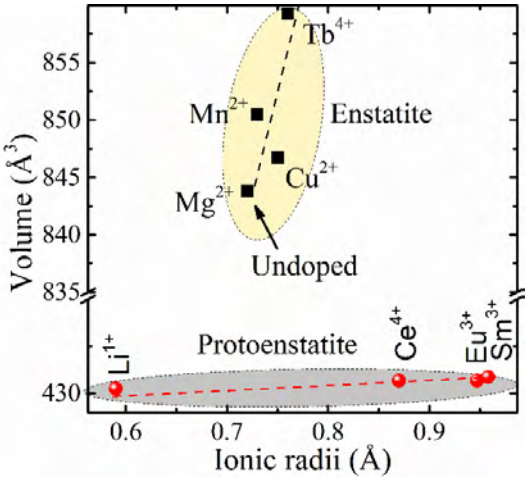

Fig. 1. Unit cell volume dependence as the ionic radii of the doping metal. The ionic radii were obtained from Shannon [2], except for the Li^{1+} (IV), with all in coordination VI.

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I16. Exciton dynamics in $FAPbBr_3$ nanocrystals embedded in transparent nanoporous film: signatures of Forster resonance energy transfer.

T. Barisien[1], V. Guilloux[1], L. Legrand[1], C. Romero-Perez[2], M Calvo[2], H Miguez[2] and M. Chamarro [1]

[1] *Sorbonne Université, CNRS, Institut des NanoSciences de Paris, Paris, France.*
[2] *Institute of Advanced Materials (INAM), Universitat Jaume I, Castelló de la Plana, Spain. .*
[4] *ICMS, Instituto de Ciencias de Materiales, Sevilla, Spain.*

**E-mail: chamarro@insp.jussieu.fr*

Lead halide perovskite nanocrystals (NCs) have attracted significant interest due to their outstanding optoelectronic properties and potential for next-generation photonic devices [1,2]. However, their long-term stability remains a major challenge, which can be addressed through encapsulation within protective matrices.

In this work, we investigate exciton transport mechanisms in $FAPbBr_3$ NCs embedded in a mesoporous silica matrix, exhibiting a narrow photoluminescence (PL) spectrum with a linewidth of 25 meV at 7K. Unlike conventional ligand-capped systems, the absence of ligands in this environment reduces interparticle spacing, facilitating efficient exciton migration through non-radiative Förster resonance energy transfer (FRET).

By performing time-resolved and spectrally-resolved PL spectroscopy at cryogenic temperatures, we observe a progressive spectral shift over time, signaling energy transfer from smaller, high-energy NCs to larger, lower-energy counterparts. To quantitatively describe these dynamics, we use a model based on a 2D array of coupled NCs, incorporating Förster's formalism to simulate exciton diffusion. Our model closely match the experimentally observed PL decay trends, confirming FRET as the primary transport mechanism, with an efficiency reaching up to 90% and a transfer rate of 50 ns^{-1}.

These results provide valuable insights into energy transfer mechanisms in ligand-free perovskite NC systems and demonstrate the potential of mesoporous silica matrices for enhancing stability while modulating excitonic interactions for advanced perovskite-based optoelectronic applications.

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Maria Chamarro, Professor in Physics at Sorbonne University, France. She received her PhD on Physics speciality of Optics form Zaragoza University, Spain in 1989. She has been member of the French Committee of for Scientific Research during five years (1995-2000) and (2019-2025). From 2012 to 2014 she was member of Directory of Research at Pierre and Marie Curie University.
Her area of expertise is the experimental study of the electronic properties of condensed matter. She was pioneer in France in the study of electronic properties of semiconductor nanocrystals. She was also co-head of the "Dynamique de spin" team at the Paris Institute of Nanosciences (INSP) where she worked in the optical orientation and the all-optical manipulation of electron spin confined in a semiconductor quantum dot by using ultra-fast optical spectroscopy techniques. Until March 2025, she coordinated a research project centered on the study of perovskite nanocrystals for nanophotonics applications and now participates to a new project aiming to obtain stable halide perovskite materials by molecular beam epitaxy.

I17. Experimental Evidence for Selection Rules of Nonradiative Transitions – Fundamentals and Consequences for Luminescent Materials

M. Suta[1]

[1] *Inorganic Photoactive Materials, Institute of Bioinorganic Chemistry, Heinrich Heine University Düsseldorf, Universitätsstr. 1, 40225 Düsseldorf, Germany.*

**E-mail: markus.suta@hhu.de*

Usually, photoluminescence is concerned with an optimization of the spontaneous radiative decay pathway, whose foundations were already laid down by the advent of (cavity) quantum electrodynamics and led to the vibrant field of photonics. In contrast, the non-radiative pathway, i.e. the coupling of the transition dipole moment to vibrational modes, has only got into a closer focus since the early 1970s [1]. One major finding was the energy gap law for multi-phonon transitions with a limited temperature dependence [2], while broad-band emission is thermally very labile due to a so-called non-radiative crossover [3]. Theoretical approaches to the non-radiative channel have ever been tackled but often require very sophisticated techniques and still do not satisfactorily agree even in the order of magnitude with experimental data. An interesting impetus was given by Burshtein in 2010 [4] that, after pioneering works by Orlovskii, Pukhov and others [5] as well as Ermolaev and Sveshnikova [6], indicated that non-radiative transition rates should also be related to transition oscillator strengths. From a quantum field theoretical perspective, this would be very intuitive and implies that many control parameters known for radiative transitions should also hold for non-radiative transitions. Such an understanding is key to the design of luminescent thermometers [7], but could even open up new avenues to control the quantum efficiency of phosphors in general.

Within this lecture, I will give a brief historical account on major theoretical and experimental breakthroughs in the understanding of radiative and non-radiative decay in phosphors and demonstrate how theoretical approaches to the non-radiative transition can be explicitly tested with Boltzmann and crossover-type thermometers [8]. Selected examples among various (in)organic emitters demonstrate what are critical experiments in the proof of selection rules of non-radiative transitions [9], what other impacts there are besides the energy gap law and how this can be used to additionally tailor the performance of luminescent materials.

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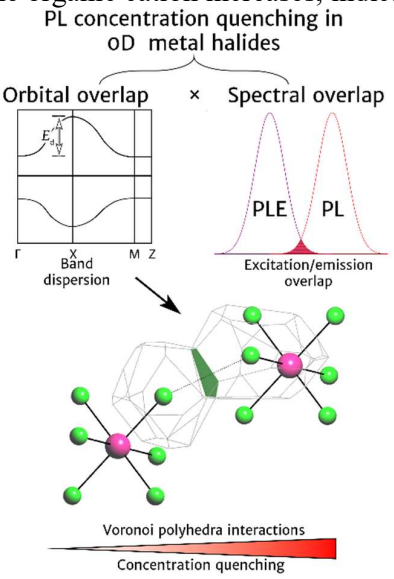
I18. Intermolecular interactions in hybrid halide compounds and their influence on the optical properties

Sergei Novikov, Hope Long, Aleksandra Valueva, and Vladislav Klepov*

[1] *Department of Chemistry, University of Georgia, Athens, 30602, USA*

**E-mail: klepov@uga.edu*

The synthesis of new hybrid halide materials is attracting increasing research interest due to their potential optoelectronic applications. However, general design principles that explain and predict their properties are still limited. In this work, we revealed the role of intermolecular interactions on the optical properties in a series of hybrid halides with an $((C_2H_5)_nNH_{4-n})_2Sn_{1-x}Te_xCl_6$ (n = 1 – 4) composition.[1] DFT calculations showed that the band dispersions of the bands involving Te-5s orbital character gradually decrease as the size of the organic cation increases, indicating a decreasing orbital overlap between neighboring $[TeCl_6]^{2-}$ complexes. We characterized the photoluminescence (PL) of the Sn/Te solid solutions in these series to correlate the electronic and optical properties. The PL response shows no concentration quenching effects in the $((C_2H_5)_4N)_2Sn_{1-x}Te_xCl_6$ series, which demonstrates electronically isolated $[TeCl_6]^{2-}$ complexes. However, the series with smaller organic cations (n = 1 – 3) and higher electronic dimensionality show concentration quenching effects, which decrease as a function of the Te-5s band dispersions in these compounds. The present results allow us to conclude that electronic dimensionality plays an essential role in the photophysical properties of hybrid halide compounds and can be used to fine-tune their properties. Additionally, we demonstrated a simple approach to a semiquantitative electronic dimensionality analysis using Voronoi polyhedra. Although this approach relies only on structural data, it enables a rapid characterization of intermolecular interactions in hybrid materials.



Schematic view of energy transfer in 0D metal halides

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Biography

Vlad received his B.S. in Chemistry from Samara State University (Russia) in 2010 and Ph.D. in Inorganic Chemistry from Samara University and Lobachevsky University of Nizhny Novgorod in 2015. During his graduate school, he worked for a year at Forschungszentrum Jülich (Germany) as a DAAD scholar. After teaching for two years as a senior lecturer at Samara National Research University, he took a postdoctoral appointment in the research group of Prof. Hans-Conrad zur Loye at the University of South Carolina, where he studied crystal growth and magnetic properties of f-element chalcogenides and fluorides. In 2021, he moved to Northwestern University to work on the synthesis and device fabrication of new radiation detectors with Prof. Mercouri Kanatzidis. Vlad moved to the University of Georgia in 2022, where he started his independent career as an Assistant Professor.

I19. Cooperative Processes in Lanthanide Luminescence

A. Meijerink[1,2], M. Mastwijk[1], J. de Ridder[1], M. Rikken[1], Y. Ma[2], J. Yu[2], Y. Wang[2] and F. T. Rabouw[1]

[1]*Debye Institute for nanomaterials Science, Princetonplein 1, 3584CC Utrecht, Utrecht University, The Netherlands*

[2] *School of Materials and Energy, Lanzhou University, Lanzhou, 730000, China.*

E-mail: a.meijerink@uu.nl

In the field of lanthanide luminescence initially the spectroscopic properties of individual lanthanides were explored and also applied, e.g. in lamp phosphors as Y_2O_3:Eu^{3+} or x-ray phosphors as Gd_2O_2S:Pr^{3+} where the performance relied on a single type of lanthanide ion. Presently it is recognized that cooperating lanthanides enable new applications and are also interesting for fundamental studies to elucidate the nature and strength of interactions between lanthanides. In this presentation we focus on cooperative processes. Cooperative absorption, emission and energy transfer were pioneered in the 1970's with a prominent role for Yb^{3+} [1]. After a historical and personal [1, 2] introduction to cooperative processes in lanthanide spectroscopy, we focus on cooperative energy transfer from a single lanthanide to two or even three neighboring lanthanide ions. Evidence for cooperative energy transfer processes is challenging but can be obtained by modelling luminescence decay curves with the discrete shell model [3]. In addition, correlated photon counting can serve as evidence for the presence (or not!) of cooperative energy transfer and quantum cutting [4]. The presentation will provide various examples of 1→2 (e.g. Tb($^5D_4$)→2Yb, Tb($^5D_3$)→2Ce, Er($^4I_{13/2}$)→2Ce, Pr($^3P_0$)→2Ce and even 1→3 (Gd($^6P_{7/2}$)→3Yb) cooperative energy transfer processes (see also Figure 1). Possibilities to sensitize cooperative Tb($^5D_4$)→2Yb for solar cell applications will be evaluated. The presentation will provide insight in the important role of interactions between luminescent lanthanide ions and show how cooperative effects lanthanides can be quantified through different time-resolved spectroscopic experiments and theoretical modelling.

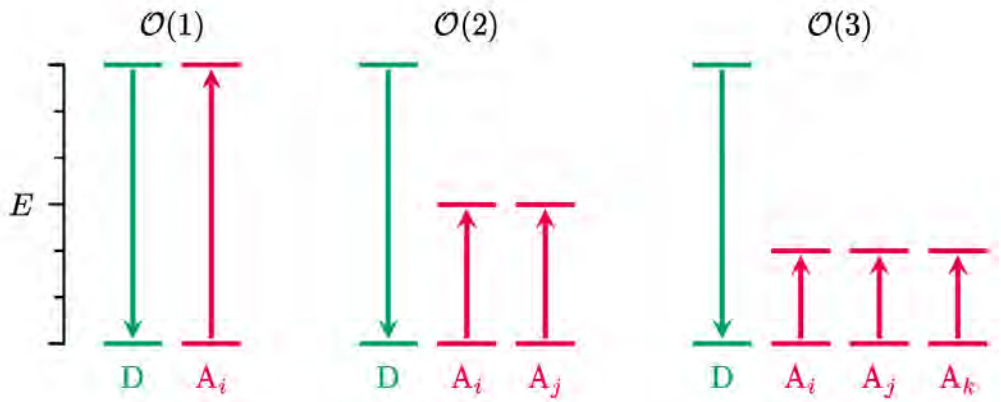

Figure 1 – Schematic of different types of energy transfer processes, including simple first order energy transfer and higher order cooperative transfer from a single donor to multiple acceptors

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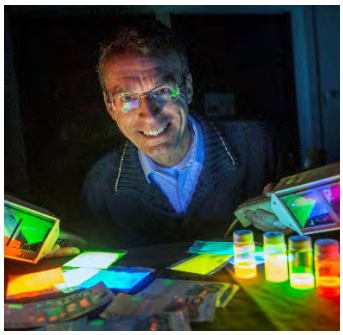
Prof. Dr. Andries Meijerink



Andries Meijerink received his MSc and PhD degree in Chemistry at Utrecht University, The Netherlands. After a post-doc in Madison (University of Wisconsin) he returned to Utrecht where in 1996, at the age of 32, he was appointed at the chair of Solid State Chemistry in the Debye Institute of Utrecht University where he leads an active group in the field of luminescence spectroscopy of rare earth ions and quantum dots. Research on rare earth ions involves fundamental research on the energy level structure, energy transfer and finding new concepts relying on efficient light conversion processes in rare earth ions for applications in white light LEDs, displays, solar cells and scintillators. His research on quantum dots is aimed at unravelling the influence of quantum confinement and surface effects on the electronic structure and exciton dynamics of quantum dots. Research on luminescence of (rare earth) doped nanocrystals integrates the two themes. His research has been recognized with many national and international awards and in 2009 he was elected into the Royal Netherlands Academy of Sciences.

O17. Charge transfer excited states in Eu^{3+}-doped mixed-anion compounds

Yuuki Kitagawa[1]

[1] *National Institute of Advanced Industrial Science and Technology (AIST), 1-8-31 Midorigaoka, Ikeda, 563-8577, Japan*

**E-mail: kitagawa.yuuki@aist.go.jp*

Eu^{3+}-doped inorganic compounds have been extensively investigated since mid-20th century for a variety of applications, including solid-state lighting and display technologies, due to their narrow-band orange-to-red emission (~600 nm) under ultraviolet (UV) excitation. While the luminescence originates from the 4f-4f intraconfigurational transition, the pumping pathways are not only through direct 4f-4f transitions but also via the charge transfer (CT) transition from the coordinating anions. The CT excitation energy (E^{CT}) is strongly dependent on the electronegativity of the anions: ionic anions such as F^- and O^{2-} result in higher E^{CT}, whereas covalent anions such as N^{3-} and S^{2-} lead to lower E^{CT} values, as scematically illustrated in Fig. 1a.

In this study, we explore the CT excited states in Eu^{3+}-doped mixed-anion compounds. Fig. 1b presents the photoluminescence excitation (PLE) spectra of the various Eu^{3+}-doped mixed-anion phosphors [1–3]. The spectral shapes of the CT excitation bands are influenced not only by the nature of the coordinating anions but also by the coordination numbers associated with each anion type. Notably, even in the presence of O^{2-}, the CT excitation bands in covalent oxynitrides, oxysulfides, and oxyhydrides are red-shifted into the near-UV region, resulting in significant thermal quenching via the CT states. In particular, the optical properties of Eu^{3+}-doped oxynitride $YSiO_2N:Eu^{3+}$ and oxyhalides $YOX:Eu^{3+}$ (X = Cl or Br) is discussed in detail in the presentation.

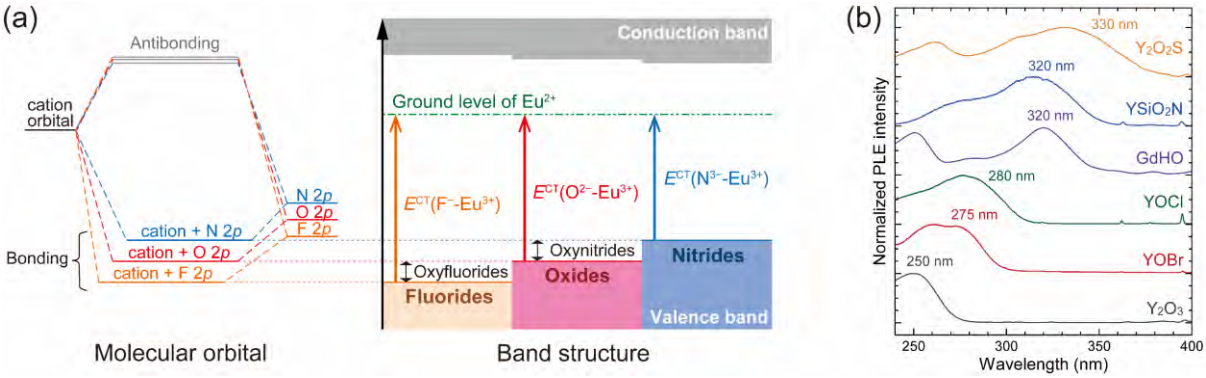


Fig. 1 (a) Schematic of the molecular orbital and band structure for Eu^{3+}-doped fluorides, oxides, and nitrides [1]. (b) Comparison of the PLE spectra for various Eu^{3+}-doped mixed-anion compounds [1–3].

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O18. Photoluminescence and electroluminescence of rare earth complexes

Zhiwei Liu,*, [1] Peiyu Fang,[1] Jiaying Zheng,[1] Jiachang Liu,[2] and Yujia Li,[1]

[1] *College of Chemistry and Molecular Engineering, Peking University, Beijing, 100871 China*
[2] *RDFZ XISHAN School, Beijing, 100193 China*

**E-mail: zwliu@pku.edu.cn*

Rare earth luminescent complexes have attracted growing attention for their versatile applications in photocatalysis, bioimaging, and organic light-emitting diodes (OLEDs). These complexes can be classified into two categories based on their luminescence mechanisms: f-f transitions and d-f transitions. Unlike parity-forbidden f-f transitions, d-f transitions exhibit distinct characteristics including tunable emission spectra, short excited-state lifetimes, and significantly enhanced absorption ability. In recent years[1-6], our research group has developed a series of stable and highly efficient d-f transition luminescent complexes of Ce(III) and Eu(II) through ligand engineering and excited-state modulation. Notably, these complexes demonstrate exceptional exciton utilization efficiency in OLEDs. This talk systematically summarizes fundamental advances in rare earth luminescent complexes, highlights recent breakthroughs in Ce(III)- and Eu(II)-based OLEDs, and critically examines the prospects and challenges for advancing d-f transition rare earth complexes in next-generation lectroluminescent technologies.

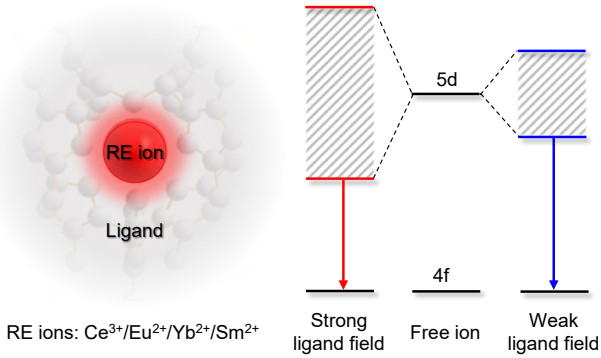

Fig. 1. Schematic diagram of d-f transition rare earth complex and its luminescence mechanism.

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O19. Tailoring Photon-Avalanche via Quantum Emission Manipulation in Tm^{3+}-Doped Nanoparticles

B. Reynier[1], N. Fardian-Melamed[2], E. Charron[1], E. Chan[3], A. Skripka[3], S. Bidault[4], P. J. Schuck[2], M. Mivelle[1,*]

[1] *Institut des Nanosciences de Paris, Sorbonne Université, CNRS, Paris 75005, France*
[2]*Department of Mechanical Engineering, Columbia University, New York, New York 10027, USA*
[3]*Lawrence Berkeley National Laboratory, Berkeley, California 94720, USA*
[4]*Institut Langevin, ESPCI Paris, Université PSL, CNRS, Paris 75005, France*

**E-mail: mathieu.mivelle@sorbonne-universite.fr*

Self-organized criticality is a pervasive phenomenon in nature, manifesting in processes as diverse as Mexican waves, earthquakes, landslides, forest fires, species extinctions, stock market crashes, and wars. In optics, one striking example is observed in the photon emission of Tm^{3+}-doped nanoparticles, where the so-called photon avalanche (PA) process triggers a highly nonlinear emission response. These Avalanching NanoParticles (ANPs) offer significant potential for super-resolution biological imaging and related applications [1].

Here, Tm^{3+}-doped nanoparticles are investigated in conjunction with a custom-built Scanning Near-Field Optical Microscope (SNOM) system, which features a high-power, precisely controlled infrared excitation path. In this setup, a gold nanomirror—fabricated at the tip of a tapered optical fiber—can be positioned in the near field of the doped nanoparticles, modifying the local optical density of states (LDOS) and enabling detailed studies of PA behavior as a function of the nanoparticle–mirror distance. Our experiments reveal a clear influence of the gold nanomirror on the PA process, providing a direct means to finely tune the underlying nonlinearities through local density of optical states manipulation.

Current efforts focus on dissecting the roles of electric and magnetic dipole transitions [2,3] as well as the cross-relaxation mechanism—an internal nonradiative process central to the PA phenomenon. By leveraging the ability to shape and control local light–matter interactions, this approach aims to deepen our understanding of the photon avalanche in Tm^{3+}-doped nanoparticles and pave the way for new avenues in high-resolution imaging and related photonic technologies.

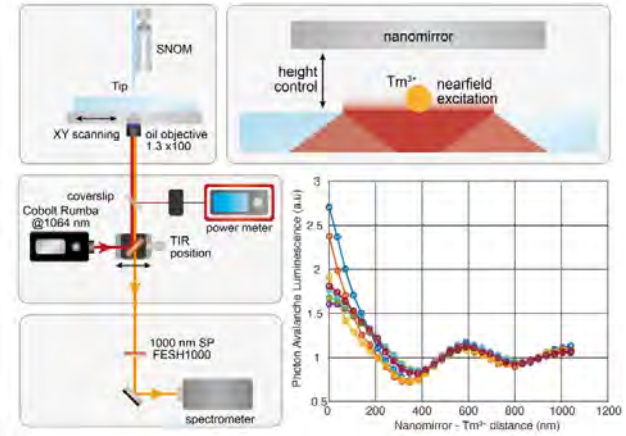

Figure: A plasmonic nanomirror is integrated at the tip of a near-field optical microscope and positioned near a Tm^{3+}-doped nanoparticle. The microscope's nanopositioning capabilities enable precise control over the distance between the nanomirror and the nanoparticle, thereby allowing the local density of optical states (LDOS) to be tuned at will. This setup demonstrates how manipulating the LDOS can modulate the photon avalanche emission.

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O20. Exploring near-infrared luminescence of nickel in $LiGa_{5(1-x)}Al_{5x}O_8:0.05Ni^{2+}$ via mechanical and chemical pressure

Mikołaj Kamiński,[1,*] Mu-Huai Fang,[2] and Sebastian Mahlik[1]

[1] *Institute of Experimental Physics, Faculty of Mathematics, Physics and Informatics University of Gdańsk, Wita Stwosza 57, 80-308 Gdańsk, Poland*

[2] *Research Center for Applied Sciences Academia Sinica, Taipei 10608, Taiwan*

**E-mail: mikolaj.kaminski@ug.edu.pl*

Phosphor-converted infrared light-emitting diodes (pc-LEDs) present a promising alternative to traditional infrared light sources, such as InGaAs- and GaAs-based semiconductor LEDs, tungsten halogen lamps, and laser diodes. These devices offer greater versatility and improved thermal stability, driving the demand for pc-LEDs capable of emitting broadband short-wave infrared (SWIR) light within the 900–1700 nm range. Such advancements hold significant potential for applications in spectroscopy, optical coherence tomography, optical communication, and noninvasive medical imaging.

Among the various activator ions studied for SWIR emission, Ni^{2+} stands out due to its broad emission spanning 1000–1700 nm. Notably, systems incorporating both Cr^{3+} and Ni^{2+} have demonstrated enhanced luminescence via energy transfer mechanisms.[1–3] To further optimize phosphor performance, a deeper understanding of Ni^{2+} optical properties is essential.

In this study, we investigate $LiGa_{5(1-x)}Al_{5x}O_8$ phosphors doped exclusively with Ni^{2+}, where x varies from 0.0 to 1.0. Our approach combines high-pressure experiments, temperature-dependent luminescence analysis, and kinetic measurements to explore the effects of crystal field strength on optical behavior and thermal quenching mechanisms.

To induce chemical pressure, we incorporate smaller Al^{3+} ions into the crystal lattice and compare this effect with externally applied pressure using a diamond anvil cell (DAC). Our findings reveal a distinct blueshift in the both emission and excitation spectra bands with increasing Al^{3+} concentration and mechanical pressure. We present the calculations of crystal field parameter Dq, and Racah parameters B and C, which are particulary useful for analyzing the optical properties of Ni^{2+}, as a function of both mechanical and chemical pressure.

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I20. Nano/microcavity coupled rare earth upconversion emission

L.D. Sun, Z. Deng, Y. Liang, S. Yang, H. Dong, and C.H. Yan

College of Chemistry and Molecular Enginerring, Pkeing University, Beijing, 100871, China

**E-mail: sun@pku.edu.cn*

Rare earth materials, with ytterbium-sensitized upconversion emission, have long been of interest for applications in near-infrared photon counting, liquid-phase lasing, and optical fiber technologies,etc. The dynamics of upconversion emission in ytterbium-activator ion pairs have been extensively investigated and are well understood. Advances in solution chemistry have enabled the synthesis of well-defined rare earth nanoparticles with uniform size, morphology, composition, and structure. The energy transfer mechanisms between rare earth ions confined within nanoscale particles or shells are systematically studied, with evidence suggesting that energy flow can be directionally controlled via spatially segregated ion distributions in distinct layers. This hierarchical design allows for tunability not only of emission wavelength but also of excitation wavelength and emission lifetime. Further integration of these nanoparticles into plasmonic nanocavities can accelerate emission rates and tunable chiroptical properties mediated by cavity interactions. Additionally, coupling nanoparticle assemblies (e.g., superparticles) with optical microcavities enables stimulated emission with polarized output and high quality factors, highlighting their potential for advanced photonic devices.

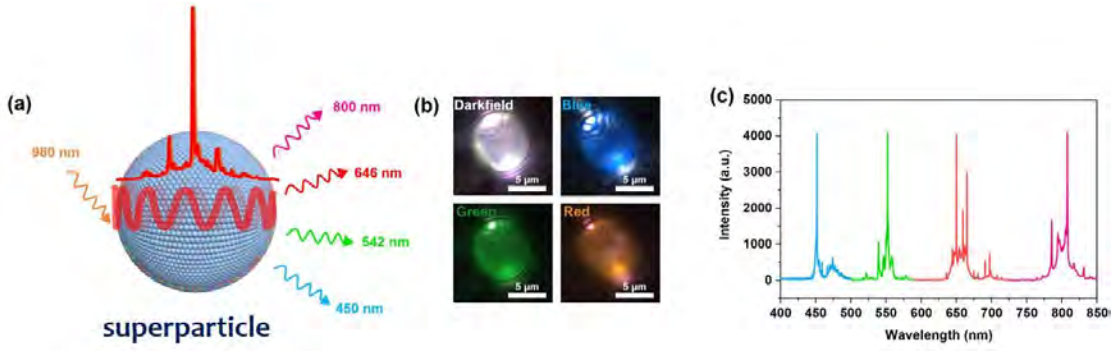

Figure 1 Amplified upconversion emission in a supercrystal-based optical microcavity. (a) Schematic illustration of the upconversion emission amplified mechanism and (b) the optical image of a supercrystal, (c) emission spectra of amplified upconversion luminescence from nanoparticles embedded within the supercrystal microcavity.

I21. Upconversion Nanoparticles: Size-Dependent Luminescence Quantum Yields

Guanying Chen
Harbin Institute of Technology, China
Email: chenguanying@hit.edu.cn

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 $NaYF_4$: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), thereby having important implications for applications of lanthanide nanophotonics and biophotonics.

I22. Selective Excitation of Directional Super- and Sub-Fluorescence in Single Upconverting Nanocrystals at Room Temperature

Rene Ganoe, Hans Hallen, Shuang Fang Lim

Department of Physics, North Carolina State University, Raleigh, NC 27695

Email: sflim@ncsu.edu

Kai Huang, Joshua F.A. Fat, Gang Han

Biochemistry and Molecular Pharmacology, University of Massachusetts Medical School

Superfluorescence (SF) is a powerful technique that offers a straightforward means to generate a substantial number of entangled photons for quantum applications, particularly given recent advancements we have achieved in SF. SF describes a remarkable optical phenomenon that occurs when an ensemble of emitters, with their dipoles collectively coupled, emits a brief yet extraordinarily intense burst of light. In SF, an external radiative field initially excites an incoherent energy level, and then the emitting dipoles synchronize their emissions through dipole-dipole interactions, forming a macroscopic dipole and establishing a coherent quantum state. These characteristics differentiate SF from processes such as lasing, superradiance (SR), and normal fluorescence, as SF arises from a single quantum transition involving N dipoles.

Our breakthrough observations in upconversion lanthanide doped nanocrystals (UCNC) of a long-lived tail in the SF decay spectra, attributed to SbF, at room temperature, validates theoretical predictions of this anti-symmetric state. The SbF state may provide a mechanism toward intriguing possibilities in quantum batteries or photon storage. The capacity to control not only the fast SF mode but also the longer lived delocalized SbF mode, for example, by designing nanostructures that slow down emission propagation in undesired directions while speeding up emission propagation in allowed directions, can potentially creating a flying or travelling qubit, that enables information transmission between quantum networks.

Following completion of a Ph.D. at the University of Cambridge, UK, 2004, **Shuang Fang Lim** served in a postdoctoral Research Position at Princeton University from 2004-2008. She is the first to report on the observation of solid state anti-Stokes shifted room temperature superfluorescence (SF) in the smallest-ever observed SF media at the single nanocrystal-level. Prior to her findings, SF has only been realized in extreme conditions (at low temperatures of around 6 K), thus limiting the feasibility of its practical applications. Her research also showed that the nanocrystals can produce a pulse sequence with a fixed time interval, known as Burnham-Chiao ringing, indicating that they could potentially become quantum optical timers.

I23. Doping Inorganic Crystals for Photonic Applications

Feng Wang[1,2,*]

[1] *Department of Materials Science and Engineering, City University of Hong Kong, Hong Kong SAR, China*

[2] *Hong Kong Institute for Clean Energy, City University of Hong Kong, Hong Kong SAR, China*

**E-mail: fwang24@cityu.edu.hk*

Luminescent materials are essential in various technological applications, including lighting, display, information encryption, and optoelectronic technologies. Impurity doping represents an appealing strategy for creating highly tunable luminescence properties within a single host material. In this talk, I focus on our recent efforts to incorporate lanthanide and transition ions into various host materials with different compositions and structures. We demonstrate rational control over luminescence processes and properties by leveraging the characteristic features of the host materials, such as their unusual response to thermal and mechanical stimuli. We show that the doped luminescent materials hold promise in many exciting applications in information security and biomedical sciences.

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I24. Large-scale calculations of quasiparticle and excitonic properties of 3D and 2D solids

Peihong Zhang
Department of Physics
University at Buffalo, State University of New York
Email: pzhang3@buffalo.edu

Accurate and efficient predictions of the quasiparticle and optical properties of complex materials remain a major challenge due to the convergence issue and the unfavorable scaling of the computational cost with respect to the system size. Two-dimensional (2D) materials pose additional challenges. The unusual analytical behaviors of the dielectric screening and the electron self-energy of 2D materials make the conventional Brillouin zone (BZ) integration approach rather inefficient and require an extremely dense *k*-grid to properly converge the calculated quasiparticle energies. In this talk, I will discuss these challenges and recent progress in calculating excited states properties of complex 3D and 2D solids.

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Peihong Zhang received his Ph.D. degree from the Pennsylvania State University in 2001. He worked at the Corporate Research division of Corning Incorporated from 2001 to 2003 as a senior research scientist before taking a postdoctoral fellow position at UC Berkeley. He joined the University at Buffalo, SUNY in 2005. Zhang's research interests include understanding and predicting materials properties from first principles and development of theory and computational methods for accurate and efficient calculation of materials excited states properties.

I25. Exciton and charge management in silicon pincer complexes

Thomas A. Schmedake,[1,*] Adesola Adeyemmi[1]

[1]*Department of Chemistry, University of North Carolina at Charlotte, Charlotte, NC 28223, United States of America*

**tschmeda@uncc.edu*

Silicon pincer complexes are an attractive, sythnthetically tailorable platform for exciton and charge management in organic electronic devices. While silicon exists primarily in tetrahedral bonding environments, dianionic tridentate ligands are able to coordinate tightly to the silicon center providing air- and moisture-stable hexacoordinate silicon complexes that possess thermal stability to over 400 ºC in inert atmosphere, thus paving the way for their application in thermally evaporated films and devices. As small organic molecules, charge transport between Si(pincer)$_2$ molecules can be modeled with Marcus-Hush charge transfer theory, and the perpindicular planes of the Si(pincer)$_2$ complexes are ideal for this process. The pincer ligands provide considerable delocalization leading to small reorganization energies $\lambda_{e/h}$ and can stack with considerable pi-pi interactions for large electron coupling $|H_{AB}|$. Si(pincer)$_2$ complexes have shown promise as electron transport layers with electron mobilities comparable to the industry standard AlQ_3 and as hole blocking layers in organic photovoltaic devices. Some Si(pincer)$_2$ complexes also possess hole mobility rates comparable to their electron mobilities, suggesting possible applications in bipolar charge transport. The electronic states of Si(pincer)$_2$ complexes and the devices they go into can be rationally tuned via conentional organic synthetic methods, which has been highlighted in a white-light emitting dual excitonic-excimeric Si(pincer)$_2$ emitting OLED device. Finally, the Si(pincer)$_2$ motif shows potential as a thermally activated delayed fluorescence (TADF) emitter in OLEDs.

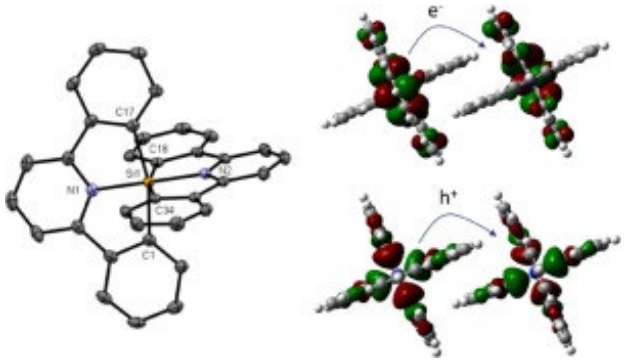

Figure 1. Crystal structure (left) and packing diagram of silicon pincer complex, Si(dpp)$_2$.

Tom Schmedake is a Professor and Chair of the Chemistry Department at UNC Charlotte. He earned his Ph.D. in Inorganic Chemistry studying coordinatively unsaturated organosilicon compounds from the University of Wisconsin under the direction of Dr. Robert West and conducted a post-doc in the lab of Dr. Michael Sailor, University of California at San Diego working on optical and sensing applications of porous silicon. His research efforts are currently focused on synthesis and characterization of hybrid inorganic-organic materials and coordination complexes for optoelectronic applications. He is an inventor on three US patents, all of which have been licensed for commercial development.

Adesola Adeyemi just successfully defended his Ph.D. in Chemistry and Nanoscale Science dissertation entitled “Development of homoleptic and heteroleptic Si(pincers)2 complexes for organic electronic applications” at the University of North Carolina at Charlotte under the direction of Dr. Tom Schmedake. He will be starting as a new faculty member in Fall 2025 in the Chemistry Department of Francis Marion University in Florence, SC, where he will continue synthesizing and exploring the unique optoelectronic properties of Si(pincer)$_2$ complexes.

I26. Insights of Ultrafast Carrier Dynamics of Light-Harvesting Nanomaterials

Amitava Patra

School of Materials Sciences, Indian Association for the Cultivation of Science Jadavpur, Kolkata-700032, India

Email: amitavapatra.patra@gmail.com, msap@iacs.res.in

Nanomaterials-based light-harvesting systems have been the research subject because they can generate exciton after photoexcitation. A deep understanding of hot carrier (HC) dynamics is crucial to improving the performance of optoelectronic devices by reducing thermalization losses. Here, we investigate the carrier dynamics, energy transfer, and charge carrier dynamics of 2D CdSe nanoplatelets and perovskite nanocrystals.[1-7] Ultrafast spectroscopic investigations provide direct insight into the impacts of electron and hole transfer at the interface of hybrid materials for optoelectronic applications. The fundamental knowledge of these photophysical processes is crucial for developing efficient light-harvesting systems.

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Prof. Amitava Patra is the Former Director at the Institute of Nano Science and Technology (INST), Mohali, and a Senior Professor at the Indian Association for the Cultivation of Science. He has been a senior editor of the Journal of Physical Chemistry Letters (ACS) since 2025, the first time in India.
He was born in 1965 and received his Ph. D. (1993) from Jadavpur University, India. He is interested in learning the fundamental mechanisms for photo-initiated processes such as exciton dynamics, ultrafast carrier dynamics, electron transfer, and energy transfer of nanomaterials for solar energy conversion.

Prof. Amitava Patra is amongst the world's top 2% scientists in 2023 with a global rank of 149 in Physical Chemistry. He is the author or co-author of more than 285 scientific papers, 16 feature articles, and one review in Chem. Rev and one in Chem. Soc. Rev, 5 book chapters, and 2 Indian patents. His research papers have been cited by more than 14560 peers (h-index= 64). He was an Advisory board member of Nanoscale, Journal of Physical Chemistry, ChemPhysChem, ChemNanoMat, and others.

Prof. Amitava Patra has been elected as a Fellow of OPTICA (formerly OSA) and the Royal Society of Chemistry (FRSC). He is a Fellow of the Indian Academy of Sciences (FASc), India, and the National Academy of Sciences (FNASc) and Indian Chemical Society, India. He is the recipient of the Acharya J. C. Ghosh Memorial Award, National Prizes for Research in Chemical Spectroscopy and Molecular Structure, MRSI-ICSC Materials Science Annual Prize, C.N.R. Rao National Prize for Chemical Research, DAE-SRC Outstanding Investigator Award, A.V. Rama Rao Foundation Prize in Chemistry, AsiaNANO 2010 Award, CRSI Bronze Medal, Ramanujan Fellowship, MRSI Medal.

O21. Contribution of triplet excited states to photoluminescence of plastic scintillators excited at vacuum ultraviolet light

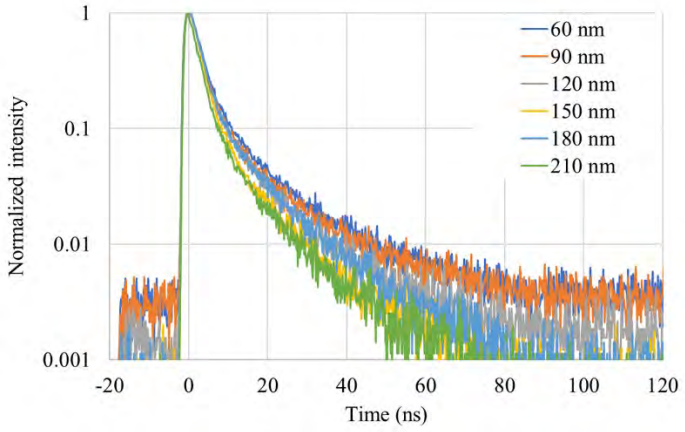
M. Koshimizu[1]

[1] *Research Institute of Electronics, Shizuoka University, 3-5-1 Johoku, Chuo-ku, Hamamatsu 432-8011, Japan*

**E-mail: koshimizu.masanori@shizuoka.ac.jp*

Scintillators are phosphors that can be used for real-time radiation detection. Among inorganic and organic scintillators, plastic scintillators are widely used for their low cost, scalability, and fast response. A shortcoming of the plastic scintillators is their low scintillation light yields, which originates from the negligible contribution of triplet excited states formed in the host polymer to the scintillation. Researchers are now trying to use the triplet excited states using molecules exhibiting phosphorescence and thermally activated delayed fluorescence.

Vacuum ultraviolet (VUV) photons, whose excitation energy is between those of UV photons and ioniring radiations, may offer unique properties as the excitation source. In this study, we explored the photoluminescence properties of plastic scintillators under VUV radiation at different wavelengths. Interestingly, I found that the contribution of the slow decay component of the photoluminescence, which originates from triplet-triplet annihilation to produce a singlet excited state and delayed fluorescence, depends strongly on the excitation wavelength in the VUV region. The photoluminescence decay curves of a plastic scintillator at different excitation wavelengths are presented in the figure below. The contribution of the long decay component, which originates from the triplet excited states, depends on the excitation wavelength in a complex manner. This result indicates that the triplet formation probability has a complex dependence on the excitation wavelength in the VUV region.



Photoluminescnece decay curves of a plastic scintillator at different excitation wavelengths.

O22. Photothermal and Fluorescence Properties in Suspensions and Solutions: Thermal Lens Z-Scan Method

Georges Boudebs[(1)], Julien-Bilal Zinoune[(1, 2)], Christophe Cassagne[(1)], Mihaela CHIS[(1, 2)]

[1] Univ Angers, LPHIA, SFR MATRIX, F-49000 Angers, France

[2] ESAIP, 18, rue du 8 mai 1945, CS 80022, 49180 St-Barthélemy d'Anjou Cedex, France

e-mail: georges.boudebs@univ-angers.fr

The characterization and optimization of nanoparticles for specific applications depend heavily on their properties, such as optical resonance wavelength and light interaction mechanisms. This study investigates spherical gold nanoparticles (AuNPs) in aqueous solutions using a multi-wavelength continuous-wave (cw) Z-scan thermal lens (TL) spectroscopic approach. The experimental setup has been enhanced through the use of top-hat beams and advanced theoretical calculations for moderate to high absorption levels. These improvements enable precise measurements of photothermal efficiency across various nanoparticle sizes (5 nm, 40 nm, 60 nm, and 80 nm) and excitation wavelengths (blue, green, and red), with results validated against Mie theory. Key advantages of the setup include minimal sample exposure to excitation light (1 mW) and the use of modulation to maintain thermal equilibrium, ensuring a linear response range.

Additionally, the single-beam Z-scan thermal lens technique is employed to evaluate fluorescence quantum yield in solutions. Two distinct scenarios are examined: solutions with substantial fluorescence and those with low fluorescence. Analytical calculations are used to quantify uncertainties arising from random errors introduced by optical detectors. While solutions with high fluorescence levels help reduce measurement uncertainties, those with low fluorescence contribute to significant errors due to detector limitations. The study also reviews the challenges associated with random errors in accurately estimating fluorescence across various conditions. By integrating insights from both photothermal efficiency and fluorescence quantum yield measurements, this research provides a comprehensive understanding of nanoparticle behavior, enabling their optimized selection for a wide range of applications.

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O23. Spectroscopy and excited state dynamics of the RE-doped lanthanum vanadate nanoparticles with different crystal structures

Oksana Chukova,[1,2,*] Tetiana Voitenko[1,3], Luiz G. Jacobsohn[4]

[1] *Taras Shevchenko National University of Kyiv, Volodymyrska Str. 60, Kyiv 01601, Ukraine*
[2] *Deutsches Elektronen-Synchrotron DESY, Notkestr. 85, Hamburg 22607, Germany*
[3] *Yusuf Hamied Department of Chemistry, University of Cambridge, Cambridge CB2 1EW, UK*
[4] *Department of Materials Science and Engineering, Clemson University, Clemson, SC 29634, USA*

**E-mail: chukova@univ.kiev.ua*

Orthovanadates are well-proven matrices for luminescent rare-earth (RE) ions, as they satisfy high efficiency transfer of absorbed excitation energy from the matrix to the RE ions. Their wide range of applications has attracted significant research efforts to develop new vanadate compositions with improved luminescence characteristics depending on the requirements of various practical tasks. In general, orthovanadate compounds $LnVO_4$ crystallize in two polymorphs: tetragonal zircon-type structure and monoclinic monazite-type structure. Compounds with small RE cations, for example, $EuVO_4$, are characterized by a zircon-type structure. Compounds with a large number of RE cations, for example, $LaVO_4$, have a monazite-type structure. However, if the $LaVO_4$ is used as a matrix for the RE activator ions, then depending on the synthesis conditions, a material that contains both crystalline phases can be obtained. These crystalline phases can lead to different rates of energy transfer from the matrix to the luminescent ions and different excited state dynamics.

$La_{1-x}RE_xVO_4$ (RE = Dy, Sm, Eu, Er, Yb) nanoparticles were obtained by aqueous nitrate-citrate sol-gel synthesis. The phase composition, crystal lattice parameters and microstructure of the nanoparticles were characterized by various techniques. X-ray diffraction analysis revealed the dependence of the crystal structure on the concentration of dopants: the monoclinic structure of the monazite type dominates at low dopant concentrations and the tetragonal structure of the zircon type at high dopant concentrations. The photoluminescence spectra showed narrow lines originated from 4f-4f transitions of the RE dopants. The intensity distribution of these lines differed for samples with different concentrations of the activators. This effect may be associated with different local symmetry of the oxygen surrounding of the RE ions in the monoclinic and tetragonal crystal phases. The excitation spectra consisted of narrow lines caused by electronic transitions of the activator ions and a broad band around 320 nm that was attributed to electronic transitions in the vanadate groups. For both excitation cases, the dynamics of the excited states was investigated in detail. In the first case, the luminescence decay curves are represented by one or two slow components characteristic of 4f-4f transitions of RE^{3+} ions. In the latter case, the energy transfer from the matrix to the activator ions led to the appearance of a fast lifetime component in the luminescence decay curves. The influence of the phase composition on the relative contribution of the fast component and the distribution of the slow components was also investigated. Special attention was paid to the consideration of the origin and properties of the fast lifetime component, since this may be important for the practical application of vanadate nanoparticles as luminescent sensors of temperature and/or pressure, which are currently under active research and development.

O24. Mn^{5+}-based luminescent thermometer in near-infrared region

Hongyu Lu

School of Physics and Optoelectronic Engineering, Hainan University, Haikou 570228, China

**E-mail: luhongyu@hainanu.edu.cn*

The Mn^{5+} ion with a $3d^2$ configuration in a 4-coordinate environment has an emission peak located between 1120 and 1253 nm, and is especially suitable for near-infrared (NIR) excitation due to a large absorption in the NIR region. The advantages of NIR excitation and emission endow it with great potential in the field of deep biological temperature imaging. For instance, the $Bi_{24}Al_2O_{39}:Mn^{5+}$ we reported can be excited at 806 nm and 970 nm. Among them, the sensitivity reaches 3.54% K^{-1} in the physiological temperature range (300–330 K) under 970 nm excitation. Meanwhile, by using single-band radiometric method, the readout errors caused by optical dispersion can be effectively avoided, and accurate temperature measurement can be achieved.

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I27. Controlled UV Emission Through Gd Doping of $MgAl_2O_4$

L.G. Jacobsohn[1,*]

[1] *Department of Materials Science and Engineering, Clemson University, Clemson, 29634, USA*

**E-mail: luiz@clemson.edu*

$MgAl_2O_4$ presents a complex luminescence behaviour due to the presence of undesired impurities at the ppm level and intrinsic defects like F-type color centers and anti-site defects. While some of these defects emit in the UV range, currently there is a lack of consensus on the nature of the defects and the physical processes responsible for the UV emission [1]. In addition to its superior mechanical properties, $MgAl_2O_4$ stands out as a wide band gap optical material that can accommodate numerous activators, including rare earths. It has been investigated as a scintillator and luminescence dosimeter, but limited attention has been paid to engineering its UV emission. In order to circumvent the difficulty of manipulating the UV-emitting intrinsic defects, Gd^{3+} was selected to activate $MgAl_2O_4$ in the UV spectrum. $(Mg_{1-x}Gd_x)Al_2O_4$ with x = 0, 0.01, 0.05, 0.075, 0.1 and 0.2 were prepared by the coprecipitation method followed by 2h-long calcination at 900 ºC in air. The powders were characterized by XRD, SEM/EDX, XPS, and evaluated in their photophysical properties by diffuse reflectance, radioluminescence (RL) under X-ray excitation from room temperature (RT) to 450 ºC, and by photoluminescence emission (PL), excitation (PLE) and lifetime measurements. XRD analysis indicated a single phase and progressive structural disorder as per the broadening of the diffraction peaks for higher Gd contents. RL showed UV emission at 314 nm due to the Gd^{3+} $^6P_{7/2} \rightarrow {}^8S_{7/2}$ transition, with the material with x = 0.075 having the most intense emission. Photoluminescence decay measurements revealed two lifetimes, *ca.* 1.7 and 4.9 ms, whose relative contributions vary as a function of the Gd content. This behaviour was tentatively attributed to the existence of Gd in different chemical environments as shown by XPS. The UV emission intensity showed a linear decrease as a function of the temperature, being 70% of the RT intensity at 200 ºC.

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I28. Ultraviolet persistent luminescence materials

Yanjie Liang*

School of Materials Science & Engineering, Shandong University, Jinan 250061, China

**E-mail: yanjie.liang@sdu.edu.cn*

Visible and infrared persistent luminescence materials have gained considerable attention in recent years and are being widely used as glow-in-the-dark materials in dark environments. In contrast, the progress on persistent phosphors emitting in the shorter-wavelength ultraviolet (200–400 nm) spectral region, is rather slow. Moreover, visible and infrared emitting persistent phosphors are not suitable to work in bright environments because of the enormous interference from ambient light including sunlight and indoor light [1,2]. Here, we have extended the emission wavelengths of persistent luminescence research to the ultraviolet spectral region [3-8]. Based on the unique merits of ultraviolet radiation, such as visible-blind emission feature, interference-free capability from ambient light and self-sustained luminescence performance, we demonstrate some interesting applications of these ultraviolet persistent phosphors.

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Prof. Yanjie Liang received his Ph.D. in Materials Science and Engineering from Shandong University in 2016. From 2012 to 2016, he studied as a Joint PhD student at the University of Georgia in the United States. Then he worked as a Horizon Postdoctoral Fellow at Concordia University in Canada from 2017 to 2018. In 2018, he joined the faculty of Shandong University as a full professor. His research interests focus on inorganic solid luminescent materials emitting in the ultraviolet and infrared spectral regions and their applications.

O25. Radiation response of ErF_3-doped strontium fluoride transparent ceramics

N. Kawano,[1,*] T. Kato,[2] L.G. Jacobsohn,[3] D. Nakauchi,[2] K. Okazaki,[2] K. Ichiba,[2] T. Kunikata,[2] A. Nishikawa,[2] K. Miyazaki,[2] T. Yanagida,[2]

[1] *Akita University, 1-1 Tegata Gakuenmachi, Akita, 010-8502, Japan*
[2] *Nara Institute of Science and Technology, 8916-5 Takayama-cho, Ikoma, 630-1092, Japan*
[3] *Clemson University, 515 Calhoun Dr, Clemson, SC 29634, USA*

**E-mail: n-kawano@gipc.akita-u.ac.jp*

A scintillator is a luminescent material that converts high energy radiation into low energy photons (e.g., visible, near-infrared photons) and has been used in many applications, including nondestructive inspection. It is generally employed with a photodetector such as a photomultipler tube to detect high enegy radiation [1]. Owing to the recent development of photodetectors that are sensitive to near-infrared photons, near-infrared scintillators have been gaining increasing attention from the scientific community. These scintillators can be used for remote enviromental radiation monitoring and bioimaging. To date, several inorganic single crystals such as Er-doped $Bi_4Ge_3O_{12}$ have been mainly developed as near-infrared scintillators [1-2]. In this work, we focused on the Er-doped SrF_2 transparent ceramics and evaluated their radiation response properties.

Transparent ceramics were fabricated by the spark plasma sintering method. Strontium fluoride and erbium fluoride powders were mixed in three molar ratios (0.1, 0.5, and 1.0 mol%), and the mixture was heated at 1353 K for 20 min under a pressure of 100 MPa.

Figure 1 shows the scintillation spectra in the near-infrared wavelength range under X-ray irradiation. Several emission peaks were observed at around 1000 nm and 1500 nm. These were attributed to the 4f-4f transition of Er^{3+} ions [2]. Emission peaks due to these transition were also observed at 550 nm.

Figure 2 exhibits the correlation between the near-infrared scintillation intensity and the X-ray dose rate. The intensity was obtained with a lnGaAs PIN photodiode. The lowest detectable dose rate was 0.5 mGy/h that was lower than that of Er-doped $Bi_4Ge_3O_{12}$ (5 mGy/h), showing an efficient near-infrared emission from the SrF_2-based transparent ceramics. The luminescence mechanism was interpreted on the basis of the scintillation and thermoluminesccne properties.

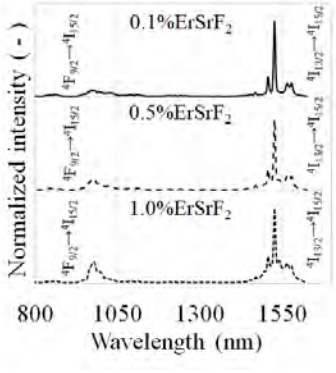

Fig. 1 Scintillation spectra.

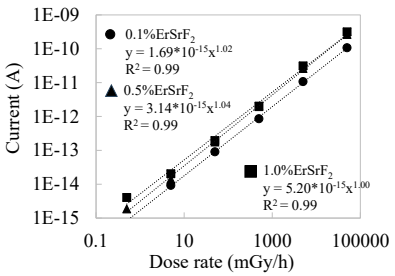

Fig. 2 Correlation between the near-infrared scintillation intensity and the X-ray dose rate.

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P1. Luminescence Property of Lunar Simulant Sample

I.A. Ferreira,[1,2] M.C.S. Nunes,[1] C. Ulsen,[3] L.G. Jacobsohn,[4] N.M. Trindade[2]

[1]*Programa de Pós-Graduação em Ciência e Tecnologia dos Materiais, Universidade Estadual Paulista (UNESP), Sorocaba, 18087-180 , Brasil.*

[2]*Instituto de Física, Universidade de São Paulo (USP), São Paulo, 05508-090, Brasil.*

[3]*Escola Politécnica- Laboratório de Caracterização Tecnológica, Universidade de São Paulo, São Paulo, 05508-090, Brasil.*

[4] *Department of Materials Science and Engineering, Clemson University, Clemson, South Carolina, USA*

**E-mail: isabela-alves.ferreira@unesp.br*

Due to the different types of particles in the space radiation field, it is important to study the interaction between ionizing radiation and extraterrestrial materials such as lunar and martial. Because of that, the objective of this work were to investigate the chemical characteristics and effects of beta-ionizing radiation on a synthetic Lunar sample (LHS-1). The luminescence was investigated by thermoluminescence (TL) technique, a physical phenomenon characteristic of some materials that, after radiation exposure, emit light when stimulated by thermal energy [1]. The powder of the sample was assessed using XRD measured in an EMPYREAN diffractometer (operating at 45 kV- 40 mA) with CuKα radiation (1.5405 Å). TL measurements were performed with a Risø reader (model DA-20) composed of a beta source $^{90}S/^{90}Y$ (dose rate 10mGy/s) used to irradiate the samples, and Hoya U-340 filter (thickness 7.5 mm; transmission window 290-370 nm), no mask. The results of XRD showed that the material consists primarily of Quartz and Anorthite, there is some evidence it may contain Muscovite and Clinochlore. The samples were irradiated with a beta dose of 1 Gy, resulting in the observation of two distinct peaks at temperatures of 85ºC and 135ºC. The Lunar sample exhibited a linear dose-response within a range of 0.02 to 1 Gy (R2 = 0.99).

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P2. Harnessing upconversion luminescence in $NaYF_4:Nd^{3+}$ for optical anti-counterfeiting under white light excitation

Bingbing Yang,[1] Yanfang Sun,[1,*] Feng Liu,[1] and Xiao-jun Wang[2,*]

[1] *State Key Laboratory of Integrated Optoelectronics, Key Laboratory for UV-Emitting Materials and Technology of Ministry of Education, Northeast Normal University, Changchun 130024, China*

[2] *Department of Physics, Georgia Southern University, Statesboro, 30460, USA*

**E-mail: yfsun@nenu.edu.cn* (Y.S)*; xwang@georgiasouthern.edu* (X.W)

Optical anti-counterfeiting technologies often falter in brightly lit environments due to interference from ambient light[1,2]. Here, we explore the application of $NaYF_4:Nd^{3+}$ materials as ultraviolet luminescent platforms for anti-counterfeiting, leveraging their unique upconversion luminescence (UCL) properties under white light excitation. When excited by a powerful white light flashlight, these materials emit ultraviolet UCL peaking at 355 nm (Fig. 1), distinct from the spectral range of typical indoor ambient light, enabling background-free signal detection. Ultraviolet imaging experiments under daylight conditions demonstrate the practical utility of these materials for robust anti-counterfeiting applications. This work introduces a versatile, white light-compatible approach to enhance security features across diverse lighting environments.

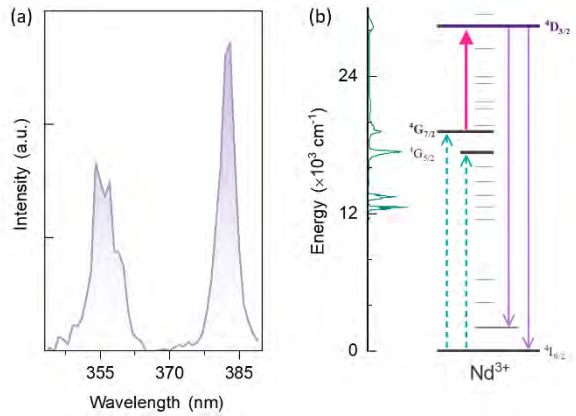

Figure **1 (a)** UCL emission spectrum of $NaYF_4:Nd^{3+}$ phosphor upon illumination with an intense white flashlight (1.5 W cm^{-2}). **(b)** Schematic representation of the UCL under excitation with the flashlight.

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P3. Mechanistic Basis of the Voltage-Sensitivity of Thiazolothiazole Dyes

Pranamita Chakraborti,[†] Sourajit Mukherjee,[‡] Daphne Oettinger,[‡] Aditya Nandy*[§] Yamuna Krishnan*[‡] and Michael G. Walter*[†]

[†]*Department of Chemistry, University of North Carolina at Charlotte, Charlotte, NC, 28223,* [‡]*Department of Chemistry, The University of Chicago, Chicago, IL 60637*

[‡]*Neuroscience Institute, The University of Chicago, Chicago, IL 60637*

[‡]*Institute of Biophysical Dynamics, The University of Chicago, Chicago, IL 60637*

[§] *Department of Chemical and Biomolecular Engineering, University of California, Los Angeles, Los Angeles, CA 90095*

E-mail: pchakra5@charlotte.edu

Voltage sensitive dyes (VSDs) are versatile and powerful reporters of the membrane potential across living cell membranes. Several VSDs already exist for understanding cellular physiology; however, they have their drawbacks in terms of fluorescence, response times and/or sensitivity. Thiazolothiazole (TTz) dyes are a relatively new and promising class of VSDs. While TTz dyes have high photostability and low cytotoxicity, the mechanistic basis of their excellent voltage sensitivity remains unknown. To answer this question, we have accessed a new generation of TTz dyes (asym-TTz) that are asymmetrically substituted, push-pull dyes. The asym-TTz push-pull molecular structure consists of one electron donating and one electron withdrawing side chain on either side of a rigid, planar, electron deficient P-conjugated aromatic TTz core. The new charge-transfer asym-TTzs showed extremely high quantum yields in non-polar environments, brilliant cell membrane localization and voltage sensitivity comparable to several other existing VSDs. In addition to that, these dyes can be accessed in copious amounts in one reaction batch due to preference of target asymmetric product formation over symmetric product formation during the reaction, something we had not been able to achieve previously. Asym-TTz derivatives exhibited strong solvatofluorochromism with large Stokes shifts and exceptionally high transition dipole moments that provided a clue towards their voltage-sensitivity. By computationally analyzing their behavior within cell membranes under an electric field, we found that asym-TTz dyes show a surprising twist on either side of the TTz bridging unit in the excited state at more positive membrane potentials, which decreases dye fluorescence. This novel mechanism can be leveraged to create newer classes of highly sensitive voltage reporter dyes for diverse sensing applications.

P4. Development of Eu-Doped TAGG Nanoparticle Scintillators

Yuma Takahashi,[1] Hiroki Kawamoto[2], Yutaka Fujimoto[2], Keisuke Asai[2], and Masanori Koshimizu[1]

[1] *Department of Electronics and Materials Science, Shizuoka University, 3-5-1 Johoku, Chuo-ku, Hamamatsu 432-8011, Japan*

[2] *Department of Applied Chemistry, Tohoku University, 6-6-07 Aoba, Aramaki, Aoba-ku, Sendai 980-8579, Japan*

**E-mail: takahashi.yuma.20@shizuoka.ac.jp*

Introduction: Scintillators are materials that convert radiation into light. They can be categorized into organic and inorganic scintillators. Organic scintillators have fast scintillation decay and low effective atomic number. In contrast, crystalline inorganic scintillators possess high density, high effective atomic number, and high light output. Recently, successful control of mouse behavior has been reported by integrating nanoparticle scintillators with photoreceptors and neurons and exposing them to external X-ray irradiation [1]. The inorganic crystal scintillator, GAGG ($Gd_3Ga_xAl_{5-x}O_{12}$):Ce, used in the study is well-suited for biological applications due to its non-hygroscopic nature, high X-ray stopping power, and high light output. We aim to expand the application of this technology toward various biological systems using red light, which enables excitation of photosynthetic dyes or photoreceptors having absorption in the red wavelength region. In addition, the use of nanoparticles facilitates non-invasive integration into living tissues. With the expectation of energy transfer from Tb^{3+} to Eu^{3+} [2], we synthesized red-emitting nanoparticle scintillators using Eu^{3+} as the luminescent centers in TAGG ($Tb_3Al_xGa_{5-x}O_{12}$), which shares the similar garnet structure to GAGG. We optimized the composition of TAGG to achieve high photoluminescence quantum yield.

Materials and Methods: Host compositions of $Tb_3Al_xGa_{5-x}O_{12}$ (x = 0–5) were used. Nitrates of Tb, Al, and Ga were dissolved in 25 mL of 0.6 mol/L aqueous solution of tartaric acid according to the stoichiometric ratio. The nitrate-to-tartaric acid molar ratio was 1:2. After stirring for 24 h, the solution was stirred at 80 °C for 2 h and then heated at same temperature for 24 h to form a dry gel, which was then ground and calcined at 1300 °C for 6 h to obtain the final sample.

Results and Discussion: Figure 1 shows the TEM image of the sample with x = 0. The observed particles were predominantly elliptical in shape with some round and angular ones also observed. The particle size ranged from approximately 100 to 200 nm. Figure 2 illustrates the X-ray-induced radioluminescence (XRL) spectra of the samples. In all the samples, peaks attributed to the 4f-4f transitions of Eu^{3+} were observed at around 592 nm ($^5D_0 \rightarrow {}^7F_1$) and 709 nm ($^5D_0 \rightarrow {}^7F_4$), which indicates the realization of red emission by the Eu doping [3]. The results indicate that nanoparticles of 100–200 nm exhibiting red light emission originating from Eu^{3+} were successfully fabricated.

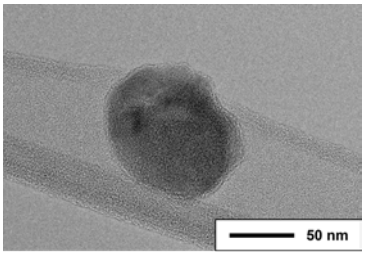

Fig. 1. TEM image of TAGG (x = 0) nanoparticle.

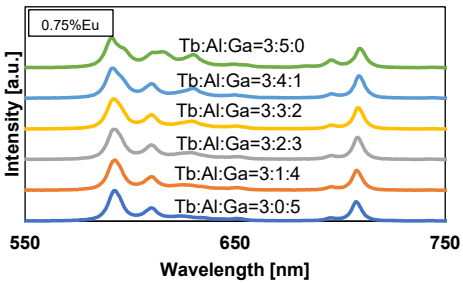

Fig. 2. XRL spectra of TAGG (x = 0–5).

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P5. Developments and Applications Thiazolothiazole Dyes for Photoredox Catalysis

Thomas Perrell,[†] Nick Eberwein, Cole Heath, Mary Kytle, Kathryn Vandergrift, Avni Nayar, Sarah Buchanan[‡] and Michael G. Walter*[†]

[†]*Department of Chemistry, University of North Carolina at Charlotte, Charlotte, NC, 28223*

[‡]*Department of Chemistry, Winthrop University, Rock Hill, SC, 29733*

E-mail: tperrell@charlotte.edu

In the broader field of photoredox catalysis, there has been a concerted effort to develop high efficiency photoredox catalysts that are both cost effective and environmentally sustainable. While there are many potent photoredox catalysts that have been well characterized and studied, many of these catalysts contain expensive and toxic metals, such as iridium and ruthenium.

With these properties in mind, we have developed, and now present the utilization of a series of Thiazolo[5,4-d]thiazoles (TTzs) as highly efficient, potent, low-cost, and sustainable photoredox catalysts. TTzs are heterocyclic molecules with many desirable traits for photoredox catalysts. They possess high (>90%) fluorescence quatum yields, powerful excited state redox potentials (*Eox=+2.00 - 2.73 V vs SCE), and high photostability. This dye series has been previously demonstrated to photocatalyze a series of imine alkylation reactions previously with high product yields and large turnover numbers (TON $\approx$ 250). We now present a variety of alternative photocatalytic applications as well, such as coupling using the pharmaceutical precursor N-methylmorpholine.

Additionally, TTzs possess multiple, spectrally distinct, reversable reductions which could enable powerful photoreductant behavior complementing their demonstrated photooxidant abilities. Similar behavior has been recently reported in other organic photocatalytic systems and could allow for an even greater degree of catalyst versatility or enable novel catalytic mechanisms. Illuminating the TTzs with multiple wavelengths of light allows for the excitation of the TTzs while in different oxidation states. We seek probe this behavior in an effort to gain greater understanding of its occurrence in TTzs.

P6. Photochemical Sensor Platform for Rapid, Non-Invasive Detection of Illicit Drugs

Naz F. Tumpa, Tyler J. Adams, Damarys H. Santana, Aiden M. Hawkins, Michael G. Walter*

Department of Chemistry, University of North Carolina at Charlotte, Charlotte, NC, 28223

E-mail: ntumpa@charlotte.edu

Amine sensing plays a vital role in detecting illegal drugs, an increasingly urgent concern currently. We have developed dipyridinium thiazolothiazole (TTz) compounds as efficient, colorimetric sensors for these substances. The TTz core is highly conjugated and electron-deficient, giving it a planar, rigid, and stable structure. These symmetric molecules undergo two low-potential single-electron reductions and can readily photo-oxidize amines, producing visible color changes that enable rapid detection. TTz compounds can distinguish between various amine-containing drugs—such as cocaine, methamphetamine, and fentanyl—based on their unique photochemical reactivity. By embedding multiple TTz dyes on a single test card, we generate a distinct colorimetric fingerprint for each drug. Although the color change is visible to the naked eye, detection accuracy can be enhanced using a smartphone camera and simple imaging tools. To improve analysis speed and reliability, we are developing a color recognition system powered by machine learning, trained on an extensive database of TTz responses. This system can identify low concentrations of drugs, detect mixtures, and even distinguish between different batches of the same drug. When combined with geotagging, this technology could help track distribution patterns and combat drug trafficking. Current drug tests are often slow, limited to single substances, or rely on invasive sampling. In contrast, our TTz-based test offers rapid, non-invasive, broad-spectrum screening using a single handheld device. This innovation provides a proactive and accessible solution for law enforcement, public health, and safety, capable of identifying unknown substances before harm occurs.

P7. Self-limiting surface oxidation ensuring the long-term stability of II-VI Organic-Inorganic Hybrid Nanostructures

Yizhou Wang[1], Thomas A. Schmedake[2], Jing Li[3], and Yong Zhang[1, 4,*]

[1]*Nanoscale Science, University of North Carolina at Charlotte, USA*

[2]*Chmestry Department, University of North Carolina at Charlotte, USA*

[3]*Department of Chemistry and Chemical Biology, Rutgers University, USA*

[4]*Electrical and Computer Engineering Department, University of North Carolina at Charlotte, USA*

* *Email: yong.zhang@charlotte.edu*

β-ZnTe(en)$_{0.5}$ is a structurally perfect II-VI organic-inorganic hybrid semiconductor with exceptional long-term ambient stability and minimal microscopic defects [1]. Contrary to the widely observed poor long-term stability of organic-inorganic hybrid materials—such as hybrid halide perovskites—certain II-VI-based hybrids exhibit exceptional durability, with no apparent degradation even after 16 years of unprotected exposure to air [2,3]. In this study, we investigate the surface properties of both aged and freshly prepared ZnTe(en)$_{0.5}$ using Time-of-Flight Secondary Ion Mass Spectrometry (ToF-SIMS) and Raman spectroscopy. We identify the surface layer composition and quantify the thickness of the oxidation layer. Notably, our results reveal the formation of a thin yet dense oxidation layer on the surface of these hybrid materials. This oxidation layer, while minimal in thickness, serves as an effective protective barrier that prevents further degradation, thereby accounting for the observed long-term stability. Our findings provide important insights into the surface chemistry and structural robustness of II-VI organic-inorganic hybrid nanostructures, offering valuable implications for their practical application in electronic devices and beyond.

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P8. IR Transmission and Reflection Spectra of Organic-Inorganic Hybrid Material β-ZnTe(en)$_{0.5}$

Javad Babaki[1], Yizhou Wang[2], Tino Hofmann[3], Thomas A. Schmedake[2], Yong Zhang[1,*]

[1] *Electrical and Computer Engineering,* [2] *Nanoscale Science and Department of Chemistry,* [3] *Department of Physics and Optical Science, University of North Carolina at Charlotte, Charlotte, 28223, USA*

**E-mail: yong.zhang@charlotte.edu*

β-ZnTe(en)$_{0.5}$ belongs to a family of II–VI based organic–inorganic hybrid materials [1,2]. It consists of ultra-thin ZnTe sheets interconnected ethylenediamine molecules, exhibiting distinctive structural perfectness both microscopically and microscopically as well as strong quantum confinement effects, such as exceptionally strong excitonic absorption, that are not readily achievable in conventional heterostructures. Aditionally, it offers anisotropic optical response and exceptional long-term stability under ambient conditions with demonstrated shelf life exceeding 15 years. Although the electronic and optical properties of this material have been studied in the visible spectral range, its vibrational behavior in the infrared (IR) region has not been experimentally investigated, despite DFT-based predictions indicating the presence of IR-active modes and anisotropic dielectric response in IR. In this study, we report polarization-resolved FTIR spectroscopy of β-ZnTe(en)$_{0.5}$ single crystals. The observed vibrational resonances show good agreement with the predicted IR-active modes. The results confirm the presence of distinct IR modes for different crystallographic axes expected from the orthorhombic, biaxial structure. This study serves as a critical milestone for subsequent determination of the material's permittivity tensors and for advancing future studies of phonon polaritons in such hybrid systems.

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P9. Photo-Induced Ion displacement in organic inorganic mixed halide perovskites: Turning stability concerns into functional opportunities.

Hasan Mahmud and Yong Zhang*

Electrical and Computer Engineering, University of North Carolina at Charlotte, Charlotte, NC 28223,USA

**E-mail: yong.zhang@charlotte.edu*

Ion migration in organic–inorganic mixed halide perovskites under external stimuli such as light plays a pivotal role in determining their optoelectronic behavior. Upon illumination, halide ions migrate outward from the excitation center, creating an ion-depleted core and an ion-enriched surrounding region. After removing the stimuli, the ions gradually return to their equilibrium positions, releasing energy via damped ultra-low frequency oscillations. This dynamic behavior indicates the presence of ionic plasma oscillations, an uncommon but potentially useful phenomenon in solids [1]. While the ion migration in the halide perovskite has typically been considered detrimental, leading to current–voltage hysteresis, phase segregation, and long-term instability in perovskite solar cells, it also unveils new functional possibilities. Rather than a limitation, the reversible and spatially controlled nature of ion migration offers a tunable platform for advanced functionalities such as ionic patterning, energy storage, and self-destructive memory. Controlling the ion migration process enables the engineering of adaptive, reconfigurable materials, opening pathways for next-generation optoelectronic devices. We perform further spectroscopy studies of the light-induced halide ion displacement in $(FA,MA)Pb(Br_xI_{1-x})_3$ to better understand the underlying mechanism and optimize the effect for novel applications.

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P10. Enhanced material removal rate of glass enabled by an ultrathin layer of gold

Arpit Dave[1,*], Hsin-Yu Yao[2], Emmanuel Sarpong1, Sabeeh Irfan Ahmad[1], and Tsing-Hua Her[1,*]

[1] *Dept. of Physics & Optical Science, The University of North Carolina at Charlotte, NC 28223, USA.*
[2] *Dept. of Physics, National Chung Cheng University, No.168, Sec. 1, University Rd., Minhsiung, Chiayi 621301, Taiwan.*

**E-mail: adave3@charlotte.edu, ther@charlotte.edu*

Abstract: We report 7× reduction of the femtosecond (fs) laser ablation threshold and ~800× increase in the material removal rate of glass in the single-shot regime by an overlaid 12.5 nm ultrathin layer of the sputtered gold.

Introduction

Femtosecond laser machining (FLM) produces minimal heat-affected zones, enabling high edge quality cuts. This makes it ideal for miniaturization and versatility, especially over nanosecond (ns) lasers. However, its low material removal rate (MRR), limits wider use. Wei et al. [1] reported a 2× MRR increase in ns ablation of diamond using a 100-nm Au film. In contrast, we observe an 800× MRR increase in fs ablation of glass using just a 12.5-nm Au film, compared to bare glass.

Results and Discussion

Figure 1a shows a Liu plot [2] of ablated hole area vs. laser fluence for Au (blue), Au-coated glass (glass*, red), and bare glass (green). Extracted ablation thresholds are, Au: 0.11, glass*: 0.54, and bare glass: 4 J/cm². This shows a 7× reduction in threshold for glass*. Figures 1b–d show AFM images of holes in each zone. In Zone I, only Au is ablated. In Zone II, glass* is ablated. In Zone III, bare glass is ablated. Comparing Figures 1b–c, we find a 6× increase in diameter and 20× in depth, yielding a 800× MRR increase.

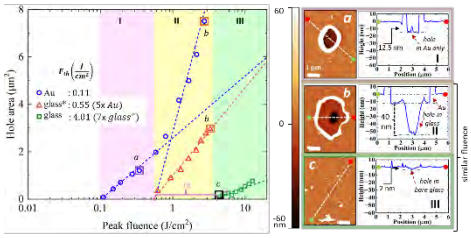

Figure 1: a. The Liu plot and b-d. AFM images of Au/glass. The AFM scale bars are 1 μm.

Previous work [3] showed a 20-nm Au film reaches ~46,000 K electron temperature (T_e) at 0.11 J/cm², forming warm dense matter (WDM). Our fluence suggests T_e > 100,000 K. These superheated particles (ions, electrons) interact strongly with the substrate, enhancing ablation. This Au-assisted method can likely apply to other transparent materials. Its simplicity and efficiency make it promising for reducing size, weight, power, and cost (SWaP-C) in FLM.

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P11. Controlled Growth of Tellurium Network Structures for Multi-Spectral Photodetector Applications

Ahmed Adel A. Abdelazeez[1], Yizhou Wang2, Wanseok Oh[2], Thomas A. Schmedake[1], Yong Zhang[2], Haitao Zhang*[3]

[1]*Chemistry and Nanoscale Science, Chemistry Department, UNC Charlotte, Charlotte, NC 28223.*

[2]*Department of Electrical and Computer Engineering, UNC Charlotte, Charlotte, NC 28223*

[3]*Mechanical Engineering and Engineering Science Department, UNC Charlotte, Charlotte, NC 28223*

**E-mail: HaiTao.Zhang@charlotte.edu , aabdelh2@charlotte.edu*

Recently, tellurium (Te) has gained significant interest for its unique helical atomic chain structure bonded by van der Waals (vdW) forces. It exhibits thickness-dependent electronic properties similarly to two-dimensional (2D) materials, along with strong spin–orbital coupling from its chiral structure and enhanced environmental stability. As a p-type semiconductor, Te has a narrow band gap (1.2 to 0.3 eV), large responsivity, high detectivity, high on/off ratios, and high carrier mobility, making it a promising material for short-wavelength infrared (SWIR) photodetection. Although a convenient physical vapor deposition (PVD) has been widely applied as a tailored growth technique for the Te growth, the critical parameters controlling the synthesis of 2D and 1D Te structures remain unclear. Herein, this research focuses on understanding the growth mechanism of Te nano- and microstructures. Key parameters, such as pressure, temperature, and growth time, have been systematically explored to study their effects on growth evolution. Various Te structures, including microspheres, microrods, microplates, nanowires, etc., have been synthesized at different growth zones. This study makes it possible to realize controlled growth of different Te structures and a research focus is centered on a unique Te network structure of microrods (Te-Net). This innovative structure is the first of its kind to be reported, as previous reports have mostly been focused on individual micro- or nanostructure. The network structure enables low-cost device fabrication without sophisticated lithography.

The Te-Net based photodetectors demonstrate excellent responsivity (R) and detectivity (D*) under different illumination conditions, with typical values as high as R = 0.43 A/W and D* =3.98 × 107 Jones at 405 nm. At 532 nm and 808 nm, the device exhibits responsivity of 8.6 × 10-3 A/W and 7.3 × 10-3 A/W, and detectivity of 9.6 × 105 Jones and 7.4 × 105 Jones, respectively. We are investigating the photoresponse mechanisms including direct carrier photogeneration and local heating for further performance improvement. One important phenomenon we discovered is that the devices are extremely sensitive to the dark environment with the room lights off. No significant visible/near-infrared light was detected from the dark environment using a commercial spectrometer and no existing theory explains this phenomenon. Therefore, future research will focus on investigating the source of the light signals and the mechanism of this extreme sensitivity. We are looking into the device performance under illumination of other light sources, especially those in the SWIR to mid-wavelength infrared ranges. Additionally, further structure characterization and optical measurement (e.g. Raman, X-ray diffraction, ellipsometry, etc.) will be performed on the Te-Net to reveal their composition, crystal structure, band structure, defects, and other optical properties. A clear structure-property relation can then be established for the Te-Net structures in multi-spectral photodetection, paving a solid pathway to realize their high-efficiency applications in environmental monitoring, imaging, and optical sensing.

P12. Development of Al_2O_3-Based Radiation Detectors via Hydrothermal Synthesis

M.C.S Nunes (student)[1*], L.C.V. Rodrigues[2], L.G. Jacobsohn[3], and N.M. Trindade[4]

[1]*Programa de Pós-Graduação em Ciências e Tecnologia dos Materiais, Universidade Estadual Paulista, Sorocaba, SP, Brasil*

[2]*Instituto de Física, Universidade de São Paulo, São Paulo, Brasil*

[3]*Instituto de Química, Universidade de São Paulo, São Paulo, Brasil*

[4]*Department of Materials Science and Engineering, Clemson University, Clemson, South Caroline, USA*

**E-mail: matheus.c.nunes@unesp.br*

Radiation detectors is essential for assessing whether the absorbed doses in environments or by human beings are appropriate for each specific situation. In this context, numerous research groups worldwide have dedicated efforts to the development of new materials, with a particular focus on synthetic compounds, which offer high reproducibility and allow precise control over chemical composition for various applications [1].

Recent studies have demonstrated that aluminum oxide crystals doped with carbon (Al_2O_3:C) and with magnesium (Al_2O_3:Mg) exhibit high potential for application in luminescent dosimetry [1]. The aim of this work is to synthesize samples of these materials using the hydrothermal method and to investigate their luminescent properties through Optically Stimulated Luminescence (OSL) and Thermoluminescence (TL) techniques, for potential use in radiation dosimetry. OSL arises from the recombination of optically released charges from metastable energy levels within a material previously exposed to ionizing radiation. TL is a similar phenomenon, with recombination induced by thermal stimulation.

OSL and TL measurements were carried out using a commercial automated reader manufactured by Risø National Laboratory (model DA-20). Irradiation was performed at room temperature using the integrated $^{90}Sr/^{90}Y$ beta source (dose rate: 10mGy/s). The synthesis involved aluminum sulfate octadecahydrate ($Al_2(SO_4)_3 \cdot 18H_2O$) as the aluminum precursor, urea (CH_4N_2O) and sucrose ($C_{12}H_{22}O_{11}$) as carbon sources, and either magnesium hydroxide ($Mg(OH)_2$) or magnesium chloride ($MgCl_2$) as the magnesium precursors. The solution was heated in a hydrothermal reactor at 120 °C for 2 hours, followed by thermal treatment in a muffle furnace at 1200 °C for 4 hours. The samples presented TL peaks consistent with the literature at 85 °C and 175 °C, similar to those found in the Al_2O_3:C dosimeters produced by Landauer Inc. The OSL signal was intense and stable for different beta doses. So far, the effects of different doping percentages on the luminescent response of the samples have been investigated.

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