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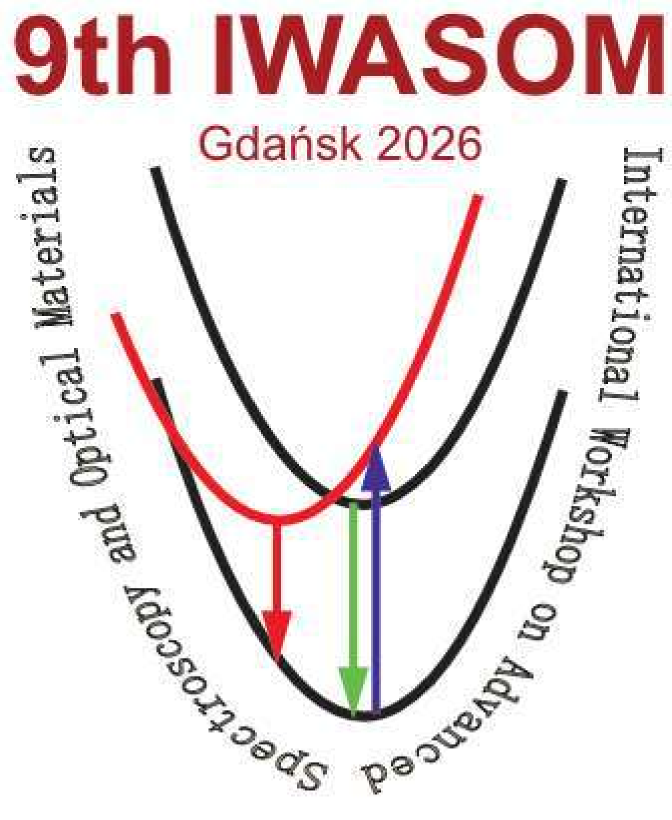
BOOK OF ABSTRACTS

The Ninth International Workshop
on Advanced Spectroscopy and Optical Materials
5-10 July 2026 Gdańsk, Poland



Ministry of Science and Higher Education
Republic of Poland

HONORARY PATRONAGE
Mayor of the City
of Gdańsk

The Ninth International Workshop on Advanced Spectroscopy and Optical Materials
5-10 July 2026 Gdańsk, Poland

Organized by;

Institute of Experimental Physics, Gdańsk University
The Foundation for the Development of Gdańsk University

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Maja Szymczak

Scientific Program

Sunday, July 5, 2026

Location: Main Hall, Faculty of Mathematics, Physics and Informatics, Institute of Experimental Physics, 57 Wita Stwosza Str., Gdansk

Time	Event
15:00 – 19:00	Registration

Monday, July 6, 2026

Location: Main Hall, Faculty of Mathematics, Physics and Informatics, Institute of Experimental Physics, 57 Wita Stwosza Str., Gdansk

Time	Event
08:00 – 09:00	Registration

Location: Auditorium D005, Faculty of Mathematics, Physics and Informatics, 57 Wita Stwosza Str., Gdansk

Session: Novel fluorophores, optical materials, devices for biosensing, biomedical and environmental applications I

Session chair: Jakub T. Gnyp

Time	Code	Presenting author	Title, authors
09:15 – 09:30		Opening ceremony	
09:30 – 10:00	IL1	Ru-Shi Liu	Efficient Infrared Phosphors Powering Tomorrow's Hyper-Speed Optical Networks R. S. Liu
10:00 – 10:30	IL2	Artur Bednarkiewicz	Anti-Stokes Förster Resonant Energy Transfer – advantages and pitfalls A. Bednarkiewicz, M. Misiak, A. Pilch, G. Bękarski, K. Prorok
10:30 – 11:00	IL3	Justyna Zeler	Persistent Luminescence at the Interface Between Materials Science, Physics, and Chemistry J. Zeler, A. Akbar, N. Lee, A. Owczarek, A. Klecha, M. Sójka, J. Brgoch, L. D. Carlos, E. Zych
11:00 – 11:30		Coffee break	

Session: Phosphors: recent progress, new materials, and applications I

Session chair: Maja Szymczak

Time	Code	Presenting author	Title, authors
11:30 – 12:00	IL4	Chao-Nan Xu	Frontiers in Mechanoluminescent Materials: Innovation, Mechanisms, and Applications C. N. Xu, T. Uchiyama, X. G. Zheng
12:00 – 12:30	IL5	Marcin Runowski	Sound-to-Light Conversion in mechanoluminescent materials M. Runowski, K. Soler-Carracedo, P. Woźny, F. Zhao, J. Moszczyński, A. Drozdowski, T. Grzyb, T. Zheng, D. Peng, J. Barzowska, S. Mahlik
12:30 – 13:00	IL6	Karol Bartosiewicz	Fe^{3+} Near-Infrared Luminescence in Single and Eutectic Crystals Y. Smortsova, R. Tomala, M. Szymczak, M. Yoshino, V. Babin, D. Szymńaski, Y. Zhydachevskyy, L. Marciniak, G. Bai, Y. Yoshikawa, K. Bartosiewicz
13:00 – 14:30		Lunch	

Session: Luminescent sensors I

Session chair: Kevin Soler-Carracedo

Time	Code	Presenting author	Title, authors
14:30 – 15:00	IL7	Víctor Lavín	Expanding the Toolbox for Optical Manometry and Thermometry V. Lavín, U. R. Rodríguez-Mendoza, M. A. Hernández-Rodríguez, M. Runowski, P. Woźny, T. Zheng, P. Du, J. Xue, N. Majewska, S. Mahlik, K. Kamada, A. Yoshikawa
15:00 – 15:30	IL8	Łukasz Marciniak	Synergy of Optical Traps and Vibronic-Level Thermalization in Mn^{2+}-Doped Materials for Visual Thermal Imaging and Thermal Threshold Detection Y. Abe, M. Szymczak, J. Zeler, L. Marciniak
15:30 – 15:45	O1	Przemysław Woźny	Pressure-Modulated Luminescence and Phase Transitions in Functional Materials P. Woźny, T. Ganeshamurthy, F.Zhao, M. Behera, T. Zheng, S. Sobczak, P. Du, V. Lavin, M. Runowski
15:45 – 16:00	O2	Maja Szymczak	Simultaneous Temperature and Pressure Detection Based on Mn^{2+} Luminescence M. Szymczak, S. Mahlik, Ł. Marciniak
16:00 – 16:30		Coffee break	

Session: Hybrid and organic optical materials

Session chair: Shirly Espinoza

Time	Code	Presenting author	Title, authors
16:30 – 17:00	IL9	Winicjusz Drozdowski	In Search of High-Performance Scintillators: TADF-Based Organic Materials W. Drozdowski1, K. J. Drozdowski, M. S. Eid, K. Wisniewski, M. E. Witkowski, A. Hadrzyński, N. Żaromińska, M. Frajtag, M. Mońka, I.E. Serdiuk
17:00 – 17:30	IL10	Robert Pązik	Synergy of the alternating magnetic field and NIR light in heat generation on ferrite nanostructures R. Pązik, A. Tomaszewska, M. Kulpa-Greszta
17:30 – 18:00	IL11	Joanna Niedziółka-Jönsson	Tools for Control of Single Silver Nanowires Towards Single Molecule Biochemistry J. Niedziółka-Jönsson
18:00 – 22:00		Welcome reception & special session	

Tuesday, July 7, 2026

Session: Radioluminescence, optically and thermally stimulated luminescence in solids

Session chair: Artur Majewski-Napierkowski

Time	Code	Presenting author	Title, authors
09:30 – 10:00	IL12	Yuriy Zorenko	Recent Advances in Luminescence Studies of Single Crystals and Single-Crystalline Phosphors Using Synchrotron Radiation Yu. Zorenko
10:00 – 10:30	IL13	Takahiko Horiai	Development of Novel Red-Emitting Scintillators Through Crystal Field Engineering T. Horiai
10:30 – 10:45	O3	Adelya Kenzhebayeva	The Nature of the High-Temperature Thermally Stimulated Luminescence Spectra of KCl:Li, NaCl:Li, KCl:Na and RbCl:Na Single Crystals K. Shunkeyev, Sh. Sagimbayeva, A. Kenzhebayeva, Zh. Ubaev, Y. Zorenko
10:45 – 11:00	O4	Nuraiym Pirzadayeva	Radiation-Induced Modifications of Luminescent Properties of YAG:Ce, LuAG:Ce and TbAG:Ce Single-Crystalline Films Under 24.5 MeV ^{14}N Ion Irradiation N. Pirzadayeva, A. Dauletbekova, A. Akilbekov, G. Aralbayeva, V. Gorbenko, T. Zorenko, V. Laguta, Y. Zorenko
11:00 – 11:30		Coffee break	

Session: Nanoscale optical materials and low-dimensional systems

Session chair: Ling-Hsuan Chung

Time	Code	Presenting author	Title, authors
11:30 – 12:00	IL14	Marta Gordel-Wójcik	Design and Development of Nanoparticulate Complexes For Near-Infrared Fluorescence Imaging and Thermotherapy M. Gordel-Wójcik
12:00 – 12:30	IL15	Maxim Pshenichnikov	Single-Object Polarization-Resolved Microscopy on Artificial Light-Harvesting Complexes M. S. Pshenichnikov
12:30 – 13:00	IL16	Agata Kamińska	Identification of UV Color Center in 2D Boron Nitride - Polytype Control and High-Pressure Studies A. Kaminska
13:00 – 14:30		Lunch	

Session: Luminescent sensors II & Phosphors II

Session chair: Przemysław Woźny

Time	Code	Presenting author	Title, authors
14:30 – 15:00	IL17	Marcin Nyk	Nonlinear Optical Properties of Colloidal Quantum Dots for Luminescence-Based Sensor Applications M. Nyk, A. Siomra, D. Wawrzyńczyk, M. Samoć
15:00 – 15:30	IL18	Michele Back	Mn^{5+}-activated Phosphors: Potential and Limits for Temperature and Pressure Sensing J. Cangiotti, A. Zarkov, M. G. Brik, J. Ueda, M. Back
15:30 – 15:45	O5	Karolina Kowalska	Understanding the Temperature-Dependent Luminescence of $LiLuF_4:Pr^{3+}$ for Emerging Applications K. Kowalska, E. Zych
15:45 – 16:00	O6	Guna Doke	From Anti-Counterfeiting to Forest Monitoring: Application-Driven Development of Cr^{3+}-Activated NIR Persistent Phosphors G. Doke, P. Rodionovs, A. Antuzevics, G. Krieke, M. Kemere
16:00 – 16:30		Coffee break	

Session: Theory and modeling I

Session chair: Andrii Shyichuk

Time	Code	Presenting author	Title, authors
16:30 – 17:00	IL19	Jonas Joos	Multiconfigurational ab Initio Calculations as a Tool to Reveal The Excited States of Transition Element Impurities in Crystals J. Joos
17:00 – 17:30	IL20	Oleg Khyzhun	Application of X-ray and Optical Spectroscopy Methods for Verification of DFT Band-Structure Calculations O. Khyzhun, V. Duy Dat, Z. Umar, M. Brik, M. Piasecki
17:30 – 17:45	O7	Marek Krośnicki	Electric Field Gradients in Embedded Cluster Calculations M. Krośnicki, V. Veryazov
17:45 – 18:00	O8	Tomasz Urbańczyk	Explainable Artificial Intelligence in Physical Chemistry. SHAP Model Explaining a Neural Network Detecting Functional Groups from FTIR Spectra T. Urbańczyk, J. Bożek, J. Koperski, M. Krośnicki

Wednesday, July 8, 2026

Session: Optical materials, optically and thermally stimulated luminescence in solids

Session chair: Renata Majgier

Time	Code	Presenting author	Title, authors
09:30 – 10:00	IL21	Philippe F. Smet	Trapping Capacity in Persistent Phosphors: Limitations and Workarounds P. F. Smet, V. Fritz, D. Van der Heggen
10:00 – 10:30	IL22	Yaroslav Zhydachevskyy	Tuning the Crystal Structure, Optical Band Gap and Persistent Luminescence Performance of Cr^{3+}-doped $LiGa_5O_8$ Spinel by Adding Aluminum and Indium A. Karabut, H. Zhydachevska, Ł. Wachnicki, V. Hreb, L. Vasylechko, Yu. Hizhnyi, T.Shevtsova, Ya. Zhydachevskyy
10:30 – 10:45	O9	Karol Lemański	UVC Upconversion Emission of $Ca_9Y_xLu_{1-x}(PO_4)_7$ Polycrystals Doped with Pr^{3+} Ions K. Lemański, O. Bezkrovna, N. Rebrova, P. J. Dereń
10:45 – 11:00	O10	Sandra Witkiewicz-Łukaszek	In Situ Electron Beam Dose Measurements in FLASH Radiotherapy Using Fiber-Optic Scintillation Sensors Based on Al_2O_3:Ce and GAGG:Ce Crystals S. Witkiewicz-Lukaszek, A. Orzechowska, S. Meleszka, J. Winiecki, Yu. Zorenko
11:00 – 11:30		Coffee break	

Session: Phosphors: recent progress, new materials, and applications III

Session chair: Joanna Krasowska

Time	Code	Presenting author	Title, authors
11:30 – 12:00	IL23	Markus Suta	The Delicate Details of Blue-to-UV Upconversion with Pr^{3+} – What is so Challenging with this Approach? T. Förster, M. Suta
12:00 – 12:30	IL24	Philippe Boutinaud	The Nephelauxetic Function *he* and the Spectroscopy of Cr^{3+}, Mn^{4+} and Mn^{5+} (and Few Others) in Solids P. Boutinaud
12:30 – 12:45	O11	Marek Adaszyński	Spectrally Tunable Ce^{3+}, Sm^{3+} Doped Phosphates for Adaptive Plant Growth LEDs Illumination M. Adaszyński, D. Stefańska
12:45 – 13:00	O12	Mykhailo Chaika	Role of Luminescence in Revealing Sintering Process of Cr^{4+}:YAG Transparent Ceramics M. Chaika
13:00 – 14:30		Lunch	

Session: Novel fluorophores, optical materials, devices for biosensing, biomedical and environmental applications II

Session chair: Sandra Witkiewicz-Łukaszek

Time	Code	Presenting author	Title, authors
14:30 – 15:00	IL25	Marek Godlewski	Nanoparticles of Oxides Doped with Rare Earth Ions for Theranostic Applications M. Godlewski
15:00 – 15:15	O13	Nadiia Rebrova	Synthesis and Blue-to-Ultraviolet Upconversion Properties of new Langbeinite-Type Phosphates N. Rebrova, A. Grippa, P. Berastegui, D. Szymański, M. Ptak, P. J. Dereń
15:15 – 15:30	O14	Jiazheng Li	From Average Structure to Local Symmetry: Understanding Cr^{3+} Luminescence in Perovskite Oxides J.Li, J. Xu, J. Ueda, M. Back, R. Zheng, N. Majewska, S. Tanabe
15:30 – 15:45	O15	Vo Duy Dat	Stability Enhancement and Optoelectronic Tailoring of Lead-Free $CsSnX_3$ and Cs_2SnX_6 Halides through Anion-Anion Exchange Z. Umar, V. Duy Dat, O. Khyzhun, M. G. Brik, M. Piasecki
15:45 – 16:00	O16	Bohdan Padlyak	Spectroscopy of the Nd-doped and Ag-Nd Co-doped Lithium Teraborate Glasses B. V. Padlyak, I. I. Kindrat, R. Lisiecki
16:00 – 16:15		Conference photo	
16:15 – 18:00		Poster session	

Thursday, July 9, 2026

Session: Nanoscale optical materials and characterization techniques for optical materials

Session chair: María Jesús Martínez-Morillo

Time	Code	Presenting author	Title, authors
09:30 – 10:00	IL26	Luisa E. Bausá	Optical Probing of Strain-Tuned Quasiparticle Control in Monolayer MoS_2 at 10 K J. Fernández-Martínez, N. Kyvelos, H.P. Van Der Meulen, G. López-Polín, D. Hernández-Pinilla, P. Ares, C.Tserkezis, M.O Ramírez, L.E. Bausá
10:00 – 10:30	IL27	Chris Sturm	Polarization-Resolved Raman Spectroscopy on Optically Anisotropic Materials S. Moritz, L. Trefflich, M. Grundmann, C. Sturm
10:30 – 10:45	O17	Bartłomiej Dominiak	Shape-Dependent Effects of ZnO Nanoparticles on Redox Status, Transcriptomic Profile, and Histopathology in Chicken Embryos B. Dominiak, A. Wal, J. Rosowska, A. Majewska, M. A. Gralak, J. Kaszewski, B. S. Witkowski, M. Godlewski, M. M. Godlewski
10:45 – 11:00	O18	Agnieszka Wal	Y_2O_3 and ZrO_2 Nanoparticles as Modulators of Embryo Development, Redox Status, Transcriptomic Profile, and Histopathology in Chicken Embryos A. Wal, B. Dominiak, J. Rosowska, A. Majewska, M. A. Gralak, J. Kaszewski, B. S. Witkowski, M. Godlewski, M. M. Godlewski
11:00 – 11:30		Coffee break	

Session: Theory and modeling II

Session chair: Mateusz Rebarz

Time	Code	Presenting author	Title, authors
11:30 – 12:00	IL28	Oscar L. Malta	Non-Radiative Energy Transfer in Lanthanide Materials O. L. Malta
12:00 – 12:30	IL29	Albano N. Carneiro Neto	Simulating Photophysical Properties of Real-Size Nanoparticles Containing Lanthanide Ions A. N. Carneiro Neto
12:30 – 12:45	O19	Andrii Shyichuk	The Breathing Mode Revisited: Ce^{3+} Energy Levels in Calcium Scandium Germanium Garnet Calculated from Scratch A. Shyichuk, F. Piccinelli, J. Ueda, M. Bettinelli, E. Zych
12:45 – 13:00	O20	Alexander Platonenko	Excited States and Racah Parameters of Ni^{2+} in $KMgF_3$ via Hybrid Density Functional Theory A. Platonenko, Z. Umar, O. Khyzhun, M. G. Brik, M. Piasecki
13:00 – 14:30		Lunch	

Session: Luminescent sensors III

Session chair: Karolina Kowalska

Time	Code	Presenting author	Title, authors
14:30 – 14:45	O21	Eugeniusz Zych	Understanding Host-Activator Interactions for Luminescence Thermometry E. Zych, J. Zeler, J. Trojan-Piegza, D. Stefanowska
14:45 – 15:00	O22	Kevin Soler-Carracedo	Breakthrough in Luminescence Thermometry-Supersensitive Emission Line Shift of Whispering Gallery Modes in Rhodamine B-Doped Cellulose Fiber Microresonators K. Soler-Carracedo, P. Woźny, M. Skwierczyńska, I. R. Martin, P. Kulpiński, M. Runowski
15:00 – 15:15	O23	Juan E. Muñoz-Santiuste	Luminescence and Local Environment of f-Elements Under Pressure J. E. Muñoz-Santiuste, V. Lavín, U. R. Rodríguez-Mendoza, M. A. Hernández-Rodríguez
15:15 – 15:30	O24	Robert Jankowski	Ru(II)-based supramolecular frameworks as potential platforms for non-linear optical thermometry R. Jankowski, J. Wang, P. J. Bonarek, M. Tamashuk, H. Tokoro, S. I. Ohkoshi, S. Chorazy
15:30 – 15:45	O25	Fang Zhao	UV Emission of Yb^{2+} in SrB_4O_7 for Highly Sensitive Optical Thermometry Enabled by Multiple Linear Regression F. Zhao, T. Zheng, P. Woźny, M. A. Hernández-Rodríguez, S. Xu, I. R. Martín, M. Runowski
15:45 – 16:00	O26	Jan Moszczyński	Influence of Flux Content on Photo-, Thermo- and Mechanoluminescence Properties of Mn^{2+} Doped ZnS/CaZnOS Heterojunction Materials J. Moszczyński, A. Drozdowski, D. Kulesza, J.Barzowska, E. Zych, S. Mahlik, M. Runowski

Friday, July 10, 2026

Session: Characterization techniques for optical materials

Session chair: Marek Adaszyński

Time	Code	Presenting author	Title, authors
09:30 – 10:00	IL30	David Van der Heggen	A Direct Observation of Ultrafast Energy Transfer, Charge Trapping and Thermal Quenching in Luminescent Materials D. Van der Heggen, K. Molkens, J. J. Joos, D. Rytz, L. C. V. Rodrigues, P. Geiregat, P. F. Smet
10:00 – 10:15	O27	Krzysztof Dorywalski	Spectroscopic Ellipsometry Signatures of Structural Evolution in NiMo-C Coatings for HER Applications K. Dorywalski, T. Suszko, E. Dobruchowska, W. Gulbiński, J. Morgiel
10:15 – 10:30	O28	Shirly Espinoza	Ultrafast Structural and Optical Dynamics in Photoexcited Thin-Film and Layered Materials S. Espinoza, E. Baron, M. Feneberg, K. P. Khakurel, Y. Gutierrez-Vela, M. Rebarz, J. Andreasson
10:30 – 10:45	O29	Mateusz Rebarz	Photoinduced Ultrafast Phase Transition in VO2 Thin Films Monitored by Time-Resolved Spectroscopic Ellipsometry M. Rebarz, Y. Gutiérrez, S. Espinoza, S. Vázquez-Miranda, K. Khakurel, Z. Zhang, J. M. Saiz, S. Ramanathan, S. Cueff
10:45 – 11:00	O30	Abdellah Bachiri	Development and Performance Assessment of Single- and Double-Layer TbAG:Ce and YAG:Ce Composite Scintillators on GAGG:Ce Substrates for Optimized α–γ Discrimination and Pulse-Shape Analysis A. Bachiri, A. Syntfeld-Każuch, V. Gorbenko, S. Witkiewicz-Lukaszek, T. Zorenko, Ł. Adamowski, Ł. Świderski, V. Stasiv, Ya. Zhydachevskyy, Yu. Zorenko
11:00 – 11:30		Coffee break	

Session: Phosphors: recent progress, new materials, and applications IV

Session chair: Patrycja Zdeb-Stańczykowska

Time	Code	Presenting author	Title, authors
11:30 – 12:00	IL31	Daniel Jaque	NIR-Emitting Nanoparticles Provide Implants New Functionalities D. Jaque
12:00 – 12:30	IL32	Przemysław J. Dereń	Design Principles of Phosphors for Visible-to-UVC Upconversion P. J. Dereń , P. Zdeb-Stańczykowska, N. Rebrova
12:30 – 13:00		Closing Ceremony	
13:00 – 14:30		Lunch	

Poster session

Code	Presenting author	Title, authors
P1	Muhammad Tahir Abbas	Luminescence Thermometry Based on Structural Phase Transition of $LaGaO_3:Eu^{3+}$ M. Tahir Abbas, M. Szymczak, V. Kinzhybalo, D. Szymanski, M. Drozd, Ł. Marciniak
P2	Yuka Abe	Filter-Free Luminescence Thermometry based on Mn^{2+} Luminescence Y. Abe, M. Szymczak, J. Zeler, Ł. Marciniak
P3	Krzysztof Anders	Photonic System for Continuous Monitoring of Eutrophic Contaminants in Aquatic Environments K. Anders, A. Jusza, J. Kalwas, P. Bortnowski, M. Kozubal, A. Bieniek-Kaczorek, A. Daniszewska, Ł. Kozłowski, S. Stopiński, E. Kiedrzyńska, R. Piramidowicz
P4	Ayisha Basheer	Tuning Mn^{4+} Luminescence Kinetics via the Nephelauxetic Effect for Lifetime Thermometry A. Basheer, M. Szymczak, M. Piasecki, A. M. Srivastava, M.G. Brik, Ł. Marciniak
P5	Mitrabhanu Behera	Pressure-Induced Changes in the Luminescence properties of $NaYF4:Ce^{3+}$, Mn^{2+} Phosphors M. Behera, P. Woźny, V. N. K. B. Adusumalli, M. Runowski
P6	Stanisław Chełkowski	Mapping of Optical Anisotropy and Strain in Ferroelectric Crystals via Single-Shot Spectroscopic Polarimetry S. Chełkowski, K. Dorywalski
P7	Ling-Hsuan Chung	Strategic Precursor Engineering and Continuous-Flow Synthesis of High-Quality PbS Quantum Dots for Enhanced Near-Infrared Photodetection L. H. Chung, K. C. Hsu, M. H. Fang
P8	Karolina Dej	Influence of Fluoride Modifiers on Structure and Optical Properties of Lead-Based and Lead-Free Phosphate Glasses Doped with Europium Ions K. Dej, M. Kuwik, J. Pisarska, W. A. Pisarski
P9	Mohanad Eid	Compositional Engineering of 2D Perovskites via Cd Substitution and its Impact on Optical and Scintillation Properties M. S. Eid, F. Maddalena, C. Dang, M. Makowski, D. Kowal, M. H. Mahyuddin, W. Drozdowski, M. D. Birowosuto
P10	Tamilarasu Ganeshamurthy	Pressure-Induced Phase Transitions in $BaGa_2Ge_2O_8:Eu^{3+}$, a Potential Pressure Marker T. Ganeshamurthy, P. Woźny, M. Runowski
P11	Antreena George	Visual Luminescence Thermometry based $KGaGeO_4$: Ce^{3+}, Cr^{3+} A. George, M. Szymczak, L. Marciniak

P12	Jakub Tomasz Gnyp	Modelling Electron Structure of Double Halide Perovskites doped with Transition Metals J. T. Gnyp, A. Gurzyńska, T. Leśniewski, S. Mahlik
P13	Natalia Górecka	Tunable Luminescence by B-site Substitution in $Cs_2NaInCl_6$ N. Górecka, N. Zhanturina, G. Beketova, K. Szczodrowski, T. Leśniewski, Z. Aimaganbetova
P14	Maciej Grzegorczyk	Photocurrent Measurements Using Precision LED Excitation Systems Across a Broad Spectral Range M. Grzegorczyk, N. Majewska, S. Mahlik
P15	Agata Gurzyńska	Spectroscopic Investigation of Luminescence in Cr^{3+}– doped $Sr_2Ga_{(1-x)}In_xSbO_6$ Double Perovskite A. Gurzyńska, N. Majewska, Y. T. Lee, Y. T. Tsai, M. H. Fang, S. Mahlik
P16	Anam Javaid	Development from a Multimodal Up-Converting Luminescent Thermometer into a Ratiometric Visual Optical Power Density Meter Based on Er^{3+},Yb^{3+} Emission A. Javaid, M. Szymczak, Ł. Marciniak
P17	Mikołaj Kamiński	Tunable Short-Wave Infrared Ni^{2+} Emission via Crystal Field Engineering M. Kamiński, R. S. Liu, S. Mahlik
P18	Anastasiia Karabut	The Effect of Lithium Excess on the Persistent Luminescence and Thermoluminescence Performance of Undoped and Cr^{3+}-doped $Li_{1+x}Ga_5O_8$ Spinel A. Karabut, H. Zhydachevska, V. Hreb, L. Vasylechko, Ya. Zhydachevskyy
P19	Dobrosława Kasprowicz	Spectroscopic Properties of Y_2SiO_5 Single Crystals Doped with Yb^{3+} Ions for Quantum Memory Applications D. Kasprowicz, J.Komar, R. Kral, J. Pejchal, T. Zhezhera, P. Dereń
P20	Andrzej Kędziorski	Spectroscopic Properties of Sr_2CeO_4 Nanocrystals Revisited A. Kędziorski, M. Stefański, W. Stręk
P21	Meldra Kemere	Crystal Field Engineering of Cr^{3+} Luminescence in Zn^{2+}/Zr^{4+}-Modified $Gd_3Ga_5O_{12}$ M. Kemere, P. Rodionovs, A. Sarakovskis
P22	Marcel Kempa / Mikołaj Krzemiński / Antonina Szutko/ Dariusz Zielonka	Quantitative Elemental Analysis Using Laser-Induced Breakdown Spectroscopy and 1D Convolutional Neural Networks M. Kempa, M. Krzemiński, A. Szutko, D. Zielonka, M. Krośnicki, T. Urbańczyk
P23	Ihor Kindrat	Effect of Ag Co-Activation on Luminescence of Dy^{3+} Ions in Lithium Tetraborate Glasses I.I. Kindrat, B.V. Padlyak, A. Drzewiecki, V.T. Adamiv, I.M. Teslyuk, R. Lisiecki

P24	Katarzyna Klimek	Spectroscopic Insights into Novel Thin Electrospun Composite Membranes Based on Curdlan, WPI, and Synthetic Polymers K. Klimek, A. Hnydka, J. Higuchi, A. Matwijczuk
P25	Agata Kowalska / Elżbieta Adamska	Nanomaterials with Tunable Optical Properties for Advanced Functional Applications A. Kowalska, E. Adamska, E. Wargala, B. Schlichtholz, P. Bojarski, B. Grobelna, A. Synak
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INVITED LECTURES

Efficient Infrared Phosphors Powering Tomorrow's Hyper-Speed Optical Networks

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This presentation reports recent advances in near-infrared (NIR) phosphors for optical fiber communications, highlighting three key innovations addressing challenges in telecommunications and shortwave infrared (SWIR) technologies. First, Cr^{4+}-doped garnet phosphors with calcium charge compensation exhibit broadband emission (1100–1600 nm), effectively covering water absorption regions; the $Y_{2.84}Al_{4.9}O_{12}$:Cr,Ca crystal fiber outperforms commercial materials. Second, dual-cation doping (Ca^{2+}/Mg^{2+}) in YAG:Cr enhances NIR-II emission via improved crystal structure and increased tetrahedral Cr^{4+} sites. Finally, a bifunctional $(Ga,Ge)_2O_3:Cr^{3+},Ni^{2+}$ phosphor achieves 10.6% internal quantum efficiency with SWIR emission at 1430 nm, enabling both optical amplifier and LED applications. These developments deliver improved efficiency, broader bandwidth, and enhanced thermal stability, advancing next-generation optical communication technologies.

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Anti-Stokes Förster Resonant Energy Transfer – advantages and pitfalls

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Förster Resonant Energy Transfer is a versatile (bio)sensing mechanism, which, owing to close proximity of donor and acceptor molecules and their spectral overlap, enable studying biomolecular interactions and perform diagnostics *in-situ, in-vitro* and *in-vivo*. However, organic donor and acceptor molecules suffer from photodegradation and spectral bleed-through – thus hindering detection in complex (absorbing, fluorescent, scattering) samples.

Using luminescent lanthanide doped particles (LnNPs) as energy donors solves many technical challenges. However, while LnNPs offer photostable, narrowband anti-Stokes emission, their sensitivity is hampered by relatively large size of such LnNPs and complex energy transfer mechanisms. In consequence the sensitivities are suboptimal, luminescence kinetics is poorly responsive to presence of acceptors and kinetic and steady state readouts differ.

This lecture will overview state-of-the-art, present challenges and opportunities related to using upconverting (UCNPs) and photon avalanching (ANPs) nanoparticles as FRET energy donors [1-4].

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Persistent Luminescence at the Interface Between Materials Science, Physics, and Chemistry

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Persistent luminescence is characterized by prolonged photon emission following the removal of external excitation. This phenomenon, driven by the trapping and thermal or optical release of charge carriers, serves as a precise tool for investigating defect architectures in wide-bandgap materials. Understanding carrier dynamics and trap-state distribution is essential for advancing research in solid-state chemistry and photonics [1].

In this work, we evaluate tailored phosphor systems with tunable persistent and thermoluminescent properties [1-3]. Through strategic co-doping and controlled synthesis, we demonstrate how host defect engineering dictates trap distribution and emission kinetics. These findings suggest that engineering charge traps may facilitate the design of materials for low-background imaging and thermometric probes. These studies contribute to the ongoing efforts to integrate long-lasting emission functionalities into next-generation sensing applications.

Furthermore, we explore the emerging field of radioluminescence thermometry, assessing phosphor stability under ionizing radiation. By analyzing temperature-dependent X-ray-excited emission, we highlight these materials' potential for thermal monitoring in environments where optical excitation is limited.

This research was funded by the National Science Centre, Poland, under OPUS grant no. 2023/49/B/ST5/04265.

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Frontiers in Mechanoluminescent Materials: Innovation, Mechanisms, and Applications

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Mechanoluminescence (ML), the light emission induced by mechanical stimuli, has emerged as a promising phenomenon for visualizing mechanical responses and energy conversion in materials. In 1999, we established reproducible ML from defect-controlled phosphors such as $ZnS:Mn^{2+}$ and $SrAl_2O_4:Eu^{2+}$, and developed hybrid inorganic/organic ML composites and coatings for real-time stress and strain visualization. These innovations opened a new avenue for mechano-optical sensing and structural health monitoring.

In recent years, material design strategies have advanced significantly, enabling precise control of defects, crystal structures, and interfaces to enhance mechano-optical sensitivity. Building on these developments, we have introduced multipiezo materials, a new class that combines strong piezoluminescence and piezoelectricity. These materials exhibit high sensitivity and stability under elastic deformation without a stress threshold. By finely tuning the morphotropic phase boundary (MPB) and crystalline symmetry, both piezoluminescence and piezoelectricity have been enhanced by more than an order of magnitude.

This presentation highlights innovative approaches in the design and mechanism of ML and multipiezo materials and explores their potential applications in nano/micro sensing, damage diagnosis, energy conversion, and multifunctional optoelectronic systems. Future research directions and challenges for real-world implementation will also be discussed.

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Sound-to-light conversion in mechanoluminescent materials

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Mechanoluminescent materials enable non-invasive optical sensing and deep-tissue bioimaging by converting mechanical inputs into self-powered, remotely activated optical signals. Ultrasound-induced ML significantly enhances these capabilities, as focused acoustic waves can trigger light emission through intact tissues with minimal thermal or mechanical damage. This remote excitation is particularly valuable for dynamic sensing and for operation in regions inaccessible to direct mechanical manipulation. Moreover, sono-optogenetics leverages ultrasound-activated ML emitters to stimulate neural tissues without the need for implanted optical fibers, offering a highly promising, minimally invasive neuromodulation strategy. Collectively, these advances position mechanoluminescent systems as attractive platforms for future biomedical diagnostics, imaging, sensing and therapeutic interfaces.

Here we show the use of different mechanoluminescent materials based on ZnS, CaZnOS, $SrAl_2O_4$, AlN and Al_2O_3, activated with lanthanides (Nd^{3+}, Er^{3+}, Eu^{2+}) and d-block metal ions (Mn^{2+}, Cr^{3+}), for optical sensing and (bio)imaging. Importantly, the mechanoluminescence effects are generated with ultrasounds, allowing acoustic waves visualization and continuous light generation, due to the sound-to-light conversion phenomenon, accompanied with sound-to-heat conversion. We show the effects of materials excitation with both continuous and pulse acoustic waves, and their implication in temperature sensing and sono-optogenetics. The effects of materials excitation with different stimuli, i.e. light and mechanical waves, are also disused and compared.[1-3]

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Fe^{3+} Near-Infrared Luminescence in Single and Eutectic Crystals

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The development of efficient near-infrared (NIR) luminescent materials is important for applications ranging from night vision and bioimaging to non-destructive optical testing. Although Cr^{3+}-activated phosphors have long dominated this field, their practical implementation is often constrained by spectral overlap with ambient light and by the need for a carefully matched host crystal-field environment to achieve efficient emission, which limits compositional flexibility. Ni^{2+}-doped systems are likewise restricted by relatively limited wavelength tunability. In this context, Fe^{3+} represents an attractive and sustainable alternative, since its NIR luminescence is highly responsive to local coordination, ligand-field strength, defect chemistry, and phase constitution, thereby offering broad opportunities for deliberate emission tuning in structurally diverse materials. The Fe^{3+}-related luminescence characteristics of $Lu_3Al_5O_{12}$:Ce (LuAG:Ce) single crystals and $Y_3Ga_5O_{12}$–Ga_2O_3 (YGG–Ga_2O_3) eutectic heterostructures were evaluated. In the LuAG host, Ce^{3+}-codoping enhanced the Fe^{3+} near-infrared emission through modification of the local crystal-field and defect chemistry. In the eutectic system, the coexistence of chemically and crystallographically distinct phases improved excitation in the blue spectral range, enabling efficient pumping with commercial blue LEDs. Moreover, eutectic crystallization facilitates spatial localization of the excitation within the Ga_2O_3 phase, whose emission around 500 nm allows selective excitation of the green and NIR luminescence. The results demonstrate that targeted crystal-chemical and phase engineering provide an effective route for Fe^{3+}-based NIR luminescent materials compatible with blue-LED excitation and relevant to illumination, thermometry, and radiation detection.

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Expanding the toolbox for optical manometry and thermometry

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Research on high pressure and/or high temperature have become a fundamental field of theoretical and experimental research spanning all scientific disciplines, from the study of water on planets to the material composition of the Earth's interior and the development of new materials, not to mention applications in our daily lives, such as in food technology [1-3]. High-pressure conditions can be induced in a solid using a diamond anvil cell, while achieving low or high temperatures requires, respectively, a cryostat or a conventional furnace. Determining the pressure and temperature of the material under study is a key issue that requires calibrated standards. Indirect *in situ* calibrations can be performed by exploiting the high sensitivity of the emission lines of various optically active rare earth and transition metal ions to changes in pressure and/or temperature [3]. In this talk, we present different luminescent ions in materials and nanomaterials that have been successfully tested as optical pressure and/or temperature sensors, along with innovative multiparametric approaches for their determination.

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Synergy of Optical Traps and Vibronic-Level Thermalization in Mn^{2+}-Doped Materials for Visual Thermal Imaging and Thermal Threshold Detection

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The development of next-generation luminescent thermometers requires new mechanisms enabling pronounced, temperature-dependent spectral responses suitable for both sensing and imaging applications. In this lecture, we present a novel thermometric concept based on the synergistic interplay between thermalization of vibronic components of the Mn^{2+} excited state and thermally assisted energy transfer from optical trap states in phosphate-based phosphors. Using two examples: $Ca_{19}Zn_2(PO_4)_{14}:Mn^{2+}$, Ce^{3+} and $Ca_{19}Ce(PO_4)_{14}:Mn^{2+}$ as model materials, we demonstrate that this cooperative effect induces simultaneous thermal enhancement and a blueshift of the Mn^{2+} emission band associated with the $^4T_1 \rightarrow {}^6A_1$ transition[1].

This unique thermal behavior enables multiple temperature readout modes. First, distinct thermal responses of Ce^{3+} and Mn^{2+} emissions allow the construction of ratiometric thermometers with sensitivities up to 4.5% K^{-1}. Second, selective analysis of different spectral regions within the Mn^{2+} emission band provides an additional ratiometric approach. Most importantly, the thermally activated increase of emission in the green spectral region enables filter-free thermal imaging using standard RGB cameras. This effect also allows the design of luminescent threshold indicators, where the appearance of a signal in the green channel marks the treshold of a critical temperature.

Furthermore, the activation temperature of this signal can be precisely tuned by adjusting the Mn^{2+} concentration, providing a versatile platform for application-specific sensor design. Overall, this approach introduces a simple, robust, and cost-effective strategy for multidimensional temperature sensing and visualization, opening new perspectives in luminescent thermometry and thermal imaging technologies.

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In Search of High-Performance Scintillators: TADF-Based Organic Materials

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In response to the increasing interest in fully organic scintillation materials [1-3], we investigated a series of compounds based on thermally activated delayed fluorescence (TADF) emitters, including DMAC-TRZ with its derivatives DMAC-diF-TRZ, DMAC-diCl-TRZ [4] and diBr-DMAC-diCl-TRZ, as well as PXZ-TRZ and PXZ-dSP-TRZ. These materials were designed with the aim of enhancing the efficiency of the $T_1 \rightarrow S_1$ reverse intersystem crossing, which is a key factor governing their luminescence performance.

All compounds were studied in the form of single crystals grown by the slow solvent evaporation method. Their basic scintillation properties were examined using pulse height and scintillation time profile measurements. X-ray excited radioluminescence spectra were recorded as a function of temperature between 10 and 350 K. In addition, low-temperature thermoluminescence following X-ray irradiation was investigated in the same thermal range.

The collected data enable a comparative analysis of the aforementioned materials in terms of their scintillation characteristics. The study provides thus an insight into the potential of TADF-based systems as fully organic scintillators and indicates some directions for further material optimization.

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Synergy of the alternating magnetic field and NIR light in heat generation on ferrite nanostructures

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The lecture aims to present recent advances in the synthesis of ferrite heterostructures, including core-shell, multi-shell, and hybrid materials, with particular emphasis on energy conversion mechanisms in coherently engineered nanostructures under alternating magnetic field (AMF) and near-infrared (NIR) laser stimulation. Special attention will be given to the interplay between magnetic and optical energy dissipation pathways and their relevance for emerging bio-related applications.

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IL11 J. Niedziółka-Jönsson

Tools for control of single silver nanowires towards single molecule biochemistry

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Because of their 1-dimensional character, silver nanowires (AgNWs) have unique optical properties and can be used as optical antennas and plasmon waveguides. This can increase the quantum yield of reactions in the vicinity of the wire. Plasmon waveguiding uses propagating surface plasmons (SPs) to transfer energy along the nanowire to locations far from the excitation point. It can also collect energy from a molecule coupled with it. There is a trade-off between these two effects, where greater field enhancement limits the propagation of the SP whether the enhancement is achieved by using thinner nanowires or working closer to the plasmon frequency [1-3].

A unique aspect of AgNWs is that their diameter, in the range of 100 nm, is small enough to facilitate plasmonic effects over broad spectral ranges, but their lengths of tens of micrometers make them visible using standard microscopy. We will show the possibility of spatial organisation of single nanowires using optical microscopy which allows a long nanowire be connected to a drop of quantum dot emitters which can then be excited by illuminating the other end of the nanowire. The QDs can also be used to transfer energy from one nanowire to the next, forming the beginning of an optical network of plasmonic wires [4,5].

By immobilizing labeled nucleotides that exhibit fluorescence upon light excitation on high-quality nanowires the plasmonic effect can enhance their fluorescence signal, creating a platform that can be used to monitor enzymatic kinetics. We show that the fluorescence properties of these conjugates depend strongly on the conjugation process. Our initial experiments indicate that the modified AgNWs can serve as effective probes for real-time monitoring of enzyme kinetics in mRNA metabolism, by examining changes of fluorescence intensity.

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Recent Advances in Luminescence Studies of Single Crystals and Single-Crystalline Phosphors Using Synchrotron Radiation

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Substantial differences in preparation methods lead to pronounced variations in the luminescent properties of bulk crystals and single-crystalline film (SCF) phosphors. These variations originate from differences in the types, concentrations, and distributions of intrinsic defects, as well as from the distribution of dopant ions over cation sites and their interactions with defect- and dopant-related centers in different crystalline forms of the same material.

In bulk oxide crystals grown from high-temperature melts, defect centers such as oxygen and cation vacancies, antisite defects, and their aggregates can contribute significantly to both the intrinsic luminescence of the host matrix and dopant emission. This often obscures the intrinsic luminescence of the host and alters the emission characteristics of dopants. In contrast, single crystalline oxide films grown by low-temperature liquid-phase epitaxy (LPE) from fluxes exhibit a substantially reduced concentration of intrinsic defects. Moreover, the preferential occupation of cation sites by dopant ions may differ markedly between films and bulk crystals. However, LPE-grown films may incorporate residual flux-related impurities, which also can act as emission or trapping centers and thus influence luminescence.

Therefore, detailed comparative study of bulk crystals and SCFs very offend enables a reliable distinction between intrinsic, dopant-related, and defect-related luminescence in complex oxides. Furthermore, the combined application of optical spectroscopy, electron paramagnetic resonance (EPR), and luminescence spectroscopy under synchrotron radiation (SR) excitation, particularly in the excitonic and interband transition energy ranges, provides a powerful approach for such analysis and allows for a consistent comparison of luminescent properties across different crystalline forms.

The aim of this presentation is to demonstrate representative examples comparing the structure of luminescent centers in bulk crystals and single-crystalline film phosphors: Mg^{2+}-doped Al_2O_3 (sapphire), Eu^{3+}-doped Lu_2O_3 (lutetia), Ce-doped $Lu_{1-x}Gd_xAlO_3$ and $Gd_{1-x}Y_xAlO_3$:Ce mixed perovskites, as well as Sc^{3+}-doped $Lu_3Al_5O_{12}$ garnet. The analysis is based on conventional spectroscopic techniques combined with time-resolved luminescence spectroscopy using VUV excitation at the P66 beamline (PETRA III, DESY, Germany).

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Development of novel red-emitting scintillators through crystal field engineering

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Radiation such as X-rays and gamma rays is widely used in modern society, including medical diagnostics, cancer radiotherapy and nuclear energy applications. Scintillator materials, which convert such high-energy radiation into optical photons, play a central role in radiation detection. In recent years, there has been growing demand for red-to-near-infrared (NIR) scintillators for radiation dosimetry in harsh environments, such as inside nuclear reactors. Emission in the NIR region (800–900 nm) is particularly advantageous due to low transmission loss in optical fibers.

In this study, we focus on chemically stable oxide scintillators doped with transition metal ions. Luminescence originating from d–d transitions of transition metal ions is strongly influenced by the crystal field at the occupied lattice sites, allowing systematic wavelength control based on Tanabe–Sugano diagrams [1]. In particular, previous studies have reported that Cr^{3+}-doped $AlTaO_4$ and Cr^{3+}-doped $GaTaO_4$ exhibit broadband emission originating from the $^4T_2$–$^4A_2$ transition over 800 nm, suggesting their potential as red-to-NIR-emitting scintillators [2, 3].

Motivated by these findings, we grew Cr^{3+}-doped $(Al,Ga)TaO_4$ crystals using the laser floating-zone method and systematically evaluated their crystal structures and optical properties. Fig. 1 shows the photoluminescence emission spectra of $(Cr_{0.01}\,Al_{0.99})TaO_4$ and $(Cr_{0.01}\,Ga_{0.99})TaO_4$, in which broad emission attributed to the $^4T_2$–$^4A_2$ transition was clearly observed, with peak wavelengths at 846 nm and 815 nm, respectively. In this presentation, the relationship between crystal structure and optical properties is discussed in more detail.

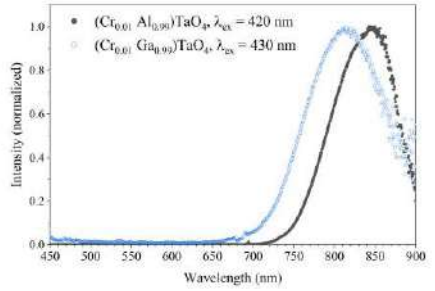

Figure 1 Photoluminescence emission spectra of $(Cr_{0.01}\,Al_{0.99})TaO_4$ and $(Cr_{0.01}\,Ga_{0.99})TaO_4$

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Design and development of nanoparticulate complexes for near-infrared fluorescence imaging and thermotherapy

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This work presents a study of the nonlinear optical properties of silver sulfide quantum dots modified with different surface ligands, including mercaptopropionic acid [1], glutathione (GSH, γ-L-glutamyl-L-cysteinylglycine), tiopronin, and chiral ligands based on penicillamine enantiomers[2]. The influence of ligand type on the optical response of the nanostructures is discussed. The formation of hybrid materials composed of silica, gold, silver sulfide quantum dots, and organic molecules is also described.[3,4] Particular emphasis is placed on how controlled design of such systems affects emission band positions and fluorescence lifetimes, both in colloidal solutions and at the single-particle level. Additionally, nonlinear optical parameters are analyzed, including changes in the two-photon absorption cross-section and effects related extinction saturation.[3] The findings are further complemented by femtosecond transient absorption measurements, providing insight into ultrafast processes occurring in these nanomaterials on the femtosecond to nanosecond timescale.[4]

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Single-object polarization-resolved microscopy on artificial light-harvesting complexes

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Natural light-harvesting antennae, found throughout photosynthetic organisms such as green algae and bacteria, achieve remarkable energy-transfer efficiencies through the dense packing and strong mutual coupling of chromophores. This organization gives rise to delocalized Frenkel excitons, whose migration through the antenna complex enables highly efficient excitation-energy transport [1]. Molecular double-walled nanotubes (DWNTs), formed by the self-assembly of amphiphilic C8S3 dye molecules in aqueous solution, offer a structurally well-defined biomimetic platform for studying these processes. Although they are soft molecular assemblies, DWNTs display an unusually low level of structural disorder, permitting exciton delocalization over hundreds of chromophores. Realizing the full potential of such systems requires experimental approaches that provide spectroscopic observables directly comparable with theory and, at the same time, establish how robust exciton delocalization remains under structural or energetic perturbations.

In this contribution, I discuss selected examples of polarization-resolved photoluminescence microscopy on individual DWNTs. I first show that the transition dipole moments of the emitting excitons are confined to a narrow angular distribution oriented along the nanotube axis. This effect originates from negative intermolecular couplings, which favor exciton states with in-phase wavefunction coefficients and yield a reduced linear dichroism close to unity [2]. I then show that Frenkel excitons in DWNTs retain extensive delocalization even when substitutional molecular dopants, acting as deep energetic traps, are incorporated into the assembly. Importantly, this behavior is not limited to photoluminescence but is also observed in absorption, demonstrating that it reflects the intrinsic excitonic structure rather than a selective subset of emissive states. Theoretical simulations capture the observed behavior and indicate that excitons redistribute adaptively to avoid trap sites [3]. Together, these results demonstrate the resilience of supramolecular nanotube architectures in sustaining efficient exciton transport under conditions relevant to molecular fabrication.

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Identification of UV color center in 2D boron nitride - polytype control and high-pressure studies

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Layered boron nitride is a wide bandgap semiconductor, which in its hexagonal form (hBN) was already synthesized in the 19th century. However, only recently, high-quality single crystals with macroscopic size were produced, leading to the realization of a light-emitting device operating in the deep UV [1]. This achievement paved the way for applications of hBN in advanced optoelectronics, making it to be considered a challenger to aluminum nitride. Furthermore, in 2016, Bourrelier et al. reported single photon emission of a color center emitting at 4.1 eV [2]. The nature of the defect giving rise to this behavior has become the subject of intense research and discussion.

In order to contribute to the elucidation of the origin of such emission, we performed high hydrostatic pressure studies of the low-temperature photoluminescence of hBN crystals and other BN stacking sequences, i.e., the Bernal bBN) and rhomboedral (rBN) forms (polytypes) using the diamond anvil cell technique. The results showed that the emission energy decreased with pressure less sensitively than the bandgap [3,4]. This behavior is typical of deep traps. Theoretical calculations of pressure dependencies of various defect levels in hBN and other BN polytypes demonstrated that the observed emission is associated with carbon-related defects, and its pressure behavior depends on BN polytype. Our results show that tuning the stacking sequence provides unique “fingerprints” contributing to the identification of defects in 2D materials [5].

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Nonlinear optical properties of colloidal quantum dots for luminescence-based sensor applications

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Quantum dots (QDs) are widely used in research and industrial fields due to their exceptional optical and electronic properties, which can be tailored by adjusting size (resulting in size-dependent optical and electronic properties due to quantum confinement) and chemical composition of these nanomaterials. Over the years, many research groups have focused on discovering improved third-order nonlinear optical (NLO) materials that could support developing applications in laser technology, telecommunications, and biophotonics [1]. In this work, we quantitatively demonstrate that colloidal QDs are capable of exhibiting a nonlinear optical response across a broad spectral wavelength range [2,3]. Our findings highlight the potential of this nanomaterial for use as a two-photon–excited luminescence sensor for detecting metal ions, including heavy metal ions [4]. The nonlinear absorption properties are present as appropriate cross sections (σ_2), given in Goeppert-Mayer unit (GM) normalized per molecular weight which allows comparison of the NLO properties of the studied QDs with various nanosystems or organic dyes.

All investigated nanomaterials exhibit notable optical properties suitable for optical sensing applications in both one- and two-photon regime. The findings of the study also underscore the promising outlook for employing novel and emerging cadmium-free QDs in various fields, including bio-related ones, as they could be an interesting alternative to nonlinear absorbers currently used, for example, as markers for nonlinear microscopy.

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Mn^{5+}-activated Phosphors: Potential and Limits for Temperature and Pressure Sensing

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While Mn^{5+}-activated materials have a long history in pigments and NIR lasers [1,2], their unique $3d^2$ electronic configuration continues to offer untapped potential for modern optical challenges. This talk examines the transition of Mn^{5+} research from its foundational spectroscopic roots in the 1960s [3] to its current status as a multifunctional dopant with potential in the next-generation NIR-II contrast agents [4], NIR LED lighting [5], and particularly in optical sensing [6-8]. The correlation between the structural preference of Mn^{5+} for tetrahedral sites and the resulting sharp $^1E \rightarrow {}^3A_2$ emission that defines its performance will be discussed in the context of the Tanabe-Sugano theory. Special emphasis will be placed on the correlation between the parameters describing the luminescent ion local site and optical performance of Mn^{5+}-activated phosphors for temperature and pressure sensing. Moreover, considering phosphates and vanadates as example, the PL emission modulation through the crystal field control is presented. Finally, general trends, possibility of predictions and limitations will be discussed.

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Multiconfigurational *ab initio* calculations as a tool to reveal the excited states of transition element impurities in crystals

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In contrast to their high application potential, *e.g.* in wavelength conversion, scintillation or quantum technology, transition elements are notoriously difficult study cases for first principles methods. The incompletely filled *d* (or *f*) shell gives rise to strong electron correlation effects, *i.e.* the electronic states are poorly described by a single Slater determinant. This is however an important requirement to justify the use of single-reference methods such as density-functional theory.

Wave-function-based quantum chemistry is presented as an alternative to study solid state systems. While such methods suffer from the exponential scaling of the wave function, it is shown that insightful and accurate results can nevertheless be obtained by adopting well-considered approximations, in particular by exploiting embedded cluster methods. An additional advantage is that spin-orbit relativistic effects are efficiently incorporated in this methodology, allowing to obtain electronic absorption and emission spectra that can be immediately compared to experiments, also for compounds that contain heavier elements.

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Application of X-ray and optical spectroscopy methods for verification of DFT band-structure calculations

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During lastdecades, first-principles band-structure calculations carrying out within a density functional theory (DFT) framework is among the most important scientific challenges [1]. However, the accuracy of DFT calculations in many cases depend on the choice of approaches used for exchange correlation (XC) potential. As a result, during recent years X-ray photoelectron spectroscopy (XPS) and different kinds of optical spectroscopy were found very important tool for verification of the accuracy of DFT calculations in the case of semiconductors and insulators where the use of generally employed GGA and LDA approaches for XC potential bring far underestimated energy band gaps as compared to measurements of optical absorption edges [2]. Energy positions of the valence-band fine-structure peculiarities and those associated with semi-core electrons are essentially shifted towards the Fermi energy [3].

In the current work (NCN, 2024/55/B/ST5/01411), we demonstrate peculiarities of X-ray and optical spectroscopy techniques that are well suited for verification of DFT band-structure calculations of solids, in particular complexadvanced optical quaternary chalcogenides $A^{I}_{2}B^{II}D^{IV}X_4$ (A^{I}= Cu, Tl; B^{II}= Cd, Hg; D^{IV}= Si, Ge, Sn; X = S, Se) and halides $CsPb(Sn)X_3$ (X = Cl, Br, I). In particular, we demonstrate advantages of combination of XPS and optical spectroscopy techniques for probing theoretical DFT data on density of states (DOSs) and the main optical properties (absorption spectrum, complex dielectric function, reflectivity coefficient, refractiveindex, extinction coefficient, optical reflectivity, electron energy-loss spectrum) of the above semiconductors.

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Trapping capacity in persistent phosphors: limitations and workarounds

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Persistent luminescence, i.e. light emission lasting from seconds to hours after the excitation source is turned off, enables many different applications, from emergency and safety signage to bioimaging and outdoor road markings [1]. Such extended photon emission originates from the trapping of charge carriers in defect states and their gradual thermally driven release, followed by radiative recombination at luminescent centers.

The decay profile after ending the excitation is determined by the phosphor's temperature, the total number of traps and the trap depth distribution. Consequently, a lot of research efforts have been put into approaches to determine the trapping and detrapping mechanisms, measure the total trapping capacity and optimize the trap depth distribution [2].

In this presentation, the state-of-the-art of high-luminance persistent phosphors is discussed [1], along with the (intrinsic) factors that limit the total light output of persistent phosphors. For instance, the actual number of traps that can be filled is typically far less than the number of purposely introduced trapping defects, which is partly due to dopant aggregation in grain boundaries. Also, optical detrapping of previously trapped charges turns out to be very relevant to understanding this limitation [3]. In a second part, workarounds are discussed that can yield much higher luminance, by means of larger optical volumes and decoupling the trapping and the final emission.

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Tuning the crystal structure, optical band gap and persistent luminescence performance of Cr^{3+}-doped $LiGa_5O_8$ spinel by adding aluminum and indium

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The possibility of tuning the optical band gap, crystal structure and persistent luminescence performance of Cr^{3+}-doped $LiGa_5O_8$ spinel by partially replacing Ga with Al and/or In has been studied extensively. For this purpose, a series of Cr^{3+}-doped $Li(Ga_{1-x-y}Al_xIn_y)_5O_8$ ($x = 0…0.5$; $y = 0…0.1$) microcrystalline phosphors were synthesized using a conventional solid-state reaction method and characterized by powder X-ray diffraction and luminescence techniques. The DFT-based electronic structure calculations were carried out for the same $Li(Ga_{1-x-y}Al_xIn_y)_5O_8$ compositions, and the results were compared with the experimental ones. Based on the studies performed, the mechanism of Al and In incorporation into the $LiGa_5O_8$ spinel structure, as well as the tuning of the crystal lattice parameters, local structure of M^{3+} (M = Ga, Al, In) cations and optical band gap of the material have been established. The multicenter structure and the broadening of the local structural disorder of the octahedrally coordinated Cr^{3+} centers observed in this case have been confirmed by the high-resolution, low-temperature photoluminescence measurements. Band gap engineering through alterations in the chemical composition of the $LiGa_5O_8$ spinel, as well as the depth of the native point defects responsible for charge trapping, allows for the efficient tuning of the thermoluminescent and persistent luminescent properties of $Li(Ga_{1-x-y}Al_xIn_y)_5O_8:Cr^{3+}$ phosphors. Thus, the room-temperature persistent luminescence performance of the phosphors modified by the addition of Al and annealing in an oxygen-free atmosphere was increased threefold compared to the pristine $LiGa_5O_8:Cr^{3+}$ phosphor synthesized under the same conditions.

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The delicate details of blue-to-UV upconversion with Pr^{3+} – what is so challenging with this approach?

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After 50 years of continuous development, near infrared (NIR)-to-visible (VIS) upconversion with Er^{3+} and Yb^{3+} has become a mature research area [1] in the field of luminescent materials with various applications in bioimaging, or luminescent nanothermometry [2]. In contrast, upconversion of visible to ultraviolet (UV) light is by far not yet at that stage. Potential applications vary from photoredox catalysis to miniaturized antimicrobial light sources and so far, triplet-triplet annihilation (TTA) in organic emitters seem to be among the brightest options so far [3].

A possible candidate for blue-to-UV upconversion is the $4f^2$ lanthanoid ion Pr^{3+}. Despite its promising electric dipolar excited-state $4f^15d^1 \leftarrow 4f^2$ absorption, upconversion efficiencies are disappointingly low [3a]. In this lecture, I will address the fundamental obstacles in this approach referring back to the pioneering works of François Auzel and what could be potential outcomes [4,5]. Moreover, it will be covered how a follow-up energy transfer to the narrow-line emitting ion Gd^{3+} could be beneficially used and how important the choice of a suited host can be in the design of this energy transfer [5].

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The nephelauxetic function *he* and the spectroscopy of Cr^{3+}, Mn^{4+} and Mn^{5+} (and few others) in solids

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These last years, it was shown that the energy of the $s^2 \rightarrow s^1p^1$ transitions of p-block cations like Tl^+, Sn^{2+}, Pb^{2+}, Sb^{3+}, Bi^{3+} and Te^{4+} can be reproduced using an equation of the form $E = E_f[1 - Khe^{\alpha}]$, where E_f is the energy of the free ion, he is the "nephelauxetic function" that is calculated at the crystal sites occupied by the cations in the considered host lattices, and (K, α) are adjustable parameters [1-3].

Here, we show that the same model can be used to reproduce the energy of the zero-phonon line of Cr^{3+} and Mn^{4+} ions (^2E_g state) within ≈ ± 350 cm^{-1} in fluorides and within ≈ ± 600 cm^{-1} in oxides [4,5]. It also reproduces the emission energy of Mn^{5+}-doped oxides with an accuracy of ≈ ± 300 cm^{-1} [6]. We will discuss these data and, if time allows, extend the discussion to the case of Mn^{4+}-doped oxyhalides [6].

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Nanoparticles of oxides doped with rare earth ions for theranostic applications

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Biocompatible ZnO nanoparticles (NPs) doped with rare earth metal ions act as fluorescence labels allowing early cancer detection [1]. Their fluorescence is observed upon host-related excitation, which we used to trace their distribution in the body. Studying their fluorescence we proved that NPs can penetrate practically all physiological barriers, including intestinal and blood-brain barrier. Their effective trafficking to the areas of cancer cells was observed. Importantly, ZnO NPs can also act as drug delivery systems transporting a given medicine to area of tumour.

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Optical probing of strain-tuned quasiparticle control in monolayer MoS_2 at 10 K

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Transition metal dichalcogenides (TMDs) are a class of atomically thin materials exhibiting a variety of emergent phenomena with promising impact in optoelectronics, electronics, and spintronics. At the monolayer level, TMDs exhibit a direct-bandgap and strongly tunable optical properties, enabling their excitonic landscape to be tailored through different physical and chemical approaches.

In this work, we explore the optical response of monolayer MoS_2 transferred onto linear chains of silver nanoparticles (Ag NPs), which are self-organized on a periodically poled $LiNbO_3$ ferroelectric substrate. These nanoparticle chains generate localized strain fields at the nanoscale, giving rise to controlled nano-wrinkles in the MoS_2 monolayer. Spatially resolved photoluminescence measurements reveal that the resulting strain gradients effectively modulate the band structure and induce exciton-to-trion conversion within regions of approximately 50 nm. At cryogenic temperatures, enhanced quasiparticle localization further boosts this effect, leading to an increase in trion emission exceeding 50% compared to unstrained areas (see Fig. 1) [1].

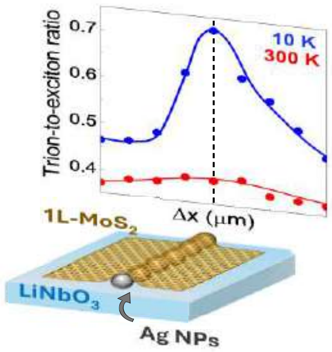

Fig. 1 Top: Spatial evolution of the trion-to-exciton ratio in monolayer MoS2 (1L- MoS2) at 10 K in the vicinity of the Ag NP chain. Bottom: Scheme of the 1L-MoS2/Ag NP chain/LiNbO3 sample.

Overall, these results demonstrate that long nanometer-scale Ag nanoparticle chains provide a versatile platform for one-dimensional strain-induced quasiparticle confinement, opening opportunities for trion-based circuits and next-generation quantum technologies.

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Polarization-resolved Raman spectroscopy on optically anisotropic materials

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Raman spectroscopy provides a powerful, non-destructive way to probe lattice vibrations, crystal symmetry, and electron–phonon interactions. For years, optically anisotropic materials have been gaining importance in solid-state physics research. Typically, measurements are carried out only in two different configurations in backscattering geometry, namely cross- and parallel polarization of the excitation and scattered light. However, for optically anisotropic samples, these two configurations are not sufficient in order to extract the properties of the Raman tensor, and extensive polarization-resolved Raman measurements are required for a precise characterization, particularly of the Raman tensor [1,2,3]. This is caused by the fact that in optically anisotropic samples, the polarization of arbitrary polarized light beams change during its propagation within the sample. Thus, the polarization of the scattered and incident light depends on the penetration depth where the scattering event takes place. This leads to an effective Raman tensor with complex-valued elements [1,3].

Here, we present a new approach for the determination of the Raman tensor elements, especially for optically anisotropic materials. This is done by determining the change of a linearly polarized incident beam after scattering within the sample. In doing so, the complex phase of the effective Raman tensor elements can be precisely determined, as well as symmetries of the corresponding Raman modes and the orientation of the crystallographic axes. The approach is exemplarily demonstrated on an a-plane sapphire substrate. In the case of the A_{1g} mode, we obtained a ratio of the Raman tensor elements a and b of 1.74, which agrees well with those reported in the literature [4]. For the phase factor between the elements of the effective Raman tensor, we determined a value of 0.51π, in agreement with theoretical expectations [1,3].

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Non-radiative energy transfer in lanthanide materials

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

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Simulating photophysical properties of real-size nanoparticles containing lanthanide ions

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The understanding of the photophysical interactions underlying the luminescence phenomena for lanthanide-based materials is a tough task due to the complex energy transfer pathways and the challenge of determining lanthanide ion (Ln^{3+}) distribution within real-sized nanoparticles. In this lecture, the audience will be in contact with these issues and new methods for a computational framework development to simulate the doping process and map extensive interactions throughout complete real-size nanoparticle structures. By utilizing crystallographic data and custom computational codes for calculations of radiative and non-radiative rates, we can design accurate structural models of various geometries, including core-shell systems, to extract Ln^{3+}-Ln^{3+} distance distributions and its interactions. Furthermore, the dynamics of populations of 4f-levels are estimated and it enables the calculations of relative intensities and emission quantum yields. This new modeling protocol incorporates theories to calculate radiative and non-radiative rates, such as energy transfer and multiphonon relaxation [1,2]. These tools could provide reliable predictions to optimize the performance of Ln^{3+}-doped materials for applications in bioimaging, sensing, and photonics.

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A direct observation of ultrafast energy transfer, charge trapping and thermal quenching in luminescent materials

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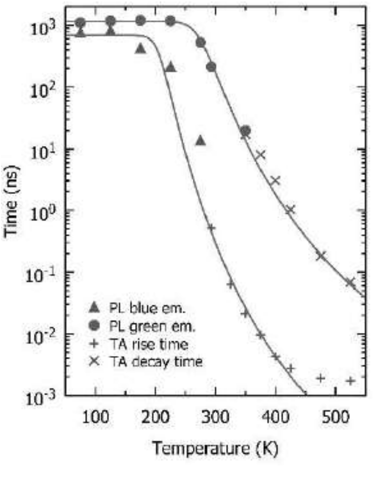
Persistent phosphors, materials that glow for hours after excitation has ended, are often seen as a typical example of slow-emitting materials. Yet, their performance hinges on ultrafast processes like energy and charge transfer.[1] Here we will present new insights into the excited-state dynamics of the benchmark persistent phosphor $SrAl_2O_4$:Eu,Dy (SAO:Eu,Dy).[2] Using a novel combination of transient absorption and time-resolved luminescence spectroscopy, we've captured the full dynamic range of these processes, spanning from picosecond to microsecond timescales.

Our findings reveal that nonradiative energy transfer between distinct Eu^{2+} centers occurs within nanoseconds, accelerating with increasing temperature to reach a remarkable 5-picosecond limit at high temperatures. Charge transfer from Eu^{2+} to trapping defects is ten times faster than radiative decay, while reverse transfer - triggered by optical stimulation - happens in just 2–3 picoseconds. This work demonstrates that pump–probe techniques can resolve the ultrafast events governing seemingly slow phosphors, bridging the gap between fast and slow timescales.



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NIR-emitting nanoparticles provide implants new functionalities

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Cardiovascular stents have revolutionized the treatment of coronary artery disease, yet once implanted they remain passive devices that provide no direct information about the biochemical state of the surrounding arterial tissue. As a consequence, the monitoring of plaque progression or implant performance still relies on indirect and often invasive imaging techniques. Developing implants capable of reporting molecular information from within the artery therefore represents an important unmet clinical challenge.

In this talk, I will present our recent efforts toward the development of light-enabled cardiovascular implants based on clinically used stents functionalized with near-infrared (NIR-II) emitting Ag_2S nanoparticles. These luminescent nanostructures transform conventional stents into active optical devices capable of generating infrared signals that can be detected through biological tissue. I will discuss the design of the nanomaterials, their integration onto clinical-grade stents, and the optical principles that allow the implanted device to act as a nanoscale light source within the artery. I will also introduce a recently developed sensing strategy based on tissue-induced spectral distortions, in which wavelength-dependent changes in the broadband emission of the nanoparticles provide information about the biochemical composition of the surrounding arterial environment. Finally, I will illustrate how this approach may enable fluorescence-based visualization of stent implantation and discuss its potential for future non-invasive monitoring of lipid-rich atherosclerotic plaques and implant status.

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Design principles of phosphors for visible-to-UVC upconversion

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Ultraviolet C (UVC) radiation plays a crucial role in medicine and industry, with applications ranging from sterilization to semiconductor manufacturing, and UV-curing technologies. Currently, UVC radiation is generated using mercury lamps for disinfection purposes and excimer lasers for technological processes. But these systems are bulky, which drives the search for compact and efficient UVC sources.

Light-emitting diodes (LEDs) are promising candidates, yet their efficiency and operational lifetime decrease significantly at wavelengths shorter than 260 nm. An alternative approach is to combine highly efficient blue LEDs with phosphor materials capable of converting visible light into UVC radiation [1]. Such a strategy could be particularly attractive if the efficiency of upconversion processes can be substantially improved.

For last four years, we have been investigating phosphor materials capable of converting visible light into UVC. Hence, in this lecture, I will present the design principles that guided the identification of efficient phosphors for blue-to-UVC conversion. These include the selection of suitable activator ions, tuning of host lattice effects on the relative positions of 5d and 4f electronic states, and control of phonon energies to minimize nonradiative losses [2]. I will also discuss the most promising host materials for solar excitation and briefly outline the historical development of this research field.

This work was supported by the National Science Centre under the OPUS 21 project, grant no. UMO-2021/ 41/B/ST5/03792, which is gratefully acknowledged.

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ORAL PRESENTATIONS

Pressure-Modulated Luminescence and Phase Transitions in Functional Materials

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The continuous advancement of luminescent materials underpins innovation across fields such as photonics, optoelectronics, bioimaging, and sensing. In particular, lanthanide ions (e.g., Nd^{3+}, Eu^{3+}, Ho^{3+}) exhibit well-defined emission features, including hypersensitive transitions, which are highly responsive to variations in local symmetry and crystal field strength. This sensitivity makes them effective probes for tracking subtle structural modifications within a material's lattice [1].

The objective of this work is to establish a novel approach for identifying phase transformations based on intrinsic optical responses, eliminating the need for direct contact or invasive techniques. The method relies on luminescence signals from lanthanide dopants or changes in optical characteristics of the host matrix as indicators of structural transformation.

Experimental studies are performed under high-pressure conditions using a Diamond Anvil Cell (DAC), enabling access to pressure up to ~100 GPa. Owing to the optical transparency of diamond across a broad spectral range, in situ spectroscopic techniques, such as absorption, photoluminescence, excitation, and Raman measurements can be applied to monitor pressure-induced changes in real time [2,3]. Mechanical compression alters key structural parameters, including interatomic distances and lattice geometry, which may ultimately trigger phase transitions. Both reversible and irreversible transformations can occur, offering distinct functional opportunities. Reversible changes may be exploited for pressure sensing applications (e.g., optical manometry), whereas irreversible transitions can yield new material phases with enhanced luminescent efficiency or improved performance characteristics.

In addition, high-pressure synthesis routes based on hydraulic pressing (up to ~30 GPa) allow for the production of bulk materials stabilized under extreme conditions. Such approaches expand the accessible materials space and support the development of advanced luminescent systems with potential utility in photonics, next-generation optoelectronic technologies, and sensing platforms.

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Simultaneous Temperature and Pressure Detection Based on Mn^{2+} Luminescence

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Temperature and pressure sensing based on luminescence offers several key advantages over conventional approaches, including remote readout, high spatial resolution, fast response, and the possibility of real-time remote monitoring under extreme or confined conditions.[1] These features make luminescent probes particularly attractive for applications where traditional sensors fail, such as high-pressure environments, microelectronics, or chemically aggressive media. Simultaneous monitoring of temperature and pressure is of particular importance, as these two parameters are inherently coupled - pressure often increases with temperature, leading to cross-sensitivity effects that can significantly distort measurement accuracy. As a result, the development of optical sensors capable of decoupling these two variables remains a critical challenge in the field of luminescent sensing.

In this work, we demonstrate that phosphor doped Mn^{2+} enable independent and reliable readout of both temperature and pressure, by exploiting optimized spectroscopic responses of the activator ions, based on luminescence intensity ratio (LIR). These approach allows for selective sensitivity to each parameter, thereby minimizing cross-interference.

The proposed system exhibits high relative sensitivity for both temperature and pressure, along with excellent repeatability and stability. This work highlights the potential of transition metal-doped phosphors as robust tools for simultaneous, decoupled sensing of temperature and pressure, opening new opportunities for advanced diagnostics in complex environments.

This work was supported by the Foundation for Polish Science under First Team FENG.02.02-IP.05-0018/23 project with funds from the 2nd Priority of the Program European Funds for Modern Economy 2021-2027 (FENG).

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The nature of the high-temperature thermally stimulated luminescence spectra of KCl:Li, NaCl:Li, KCl:Na and RbCl:Na single crystals

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High-temperature integral peaks of thermally stimulated luminescence (HTSL) are widely used as probes in the dosimetric monitoring of ionizing radiation. In classical dosimeters systems, the principal dosimetric features correspond to HTSL peaks at 473 K (TLD-100) and 490 K (TLD-700H).

However, the mechanisms responsible for the efficient formation of radiation defects, have not yet been systematically investigated in dosimeters based on alkali halide crystals, as well as contribution of cationic impurities on radiation defect formation and, finally, HTSL spectra have not been fully incorporated into interpretations of the recombination nature of luminescence.

In this work, systematic studies [1–3] were conducted on KCl:Li, NaCl:Li, KCl:Na, and RbCl:Na crystals. The investigation included measurements of integral HTSL, HTSL spectra, X-ray luminescence (XRL), tunneling luminescence (TL), TL decay kinetics, and optical absorption associated with radiation defect concentrations, with the aim of identifying a common mechanism responsible for enhanced light yield of dosimetric peaks.

Pronounced HTSL dosimetric peaks were observed with maxima at 530 K for NaCl:Li, 505 K for KCl:Li, 570 K for KCl:Na, and 550 K for RbCl:Na. Their spectral composition exhibit maxima at 3.4 eV (NaCl:Li), 2.8 eV and 3.1 eV (KCl:Li, KCl:Na), and 3.48 eV (RbCl:Na).

It is established that the enhanced formation of radiation defects proceeds via an associative mechanism involving mobile halogen atoms interacting within the field of light cations (Li^+, Na^+). Upon their thermal dissociation, Li^+ (Na^+) ions facilitate recombination of free electrons with non-relaxed holes, leading to the formation of exciton-like luminescence centers. Thus, the integral HTSL in these materials is governed by exciton-like luminescence in the field of light cations.

Additional confirmation of these assumptions was obtained from the results of an investigation of the luminescence of Li^+(Na^+) centers in comparison with other compounds doped with isoelectronic impurities, such as CsI:Na [4] and Sc^{3+} doped (Y, Lu)AG garnets [5].

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Radiation-induced modifications of luminescent properties of YAG:Ce, LuAG:Ce and TbAG:Ce single-crystalline films under 24.5 MeV ^{14}N Ion Irradiation

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Single-crystalline films (SCFs) of Ce^{3+}-doped $Y_3Al_5O_{12}$ (YAG:Ce), $Lu_3Al_5O_{12}$ (LuAG:Ce), and $Tb_3Al_5O_{12}$ (TbAG:Ce) garnets, are promising scintillator screens for microtomography due to their high X-ray absorption efficiency, high light yield (LY), and low phosphorescence [1,2]. However, their radiation resistance remains insufficiently understood. In bulk garnets, radiation tolerance is strongly affected by structural defects, particularly antisite defects (ADs) and oxygen vacancies formed during high-temperature growth. In contrast, SCFs grown by liquid-phase epitaxy at lower temperatures exhibit near-stoichiometric composition and significantly reduced intrinsic defect concentrations, making them suitable for studying intrinsic radiation effects [3, 4].

This work investigates absorption and luminescent properties of YAG:Ce, LuAG:Ce, and TbAG:Ce SCFs irradiated with 24.5 MeV ^{14}N ions at fluences of 10^{11}–10^{14} ions/cm^2 using the DC-60 accelerator (Astana). The irradiated samples were compared with as-grown films. Measurements included absorption, photoluminescence (PL), scintillation LY, and decay kinetics at room temperature, as well as synchrotron radiation (SR) studies (3.7–12.5 eV) at 300 K and 8 K (Superlumi station, PETRA III, DESY).

At fluences of 10^{11}–10^{13} ions/cm^2, measurable changes in luminescence and Ce^{3+} emission intensity occur mainly in LuAG:Ce and TbAG:Ce, while YAG:Ce exhibits higher radiation tolerance. In LuAG:Ce and TbAG:Ce, radiation-induced defects are attributed primarily to interstitial–vacancy pairs rather than antisite defects. This is supported by unchanged band-gap energies, stable excitonic luminescence and positions excitation band corresponding to excitons bound with Ce (BSE(Ce), preserved Ce^{3+} local environments (ESR), and absence of antisite-related UV emission bands.

The strongest effects are observed in TbAG:Ce, where shifts of the Ce^{3+} emission band and BSE(Ce) peaks indicate increased crystal-field strength and reduced local symmetry. These changes are attributed to irradiation-induced lattice strain, likely associated with oxygen-related interstitial defects. Thus, nitrogen irradiation predominantly induces local lattice distortions rather than cation disorder, with TbAG:Ce being most sensitive.

At the highest fluence (10^{14} ions/cm^2), all SCFs exhibit significant optical degradation, including reduced scintillation LY, enhanced excitation above the band gap, and altered PL and scintillation decay kinetics. These changes indicate the formation of competing radiative and nonradiative recombination channels involving the host lattice, Ce^{3+} ions, and defect-related centers.

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Understanding the Temperature-Dependent Luminescence of $LiLuF_4:Pr^{3+}$ for Emerging Applications

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Among the diverse classes of Pr^{3+} doped optical materials, fluoride crystals remain at the forefront of interest due to their high ionicity and exceptionally wide band gaps. $LiLuF_4$, in particular, serves as an ideal host matrix owing to its low phonon cutoff energy and proven stability for high-temperature applications [1].

In this work, we report on the hydrothermally synthesized of tetragonal $LiLuF_4:Pr^{3+}$. We characterize its morphology and present detailed luminescence spectra recorded over the extensive temperature range of 5–1100 K. Under excitation at 444.1 nm ($^3H_4 \rightarrow {}^3P_2$ transition), the obtained material exhibits intense visible emissions originating from the $^3P_J \rightarrow {}^3H_J$ and $^1D_2 \rightarrow {}^3H_J$ manifolds.

Our discussion focuses on the thermally induced evolution of photoluminescence, specifically on the redistribution of Stark level populations within the $^1D_2$ state. Furthermore, we analyze spectral variations at elevated temperatures, driven by shifts in the Boltzmann distribution between Pr^{3+} electronic levels. Finally, we evaluate the $LiLuF_4:Pr$ material as a candidate for emerging applications.

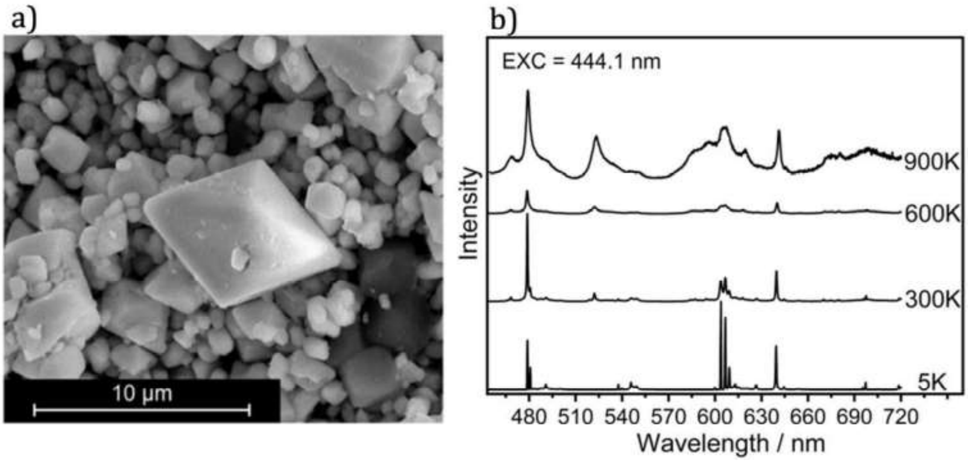

Fig. 1. Typical SEM image (a) and emission spectra collected under 444.1 nm excitation at selected temperatures (b) for $LiLuF_4:0.5Pr^{3+}$.

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From Anti-Counterfeiting to Forest Monitoring: Application-Driven Development of Cr^{3+}-Activated NIR Persistent Phosphors

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Cr^{3+}-activated materials are some of the most versatile platforms for near-infrared (NIR) persistent luminescence (PersL), combining favorable emission characteristics with a rich landscape of defect-related energy storage. In our previous studies on Cr^{3+}-doped germanate and gallogermanate hosts, we demonstrated efficient broadband NIR emission, complex trapping behavior, and long-lasting afterglow governed by a quasi-continuous distribution of trap states [1], [2]. These properties enable advanced functions such as multi-level anti-counterfeiting and time-dependent information encryption. However, expanding the application of Cr^{3+}-activated PersL materials to large-area environmental monitoring requires fundamentally different conditions. Specifically, forest monitoring calls for eco-friendly, low-cost materials that can be activated by sunlight and produce minimal optical pollution, favoring NIR-only or spectrally suppressed visible emission. A critical review of the current state reveals that many established Cr^{3+}-based systems rely on suboptimal excitation conditions or exhibit residual visible emission, thereby limiting their usefulness in low-visibility settings. To overcome these issues, we have started developing Cr^{3+}-activated perovskite-type materials as environmentally safe platforms for NIR PersL. Early experimental results show NIR emission and thermally stimulated luminescence (TSL), confirming the feasibility of the chosen material system. Although phase purity and emission intensity are not yet optimized, these results give valuable insight into the underlying trapping and recombination processes and guide further material improvements. Overall, this work signifies a shift from well-controlled model systems to application-driven design of eco-friendly, NIR-persistent phosphors for remote forest monitoring.

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Electric field gradients in embedded cluster calculations

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Electric field gradients (EFGs) at atomic nuclei provide a sensitive probe of the local electronic structure and symmetry of solids. In this contribution, we present a methodology for the calculation of EFGs in solids using embedded-cluster method. In particular, we demonstrate its application to ^{229}Th-doped calcium fluoride (CaF_2:Th) [1,2]. As EFGs determine the quadrupole splitting of the low-energy nuclear states of ^{229}Th, they are a key parameter in the development of solid-state nuclear clocks. We discuss the results in the context of recent Mössbauer spectroscopy experiments that demonstrated the existence of several distinct thorium sites in CaF_2 [3,4].

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Explainable Artificial Intelligence in physical chemistry. SHAP model explaining a neural network detecting functional groups from FTIR spectra

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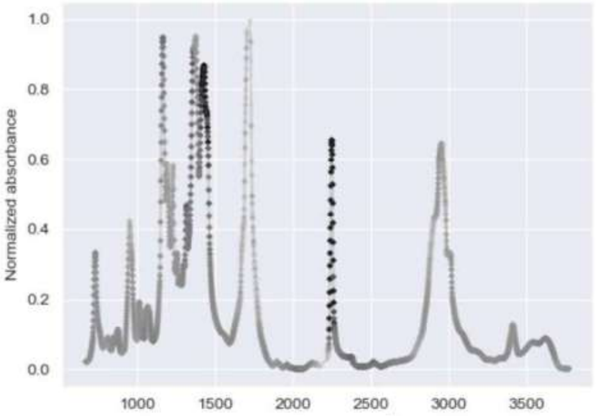
In paper [1], a deep learning model for predicting the presence of selected functional groups based on FTIR spectra is described. In the model, each group is predicted by an independent binary classifier using a convolutional neural network with Kolmogorov–Arnold layers (CNN-KAN model). A drawback of deep models is that they operate as a “black boxes,” making it unclear on what premises a specific decision is made. The ability to understand these premises is important, as it may increase user confidence in the correct operation of the deep model. Therefore, using explainable AI techniques, we developed an interpretable model utilizing Shapley values to explain the decisions of deep classifiers [2].



The result of an explainable model on a spectrum of molecule containing the group of nitriles. Dark points indicate areas of the spectrum that, according to an explainable model, are especially important for the decision process.

The figure below presents the result of the explainable model for a spectrum of molecule containing the nitrile group. Regions of the spectrum that contribute to the CNN-KAN model’s positive decision are marked by darker points. The strong peak, highlighted with dark points in the 2200–2280 cm^{-1} region (associated with C≡N bonding), was correctly interpreted as evidence that the spectrum originates from a molecule containing a nitrile group.

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UVC upconversion emission of $Ca_9Y_xLu_{1-x}(PO_4)_7$ polycrystals doped with Pr^{3+} ions

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In recent years, there has been growing interest in disinfection methods, especially those that effectively and naturally eliminate microorganisms that threaten humans. Using radiation within a specific UVC range is a good approach because it can eliminate bacteria and viruses from surfaces that people come into contact with. One idea for combating microorganisms in the human environment is the use of luminescent materials that would produce UVC radiation (range 100-280 nm) when excited by visible light, including sunlight, thus eliminating the need for specialized equipment in disinfection areas. Praseodymium is a rare earth element that, due to its electronic structure, is well suited for achieving upconversion from the UVC range when excited by visible light [1, 2]. In this work, we present the results of research on $Ca_9Y_xLu_{1-x}(PO_4)_7$ polycrystals doped with Pr^{3+} ions. The absorption, excitation, luminescence, and emission decay profiles of praseodymium(III) ions were measured and discussed. The investigated compounds possess characteristics that confirm their potential in luminescent and disinfection applications.

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In situ electron beam dose measurements in FLASH Radiotherapy using fiber-optic scintillation sensors based on Al_2O_3:Ce and GAGG:Ce Crystals

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FLASH radiotherapy (FLASH-RT) is an emerging radiation treatment modality designed to reduce damage to healthy tissues while maintaining effective tumor control. This technique employs ultra-high dose rates (UHDRs) exceeding 40 Gy/s, which are several orders of magnitude higher than those used in conventional radiotherapy. From a radiation dosimetry perspective, accurate real-time monitoring of such ultra-high-dose-rate radiation beams remains a significant challenge.

Conventional ionization chambers (ICs), which are widely used as reference detectors in radiotherapy dosimetry, exhibit a dose-per-pulse (DPP) dependence caused by ion recombination effects. As a result, measurements obtained with ICs require correction procedures when the DPP exceeds approximately 0.01 Gy per pulse [1]. Radiochromic films may also be employed for FLASH-RT dosimetry; however, these detectors are inherently unsuitable for real-time dose measurements due to the need for post-irradiation analysis [2].

In this study, we developed a fiber-optic dosimeter consisting of an optical fiber coupled to a scintillation crystal positioned at its distal end. Two scintillation materials, Al_2O_3:Ce and GAGG:Ce, were investigated as sensing elements for dose measurements of electron beams used in FLASH radiotherapy. To evaluate the linearity of the detector response, absorbed doses ranging from 1.5 Gy to 30 Gy were delivered and measured.

The experimental results demonstrated a highly linear response of the developed sensor over the investigated dose range. Furthermore, the study confirmed that ultra-high-dose electron beams employed in FLASH radiotherapy can be measured accurately and in real time using the proposed fiber-optic scintillation detector. These findings highlight the potential of the developed dosimetric system as a promising tool for online monitoring and quality assurance in FLASH radiotherapy applications.

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Spectrally tunable Ce^{3+}, Sm^{3+} doped phosphates for adaptive plant growth LEDs illumination

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Modern agriculture faces increasing challenges caused by multiple factors such as climate changes, limited arable land and restricted freshwater resources [1, 2]. To address this factors, alternative farming strategies e. g. indoor or greenhouse planting are becoming essential. As these environments rely on fully controlled growth conditions, precise control of illumination is required to provide optimized condition for plant's growth, blooming and fruiting [2]. Since photosynthesis is a fundamental physiological process for plant organism providing essential biochemical energy, the emitted light must match the photosynthetic action spectrum, which represents the combined effective absorption of all photosynthetic plant pigments participating in that process. In particular, blue light (430-470 nm) and red light (640-670 nm) are important, as they matches the absorption band of chlorophylls [1].

In this study, the $Ca_2Sr(PO_4)_2$ phosphor co-doped with Ce^{3+} and Sm^{3+} is proposed as a candidate material to meet these agricultural lighting requirements. The structural and spectroscopic properties analysis were performed including XRD analysis, emission, excitation and luminescence decay time. The excitation spectrum of the co-doped phosphor exhibits a broad band centered at around 320 nm, corresponding to 4f → 5d transition of Ce^{3+}, and narrow excitation lines with the most intense at around 403 nm, attributed to the $^6H_{5/2} \rightarrow {}^6P_{3/2}$ transition of Sm^{3+} ions. The material demonstrates excitation-dependent emission behavior. Under 266 nm excitation, the emission spectrum is dominated by a broad Ce^{3+} band with a maximum around 380 nm, accompanied by four weaker Sm^{3+} characteristic bands at around 562 nm, 646 nm, 708 nm, and 790 nm, corresponding to the transitions from $^4G_{5/2}$ excited level to ^6H_J levels respectively ($J = 5/2, 7/2, 9/2, 11/2, 13/2$). In contrast, under 360 nm excitation emission is characterized by inverted blue-to-red intensity ratio. The Ce^{3+} broad band is weaker with maximum at around 410 nm, while Sm^{3+} emission become dominant and possess fine structure, as a result of Sm^{3+} multiple occupation sites in the crystal structure. Finally, the potential applicability of the Ce^{3+}, Sm^{3+} co-doped phosphor in agricultural lighting systems is evaluated.

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Role of luminescence in revealing sintering process of Cr^{4+}:YAG transparent ceramics

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Since the first successful synthesis of transparent Nd:YAG ceramics described by Ikesue and co-workers in 1995, the development of transparent ceramic technology has significantly expanded the range of applications of lasers operating in both continuous-wave and pulsed modes. The most widely used active medium in solid-state lasers remains Nd:YAG, which accounts for more than half of the laser crystal market. A significant portion of this market consists of passively Q-switched lasers capable of operating in the so-called giant pulse generation mode.

A key component of these lasers is a phototropic material. Cr^{4+}:YAG is currently the best material for passive Q-switching and is effectively replacing other alternatives, except for LiF crystals, which are expensive and have a short lifetime. Despite the importance of Cr^{4+}:YAG ceramics, the number of available scientific publications on this topic remains limited, primarily due to challenges associated with the fabrication technology of transparent Cr^{4+}:YAG ceramics.

One of the key elements in the technology of transparent YAG ceramics is the use of the sintering additive TEOS. Sintering transparent YAG ceramics without its use represents one of the most promising directions for further development of this technology. To date, only a few papers have reported on the sintering of transparent Nd:YAG ceramics without the use of TEOS. Obtaining high-quality transparent Cr^{4+}:YAG ceramics requires the elimination of sintering additives such as TEOS, which itself constitutes a significant technological challenge. An additional difficulty is the need to introduce Ca^{2+} and/or Mg^{2+} ions to compensate for charge in the Cr^{4+}:YAG structure.

The synthesis of Cr^{4+}:YAG ceramics is associated with numerous challenges, and a full understanding of the sintering mechanisms requires the use of a wide range of research techniques. This presentation focuses on the role of luminescence in improving the sintering process of Cr^{4+}:YAG ceramics and demonstrates how the analysis of dopant ion emission can provide insight into sintering mechanisms and contribute to improving the quality of laser materials, while also discussing the luminescent properties of Cr^{4+} ions in the YAG structure.

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Synthesis and blue-to-ultraviolet upconversion properties of new langbeinite-type phosphates

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Ultraviolet C (UVC) radiation has attracted significant attention due to its strong ability to damage DNA, leading to cell death, bacteriostatic effects, and viral inactivation [1]. These properties make it highly effective for sterilization and disinfection applications. In recent years, UVC LEDs have increasingly been used as radiation sources because of their long operational lifetime, low energy consumption, and compact size. However, their efficiency remains limited, which drives the search for alternative mechanisms for UVC generation. One promising approach is photon upconversion, a process in which the sequential absorption of two or more low-energy photons results in the emission of higher-energy radiation with a shorter wavelength, such as ultraviolet light [2]. For instance, Pr^{3+}-doped materials can emit UVC radiation under blue-light excitation via intermediate states such as ^3P_J or $^1D_2$. Although a wide variety of praseodymium-activated host matrices exhibiting upconversion have been reported, they have not yet achieved broad practical application. Therefore, current research efforts are primarily focused on improving existing materials and discovering new compounds.

This work is devoted to the synthesis of new langbeinite-type phosphates and the investigation of their luminescent and upconversion properties. The potential of these materials for practical applications will also be discussed.

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From Average Structure to Local Symmetry: Understanding Cr^{3+} Luminescence in Perovskite Oxides

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Understanding the luminescence behavior of Cr^{3+} in solid-state hosts requires going beyond conventional descriptions based on average crystal structures. In many oxide phosphors, optical properties are typically interpreted in terms of global symmetry and averaged crystal field strength, which may overlook the complexity of local environments experienced by activator ions.

In this work, $Sr_{1-n}Ba_nHfO_3$:Cr^{3+} is employed as a model system to investigate how local coordination influences near-infrared (NIR) emission. With increasing Ba content, synchrotron X-ray diffraction reveals a gradual evolution of the average structure toward higher symmetry. Such behavior would suggest a continuous modification of the crystal field environment.

However, X-ray absorption spectroscopy combined with theoretical simulations uncovers a heterogeneous distribution of local Cr^{3+} environments, indicating varying degrees of octahedral distortion. This discrepancy between average symmetry and local coordination plays a decisive role in determining luminescence properties. In particular, excitation characteristics, R-line evolution, and thermal population between the $^4T_2$ and ^2E states are found to correlate strongly with local symmetry rather than the average structure.

These findings demonstrate that local structural distortion governs the excited-state dynamics of Cr^{3+}, highlighting the limitations of average crystal field models. Ongoing work extends this concept to a broader range of perovskite systems, aiming to establish general principles for tuning Cr^{3+}-based NIR emission through local symmetry control.

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Stability Enhancement and Optoelectronic Tailoring of Lead-Free $CsSnX_3$ and Cs_2SnX_6 Halides through Anion-Anion Exchange

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The perovskite $CsSnX_3$ and defect-perovskite Cs_2SnX_6 (X = I, Br, Cl) systems are prominent lead-free candidates for next-generation optoelectronic applications, yet they are limited by distinct fundamental factors. While the substitution of toxic lead with tin facilitates industrial viability, $CsSnX_3$ halides exhibit poor chemical stability due to the spontaneous oxidation of tin from the Sn^{2+} state to the more stable Sn^{4+} state. Cs_2SnX_6 compounds demonstrate superior moisture resistance as tin is already present in the Sn^{4+} oxidation state, they lack the extensive three-dimensional electronic connectivity characteristic of the $CsSnX_3$ perovskite framework.

This study addresses these challenges through compositional engineering via the formation of mixed $Cs_2SnX_{6-x}Y_x$ and $CsSnX_{3-x}Y_x$ solid solutions. First-principles DFT calculations indicate that replacing iodine with more electronegative bromine or chlorine significantly enhances thermodynamic stability. Specifically, the formation energy of Cs_2SnX_6 increases from 33.44 eV (for X = I) to 55.11 eV (for X = Cl). Analysis of the mechanical properties shows that $CsSnX_3$ possess higher structural rigidity, with $CsSnCl_3$ reaching a maximum bulk modulus of 20.6 GPa. Furthermore, the E_g band remains highly tunable. The primary mechanism underlying these improvements involves the modification of the electronic density of states (DOS) and the halide-induced "size effect." The substitution of large I atoms with smaller Br or Cl anions triggers unit-cell contraction and a corresponding reduction in Sn–X and Cs–X bond lengths. DOS analysis reveals that increasing halide electronegativity shifts the hybridized X p-states toward lower energy levels, thereby widening the band gap and increasing the covalent character of the chemical bonding. These electronic shifts directly correlate with the observed gains in thermodynamic and structural integrity. To limit phase separation in mixed-halide systems, a synthesis approach utilizing hydriodic acid (HI) is proposed to facilitate the stable incorporation of iodide into Cs_2SnCl_6 matrices. These optimized materials are highly suitable for high-efficiency solar cells, light-emitting diodes (LEDs), photodetectors, and hole-transporting layers in dye-sensitized photovoltaics.

O16 B. V. Padlyak

Spectroscopy of the Nd-doped and Ag-Nd co-doped lithium teraborate glasses

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Spectroscopic and luminescent properties of the Nd-doped and Nd-Ag co-doped borate glasses with $Li_2B_4O_7$ ($Li_2O{-}2B_2O_3$) basic composition are presented and analysed using experimental results of optical absorption, electron paramagnetic resonance (EPR), photoluminescence (excitation, emission, decay kinetics) and Judd-Ofelt theory. Technology, local structure, spectroscopic and luminescent properties of the $Li_2B_4O_7$:Nd and $Li_2B_4O_7$:Nd,Ag glasses containing 0.5 and 1.0 mol.% Nd_2O_3 and 2.0 mol.% $AgNO_3$ doping impurities firstly were presented in articles [1,2]. EPR and optical spectroscopy show that Nd impurity is incorporated into the $Li_2B_4O_7$:Nd and $Li_2B_4O_7$:Nd,Ag glasses network as Nd^{3+} ($4f^3$, $^4I_{9/2}$) ions, exclusively. Optical absorption, photoluminescence, and decay kinetics of Nd^{3+} centers were detailed studied. Experimental and theoretical oscillator strengths (f_{exp} and f_{theor}), phenomenological Judd-Ofelt intensity parameters (Ω_2, Ω_4, Ω_6), and important to laser applications parameters such as radiative transitions rates (W_{r}), probabilities of radiative transitions (A_{rad}), branching ratios (β), radiative lifetimes (τ_{rad}), emission cross-sections (σ_{em}), and quantum efficiency (η) of the Nd^{3+} luminescence centers in the $Li_2B_4O_7$:Nd [1] and $Li_2B_4O_7$:Nd,Ag [2] glasses have been calculated and analyzed. In the $Li_2B_4O_7$:Nd,Ag glass optical absorption band of surface plasmon resonance (SPR) related to silver nanoparticles was observed. Presence of the Ag^{2+} ($4d^9$, $^2D_{5/2}$) paramagnetic centers and small non-plasmonic Ag aggregates or nanoclusters in the $Li_2B_4O_7$:Nd,Ag glass was confirmed by EPR spectroscopy [2]. Enhancement of the Nd^{3+} emission intensity in 1.3 and 20 times was observed in the $Li_2B_4O_7$:Nd,Ag glass under excitation at 585 nm and 350 nm, respectively. The observed luminescence enhancement is assigned to energy transfer from Ag^+ isolated ions and Ag aggregates to the Nd^{3+} ions as well as local field effects induced by the SPR of Ag nanoparticles. The Ag co-doping is a promising approach for improving of luminescent and laser properties of the Nd^{3+} ions in borate glasses.

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Shape-dependent effects of ZnO nanoparticles on redox status, transcriptomic profile, and histopathology in chicken embryos

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In recent years, the use of nanomaterials has increased markedly. To date, nanoparticles (NPs) have been widely applied as food additives, components of food packaging, and ingredients in cosmetic products. Zinc oxide nanoparticles (ZnO NPs) are among the nanomaterials most frequently used in commercial products. Due to their hydrophilic nature and solubility in biological media, they have often been regarded as safe. Nevertheless, earlier studies have shown that these nanoparticles can penetrate biological barriers such as the blood–brain barrier and, importantly, the placental barrier, thereby potentially influencing embryonic development [1].

In the present study, the effects of ZnO NPs on embryonic development were evaluated. In a chicken embryo model, the effects of nanoparticle dose and shape (oval vs. long) on developmental processes were investigated. The nanoparticles were administered as suspensions into the fertilised egg to air chamber on the first day of incubation at concentrations of 10 and 100 μg/ml. Their possible influence on embryonic redox balance was assessed by determining superoxide dismutase activity, the level of lipid peroxidation, and carbonylated protein content. Additionally, transcriptomic analysis was performed using microarrays. To determine whether exposure to the tested nanoparticles influenced programmed cell death in developing embryos, immunohistochemical staining for Bax, Bcl-2, and the active form of caspase-3 (CPP32) was carried out. Histopathological analysis was also performed.

Both shapes of ZnO NPs induced alterations in the redox status; however, long ZnO NPs exerted a weaker and more delayed effect on the evaluated parameters. Exposure to both nanoparticle shapes also affected the expression of numerous genes during early embryonic development, with 1487 genes differentially expressed in response to oval NPs and 548 in response to long NPs. Unexpectedly, oval ZnO NPs decreased the pro-apoptotic potential in chicken embryos. By contrast, long ZnO NPs did not induce changes in the presence or localisation of Bax, Bcl-2, or CPP32. Histopathological examination showed no detectable effect of the analysed nanoparticles on embryonic tissue development, regardless of nanoparticle shape or dose.

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Y_2O_3 and ZrO_2 nanoparticles as modulators of embryo development, redox status, transcriptomic profile, and histopathology in chicken embryos

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Yttrium oxide (Y_2O_3) nanoparticles (NPs) have attracted increasing attention because of their favourable physicochemical properties, including high electrical conductivity, strong mechanical performance, a high melting point, and excellent chemical stability [1]. Despite their insolubility in water, Y_2O_3 NPs have been reported to exhibit antibacterial activity, which may be relevant for biological applications. Similarly, zirconium oxide (ZrO_2) nanoparticles are characterised by water insolubility, high hardness, mechanical strength, and chemical stability, making them useful in ceramic dental applications [2]. Nevertheless, the embryotoxic potential of both insoluble nanomaterials, Y_2O_3 and ZrO_2, has not yet been investigated.

The aim of this study is to evaluate the impact of Y_2O_3 and ZrO_2 nanoparticles on embryonic development. Using the chicken embryo as an experimental model, we investigated the influence of nanoparticle type and dose on embryo development. The nanoparticles were administered as suspensions into the fertilised egg on the first day of incubation at doses of 10 and 100 μg/mL. Their potential effects on the embryonic redox status were assessed by measuring superoxide dismutase activity, the level of lipid peroxidation, and the content of carbonylated proteins. To determine whether the tested nanoparticles affected programmed cell death in developing embryos, immunohistochemical staining was performed. Moreover, histopathological examination and transcriptomic profiling based on microarray analysis were conducted.

For both Y_2O_3 and ZrO_2 nanoparticles, a significant upward trend was observed for all examined oxidative stress markers over the course of the experiment, suggesting a cumulative effect of the nanoparticles used. Immunohistochemical analysis also revealed significant changes in the levels of proteins associated with pro-apoptotic potential following exposure to both Y_2O_3 and ZrO_2 nanoparticles.

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The breathing mode revisited: Ce^{3+} energy levels in calcium scandium germanium garnet calculated from scratch

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In this work, we have applied known ab initio calculations techniques such as cell-based DFT and multiconfigurational embedded cluster calculations, to describe a broad excitation band in the Ce-doped garnet $Ca_3Sc_2Ge_3O_{12}$. The RASSCF/CASPT2 calculations agree with the group theory assessment of Ce^{3+} 5d level splitting, and illustrate strong non-degeneracy in the ^2F_J Stark levels. The 3 lowest spin-free levels for the $^2F_{5/2}$ manifold, closely followed by 3 out of 4 levels of $^2F_{7/2}$ manifold: these lie no higher than 500 cm^{-1} from the ground state. The highest $^2F_{7/2}$ level is about 4000 cm^{-1} from the ground state. These 7 levels exhibit slightly different responses to the cluster deformations, resulting in variable energy differences between them.

From comparison between the modeled and the experimental band shapes, conclusions regarding underlying atomic motion can be made, regarding the roles of both CeO_8 cluster motion, and distortions in the geometries of the nearby GeO_4 units. In this context, we propose to extend the concept of breathing mode from coordination surround scaling to more complex yet very similar (and more chemical) deformations.

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O20 **A. Platonenko**

Excited states and Racah parameters of Ni^{2+} in $KMgF_3$ via hybrid density functional theory

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Developing affordable materials capable of serving as host matrices for transition-metal (TM) activator ions—particularly those with unfilled 3d electron shells—has been a major scientific and engineering challenge in recent decades. These materials are essential for creating phosphors that efficiently convert excitation energy into light emission. Optical properties of the TM-dopant in the host lattice depend on charges, bond lengths, covalency, coordination and others. While the absorption energies of d-d transitions can be estimated from these parameters from ground state calculations, here we obtain these energies and electronic structures of excited state by Δ-SCF (self-consistent field) approach in solid-state physics. This approach has been used previously to predict the d-d excitation energies in bulk and surface NiO [1] in good agreement with the experimental values.

In continuation of our work on d-ions in $KMgF_3$[2,3], here we demonstrate results of *ab initio* calculations of 45 microstates of Ni^{2+} in a periodic $KMgF_3$ supercell. These include single-, double-electron and spin-flip transitions ($z^2 \uparrow \rightarrow z^2 \downarrow$), all within a single computational framework. We analyze the effect of exact exchange and correlation functionals on excitation energies, calculate Racah parameters and pressure-energy curves for every unique electron configuration. Inclusion of high amount of Hartree-Fock exact exchange is important to properly describe the ionic system and improve predicted energies of d-d transitions, CRYSTAL23 code allows to do it at very low computational cost.

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Understanding Host-Activator Interactions for Luminescence Thermometry

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Over the last twenty years or so, luminescence thermometry has advanced significantly and has become an established methodology for determining temperature from luminescence spectra or decays. It continues to grow, and both the design of materials and the development of methods for analyzing experimental data contribute to this field of luminescence.

Many papers and reports on thermometric phosphors exploit the effect of the Boltzmann distribution. At low temperatures, emission arises from radiative relaxation from a lower-energy electronic level, whereas at higher temperatures the upper level is populated at the expense of the lower one, and both contribute to luminescence. As a result, two bands with temperature-dependent intensity ratios are recorded and may be used to sense temperature. This method is elegant, and the physics behind it is described with a simple mathematical equation:

$$\frac{p_i}{p_j} = \exp\left(-\frac{\Delta E}{k_\mathrm{B}T}\right),$$

where $\frac{p_i}{p_j}$ is the Boltzmann factor with p_i and p_j representing occupancy of the higher and lower levels, respectively. ΔE is the energy gap between the two levels “i” and “j”, k_B is the Boltzmann constant, and T stands for temperature in kelvins. This method has limitations, however. Among others, it works well only within a restricted temperature range. Hence, when genuinely wide-range, high-quality luminescence thermometry is needed, a more complex, multidimensional approach is required.

In this presentation, we will focus on the possibility and need to combine different spectroscopic effects to obtain a sensitive, robust, and operating over a wide temperature range thermometric phosphor.

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Breakthrough in Luminescence Thermometry-Supersensitive Emission Line Shift of Whispering Gallery Modes in Rhodamine B-Doped Cellulose Fiber Microresonators

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The development of optically responsive materials for remote sensing is essential for modern photonic technologies. Here, cellulose microfibers doped with Rhodamine B were fabricated via N-methylmorpholine N-oxide spinning and investigated for optical thermometry. Spectroscopic analysis confirmed successful dye incorporation and strong emission behavior, consistent with previous reports on dye-doped polymer systems. The cylindrical geometry of the fibers supports the phenomenon known as whispering gallery modes (WGMs) [1], which, observed using a confocal setup with 532 nm excitation, leads to sharp, structured emission spectra in agreement with established WGM microresonator studies [2]. These WGMs exhibit exceptional sensitivity to temperature due to the negative thermo-optical coefficient of the cavity, producing an unprecedented blue shift of ~0.47 nm K^{-1}, highest value reported for such kinds of optical thermometers based on the WGMs. The system achieves a high temperature resolution of ~0.17 K, demonstrating its potential as a highly sensitive optical thermometer.

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Luminescence and local environment of *f*-elements under pressure

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The luminescence of lanthanide *f*-elements at high pressures is determined by the compression of their bonds and changes in the symmetry of their local environment in the host matrix, which alter the intensity, energy, and lifetime of the emission [1-3]. In addition, a reduction in the volume of the host matrix can lead to phase transitions and, ultimately, to the amorphization of the network. The modification of the local environment occupied by optically active ions, caused by pressure and resulting from the reduction in interatomic distances, in turn increases the crystal-field interaction between the *f*-element and its ligands, as well as the covalent nature of their bonds, due to the increasing overlap of their orbitals. Consequently, the optical response manifests itself primarily in two main ways [1-3]: (i) an energy shift in the absorption and emission lines due to changes in the energy level scheme of the f-element; and (ii) a variation in emission intensity due to competition between radiative and non-radiative (multiphonon plus energy transfer) processes.

The europium (Eu^{3+}) and neodymium (Nd^{3+}) ions are convenient pressure probes because some of their electronic transitions are extremely sensitive to the symmetry of their immediate environment. In this work various examples of the intimate relationship between the local environment and the luminescence of the lanthanide ions is described analyzing in detail the crystal-field interaction in (i) an Eu^{3+}-doped fluorozirconate amorphous glass, (ii) the pressure-induced phase transition in Nd^{3+}-doped $LaVO_4$ crystal, and (iii) the blue and red shifts of the emission lines in Nd^{3+}-doped $YAlO_3$ crystal; and (iv) the energy shift of the emission lines of Nd^{3+} in some garnet crystals, which can be used as pressure gauges.

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O24 **R. Jankowski**

Ru(II)-based supramolecular frameworks as potential platforms for non-linear optical thermometry

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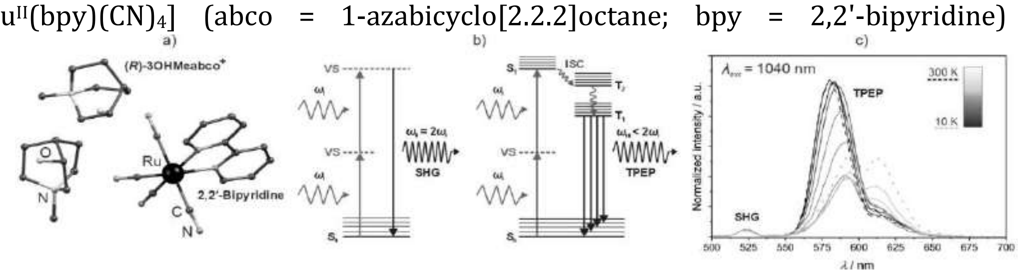
Sensors play a vital role in contemporary technology by converting physical quantities such as temperature, pressure or light into digital signals suitable for computational analysis and interpretation. For example, photoluminescence-based techniques constitute an important class of such sensing methods [1], positioning luminescent thermometry as an effective non-contact approach for temperature determination [2]. Moreover, progress in the study of non-centrosymmetric materials enabled the integration of nonlinear optical phenomena (NLO) into the field of optical temperature sensing [3]. Taking the above into consideration, selected Ru(II) complexes (Figure a) were chosen as starting molecular building blocks due to their well-documented temperature sensitivity and intense MLCT emission, alongside the potential for observing the two-photon absorption (TPA) effect (Figure b) [4]. Their additional functionalization and the inducement of crystallization in noncentrosymmetric space groups, crucial for observing the second-harmonic generation (SHG) effect, can potentially enable simultaneous observation of two optical signals under a selected excitation source, each exhibiting distinct temperature sensitivity (Figure c). Herein, we present the above-mentioned approach on the example of a single-phase crystalline material, namely ((R)-3OHMeabco)$_2$[Ru^{II}(bpy)(CN)$_4$] (abco = 1-azabicyclo[2.2.2]octane; bpy = 2,2'-bipyridine) highlighting the potential of coexistence of NLO effects in ratiometric optical sensing.



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UV Emission of Yb^{2+} in SrB_4O_7 for Highly Sensitive Optical Thermometry Enabled by Multiple Linear Regression

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Optical thermometry is a modern, non-contact technique for temperature measurement, whose performance is strongly dependent on the choice of thermometric parameters. The unique luminescence of divalent lanthanide ions provides a promising route to significantly enhance the sensitivity of optical temperature sensors.[1,2] Here, we report a luminescent thermometer based on the rarely observed UV emission of Yb^{2+}. Yb^{2+} ions were successfully incorporated into the SrB_4O_7 host, which exhibits excellent thermal stability over a wide temperature range of ≈80–420 K. Under thermal stimulation, the material shows pronounced luminescence modulation, including emission enhancement and spectral shifts toward both higher and lower energies depending on temperature. These behaviors originate from thermally activated population redistribution within the excited $4f^{13}5d^1$ electronic configuration of Yb^{2+}, resulting in distinct temperature responses across multiple relaxation channels. To fully exploit these multidimensional luminescence characteristics, a multiple linear regression (MLR) strategy is employed to integrate different thermometric parameters, leading to a substantial improvement in temperature sensitivity compared with single-parameter methods.[3] This work provides a general framework for extracting temperature information from luminescence dynamics in lanthanide-doped phosphors, offering a strategy for designing high-performance optical thermometers.

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Influence of flux content on photo-, thermo- and mechanoluminescence properties of Mn^{2+} doped ZnS/CaZnOS heterojunction materials

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Photo-, thermo- and mechanoluminescence properties of ZnS/CaZnOS heterojunctions doped with d- and f-block elements have already been described in the literature[1–4]. The emission properties of these heterojunctions are strongly dependent on the dopant ion and its concentration[1,2]. During synthesis, the use of flux compounds is a well-established approach to tailor physicochemical properties and enhance the crystallinity of the resulting materials[1,2,5]. Moreover, this heterostructure is capable of exhibiting persistent luminescence under radiation stimuli[6].

Here, we present results for Mn^{2+}-doped ZnS/CaZnOS heterostructures, focusing on the influence of the flux compound content on their photo-, thermo- and mechanoluminescence properties. Optical properties were strictly dependent on the synthesis conditions./Synthesis conditions were crucial for optimization of optical properties of the Mn^{2+}-doped ZnS/CaZnOS heterostructure. The results provide insight into the role of flux-assisted synthesis in the luminescent performance under different stimuli and demonstrate the potential of these heterojunctions for advanced optoelectronic and sensing applications.

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Spectroscopic ellipsometry signatures of structural evolution in NiMo-C coatings for HER applications

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Transitioning to sustainable energy systems requires efficient hydrogen production technologies, with the Hydrogen Evolution Reaction (HER) playing a central role. Our recent work has demonstrated that NiMo-C coatings with a carbon content of 20 at. % or higher serve as promising alternatives to noble metal catalysts due to their high corrosion resistance in acidic environments and favorable HER performance.

NiMo-C coatings synthesized by reactive magnetron sputtering exhibit a structural evolution from a dense nanocrystalline phase to an amorphous and nanocolumnar morphology as carbon content increases. This study presents spectroscopic ellipsometry (SE) as a rapid and non-destructive tool to resolve this evolution, identifying specific optical signatures associated with morphological transitions. For coatings with carbon content up to ~23 at. %, a homogeneous isotropic model based on Drude–Lorentz dispersion was applied, effectively capturing the metallic-like behavior of the nanocrystalline structure. For carbon-rich coatings (> 23 at. %), a uniaxial anisotropic model combined with the Bruggeman Effective Medium Approximation (BEMA) was required to account for the heterogeneous nanocolumnar morphology. The detected positive birefringence $n_z > n_{xy}$ serves as a direct optical signature of vertically oriented metallic-rich nanopillars embedded within the carbon matrix.

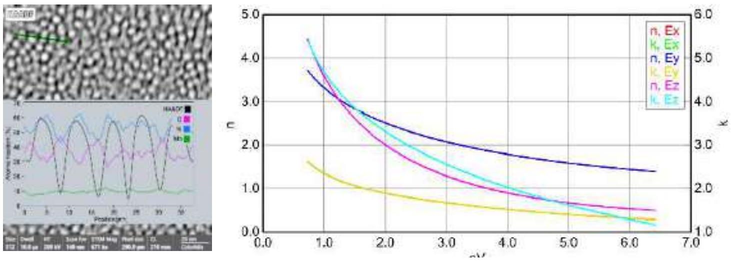

Figure 1. HAADF plan view picture (a) of the NiMoC/a-C:H thin film containing 74 at. % carbon, combined with EDS line scan and complex refractive index (b) derived from ellipsometry

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Ultrafast Structural and Optical Dynamics in Photoexcited Thin-Film and Layered Materials

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Understanding the transient response of photoexcited materials requires tracking both the evolution of the electronic structure and the accompanying lattice rearrangements on ultrafast timescales. Here, we highlight how complementary optical and structural probes provide access to these coupled processes in representative semiconductor systems. Our comparative approach combines time-resolved spectroscopic ellipsometry, which directly resolves transient changes in the dielectric function, with time-resolved X-ray diffraction, which reveals photoinduced structural distortions inaccessible to optical probes alone.

For zincblende cubic GaN thin films, femtosecond pump–probe spectroscopic ellipsometry captures pronounced carrier-induced modifications of the dielectric response near the band edge. The data reveal ultrafast shifts of the absorption onset driven by band filling and band-gap renormalization, followed by relaxation channels involving carrier cooling, recombination, and lattice heating [1]. For layered GaS, time-resolved X-ray diffraction provides direct evidence of laser-induced structural changes associated with transient and irreversible modifications of crystal anisotropy, including an elongation of the unit cell along the *c*-axis under femtosecond excitation [2].

Together, these case studies illustrate how correlated optical and structural measurements help disentangle nonequilibrium processes in photoexcited semiconductors across different dimensionalities and excitation regimes. Such a combined perspective is essential for understanding the microscopic origin of ultrafast functionality and for guiding the optical engineering of emerging materials under strong photoexcitation.

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Photoinduced Ultrafast Phase Transition in VO2 Thin Films Monitored by Time-Resolved Spectroscopic Ellipsometry

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Phase-change materials (PCM) can undergo fast and reversible changes between crystalline and amorphous phases what makes them great candidates for many reconfigurable photonic devices. A thorough understanding of processes affecting local and temporal optical constants of PCMs provides the knowledge of technological limitations of these materials and their applicability. The changes in optical and electrical properties can be induced thermally, electrically or optically. Photoexcitation by laser pulses opens the perspective of monitoring even ultrashort changes in subpicosecond timescale. Employment of broadband ultrashort laser pulses for time-resolved ellipsometry enables monitoring ultrafast temporal evolution of the complex dielectric function of the studied material [1]. Here, we present application of this technique to study the ultrafast dynamics of the photoinduced insulator-to-metal transition (IMT) in vanadium dioxide (VO2) thin films [2]. We have identified distinct thermal and non-thermal dynamics in the photoinduced IMT, which critically depends on the exciting wavelength and fluence. Time evolution of the pseudodielectric function of the VO2 thin film during thermally and photoinduced phase transitions reveals that the primary differences in the IMT pathways are driven by nonequilibrium dynamics during the first picosecond after the photoexcitation. These and other findings of the study underscore the utility of time-resolved pump–probe spectroscopic ellipsometry as an effective tool for investigating phase transitions in strongly correlated materials.

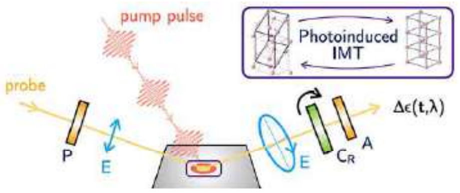

Figure 1: Pump-probe ellipsometry experiment to monitor photoinduced insulator-to-metal transition

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O30 | **A. Bachiri**

Development and Performance Assessment of Single- and Double-Layer TbAG:Ce and YAG:Ce Composite Scintillators on GAGG:Ce Substrates for Optimized α–γ Discrimination and Pulse-Shape Analysis

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In this work, we report the fabrication and characterization of composite scintillators based on the single-layered and double-layered epitaxialstructures containing single-crystalline films (SCFs) and bulk single crystal (SC) scintillators of garnet compounds for enhanced α–γ discrimination in mixed radiation fields. The composite scintillators under study consist of TbAG:Ce SCF (first layer) and YAG:Ce (second layer) SCFs grown step-by-step using liquid-phase epitaxy (LPE) method onto Czochralski-grown $Gd_3Ga_{2.5}Al_{2.5}O_{12}$ (GAGG:Ce) bulk SC substrates. Suich single- and double-film architectures were designed to optimize energy absorption and pulse-shape discrimination (PSD) performance for low-penetrating α-particles and high-energy γ-rays.

Energy calibration of composite scintillators was performed using different γ-ray sources (^{57}Co, ^{51}Cr, and ^{137}Cs), enabling conversion of detector signals to a calibrated electron-equivalent energy scale (keVee). Integration gates were systematically optimized, yielding maximum figures-of-merit (FOM) of 1.4 for the GAGG:Ce SC substrate, 1.9 for the TbAG:Ce SCF/GAGG:Ce SC single-film composite, and 5.0 for the YAG:Ce SCF/TbAG:Ce SCF /GAGG:Ce SC double-film composite, demonstrating progressive improvement in α–γ discrimination with increasing structural complexity. Two-dimensional PSD density maps reveal well-separated α and γ populations, with the highest separation observed for the double-film composite. These results indicate that engineering of LPE-grown composites provides tunable scintillation decay profiles, enhanced temporal separation, and increased light yield, making them promising candidates for applications such as mixed-radiation-field detection, dosimetry, and radiation monitoring [1].

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POSTER PRESENTATIONS

Luminescence Thermometry Based on Structural Phase Transition of $LaGaO_3$:Eu^{3+}

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Luminescence thermometry has drawn significant research interest recently, due to its remote and electrically passive readout capability and high reliability. The various strategies have been studied to improve the thermometric performance of luminescence thermometer. Among these, the thermally induced phase transition-based luminescence thermometry has received remarkable recognition due to its outstanding thermometric performance. In this work, luminescence thermometry based on structural phase transition of Eu^{3+} doped $LaGaO_3$ has been investigated. The spectroscopic properties of $LaGaO_3$: x% Eu^{3+} (x= 0.1, 0.25, 0.5, 1, 2) were determined as function of temperature and significant changes were observed around phase transition temperature. The thermally induced changes in emission spectra due to phase transition enabled the development of ratiometric luminescence thermometer. The maximum value of S_R = 6% K^{-1} was achieved at 480 K for $LaGaO_3$:0.1%Eu^{3+}. Moreover, it was shown that increasing Eu^{3+} concentrations result in a shift of the phase transition temperature, facilitating tunable thermometric behavior. These findings indicate that $LaGaO_3$ is a highly suitable host matrix for luminescence thermometers exploiting structural phase transitions in the temperature range above 400 K.

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Filter-Free Luminescence Thermometry based on Mn^{2+} Luminescence

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Luminescent thermometry, which uses the spectroscopic properties of phosphor materials to detect temperature-dependent changes, enables to sense not only point temperature but also two-dimensional temperature distributions. Two-dimensional thermal imaging requires appropriate band-pass optical filters to record luminescence signal in selected spectral ranges. However, the loss of temporal resolution due to the exchanging optical filters is the notable limitation of this approach. To overcome this limitation, a filter-free imaging strategy based on the RGB channels of a standard camera has recently been proposed[1]. Single photograph provides spatially resolved intensity maps for the red (R), green (G), and blue (B) channels, allowing to achieve fast, low-cost, and real-time thermal imaging.

In this study, we introduce the filter-free thermal imaging by utilizing Mn^{2+} and Ce^{3+} emissions. Ce^{3+} ions works as a sensitizer to enhance emission efficiency of Mn^{2+} ions resulting from spin-forbidden electronic transitions through $Ce^{3+}\rightarrow Mn^{2+}$ energy transfer[2]. On the other hand, Mn^{2+} emission band can be modulated through the crystal field strength. We observed two unusual thermal effects of Mn^{2+} emissions: (i) a temperature-induced blueshift of the ${}^4T_1\rightarrow{}^6A_1$ emission band of Mn^{2+} ions, and (ii) thermally assisted population of the ${}^4T_1$ excited state via optical trap sites. These combined processes result in a simultaneous blueshift and thermal enhancement of the Mn^{2+} emission band. Consequently, the luminescence signals in the G channel increases with temperature, while the emission intensity in B channel decreases. The synergy of these thermal behaviors of Mn^{2+} ions enables investigated $Ca_{19}Zn_2(PO_4)_{14}$:Mn^{2+}, Ce^{3+} to demonstrate not only ratiometric readout schemes, but also sensitive filter-free thermal imaging. Based on the comprehensive spectroscopic analysis of Mn^{2+} and Ce^{3+}-doped $Ca_{19}Zn_2(PO_4)_{14}$ as a function of dopant concentration and temperature, the potential of this phosphors for applications in filter-free thermal imaging is demonstrated in this work.

Acknowledgments: This work was supported by the Foundation for Polish Science under First Team FENG.02.02-IP.05-0018/23 project with funds from the 2nd Priority of the Program European Funds for Modern Economy 2021-2027 (FENG).

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Photonic system for continuous monitoring of eutrophic contaminants in aquatic environments

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This work presents the development and validation of an advanced optical method for identifying and quantifying water contaminants responsible for eutrophication. The research is focused on the application of UV–VIS–MIR absorption spectroscopy for the precise detection of trace concentrations of nitrogen compounds, specifically nitrite (NO^2) and nitrate (NO^{3-}) ions. To translate the spectroscopic concept into a practical sensing solution, compact and energy-efficient, the method was implemented in a functional photonic system demonstrator.

The device integrates a cuvette measurement chamber, a miniaturized UV light source, and a highly sensitive photodetector, enabling direct spectral measurements without the need for complex chemical reagents or sample preparation procedures.

The developed demonstrator represents an important step towards the miniaturization and commercialization of autonomous water-monitoring systems. By enabling continuous, real-time assessment of water quality, the proposed technology offers a promising, sustainable solution for environmental monitoring and early detection of eutrophication.

The presented approach also demonstrates the potential of photonic technologies to enable compact, low-cost, and reagent-free environmental sensing systems for future distributed monitoring networks.

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Tuning Mn^{4+} Luminescence Kinetics via the Nephelauxetic Effect for Lifetime Thermometry

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Luminescence thermometry is a versatile remote technique for temperature sensing, based on temperature-dependent luminescence. Among different approaches, luminescence Kinetics is a reliable parameter due to its immunity to spectral distortions.

In transition metal ion-doped phosphors, luminescence originates from *d-d* transitions, where unshielded *d* electrons are sensitive to crystal field and temperature [1]. The host lattice governs emission behavior and thermometric performance [2]. Although Mn^{4+} based luminescence thermometry using emission kinetics is well studied, predictive models remain limited. Designing such thermometers requires understanding the relationship between the host composition and thermometric behavior. Here, we propose a model describing the ^2E state lifetime of Mn^{4+} ions and the corresponding absolute and relative sensitivities in terms of the nephelauxetic effect.

In this study, Mn^{4+} doped double perovskites Sr_2InNbO_6, Sr_2InTaO_6, Ba_2InNbO_6, and Ba_2InTaO_6 are investigated by varying A and B' site cations to relate structure property relationships to thermometric behavior. Results show that, beyond the Dq/B parameter, additional host dependent effects significantly influence temperature response, enabling selection of optimized materials for Mn^{4+} based luminescence thermometry.

Acknowledgments: This work was supported by National Science Center Poland (NCN) under project No UMO-2023/49/B/ST5/03384.

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Pressure-Induced Changes in the Luminescence properties of NaYF4:Ce^{3+}, Mn^{2+} Phosphors

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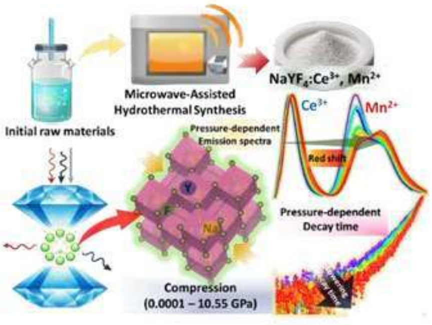
Novel optical sensor, Ce^{3+}, Mn^{2+} co-doped $NaYF_4$ polycrystalline phosphor material was developed by microwave assisted hydrothermal synthesis method. Single phase of crystal structure of synthesized material was confirmed by X-ray diffractometry and found that it crystalize in cubic crystal structure of the $Fm\bar{3}m$ space group. The morphology and distribution of the parent elements were analyzed by SEM coupled with EDX analysis. The emission spectra show two emission bands at 333 (Ce^{3+}, $^5d_1 \rightarrow {}^4f_1$) and 560 nm (Mn^{2+}, $^4T_1(G) \rightarrow {}^6A_1(6S)$) when excited at 270 nm. High pressure luminescence studies of the synthesized materials were carried out using diamond anvil cell for multi-mode optical pressure sensor applications. The pressure-dependent spectral shift of both bands at 333 and 560 nm show linear tendency with rate ($d\lambda/dP$) of 1.05 and 2.67 nm GPa^{-1} respectively. The rate ($d\tau/dP$) of change of decay time with pressure for the band at 560 nm was found to be 1.10 ms GPa^{-1}. The as synthesized phosphor material exhibit significant color tuning behavior varying from red to yellow region in the CIE chromaticity diagram with respect to increasing pressure. The absolute sensitivity of both the x and y coordinates were calculated to be 1.7 and 3.7 GPa^{-1}. Considering the multimode parametric values, the as obtained novel phosphor ($NaYF_4$:Ce^{3+}, Mn^{2+}) material can be utilized as potential optical pressure sensor in the pressure range from ambient pressure to 10.55 GPa.



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Mapping of Optical Anisotropy and Strain in Ferroelectric Crystals via Single-Shot Spectroscopic Polarimetry

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In this contribution, we present the concept and realization of a low-cost, automated birefringence microscope designed for real-time quantitative imaging of optical anisotropy parameters ($|sin(\delta)|$), optical axis azimuth φ, and transmission I_0.

Unlike classical polarimetric setups (e.g., Metripol-type systems) [1], where determining the polarization state requires the mechanical rotation of optical components and sequential frame acquisition, the developed device utilizes a camera equipped with a micro-polarizer mosaic array (DoFP – *Division of Focal Plane*). This enables the simultaneous measurement of four light intensity components in a single exposure (*single-shot*), effectively eliminating motion artifacts and allowing for smooth, "live" previewing of the measured physical quantities. Integrating the optical path with a monochromator enables the investigation of the spectral dependence of birefringence.

The application potential of the system was demonstrated through the quantitative analysis of macroscopic inhomogeneities and internal strain fields (growth striations) in a $Sr_{0.4}Ba_{0.6}Nb_2O_6$ (SBN-40) ferroelectric relaxor crystal.

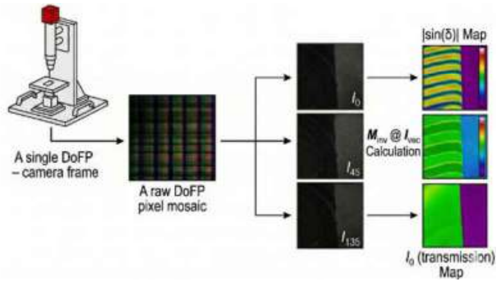

Figure 1. Data acquisition and processing flow of the single-shot polarimeter

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Strategic Precursor Engineering and Continuous-Flow Synthesis of High-Quality PbS Quantum Dots for Enhanced Near-Infrared Photodetection

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This study investigates the development of cost-effective and sustainable sulfur sources, such as sulfur powder, for the synthesis of PbS quantum dots. Initial investigations demonstrated that conventional lead oxide precursor systems, when utilizing sulfur powder or alternative green sulfur sources such as dodecanethiol and thioacetamide, failed to produce nanocrystals with well-defined excitonic features [1]. This structural deficiency led to poor optoelectronic performance in graphene-QD composite devices, which exhibited negligible photoresponse and failed to provide meaningful signals during characterization, indicating that the material quality was insufficient for practical applications. To address these challenges, we optimized the precursor coordination environment by transitioning from lead oxide to lead chloride [2]. This modification successfully induced strong excitonic absorption, confirming that the precursor chemistry is fundamental to the electronic structure of PbS QDs. To further ensure reproducibility and precise material control, a flow chemistry system was implemented. This approach leverages enhanced mass and heat transfer to achieve superior control over the reaction environment. The primary objective of this research is to evaluate the excitonic quality, colloidal stability, and reaction kinetics of the resulting nanocrystals [3]. Furthermore, the performance of these QDs in near-infrared photodetectors is analyzed to establish a robust experimental framework for low-cost, high-performance optoelectronic sensing technologies.

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Influence of fluoride modifiers on structure and optical properties of lead-based and lead-free phosphate glasses doped with europium ions

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Previous reports on rare earth doped lead phosphate glasses suggest that these glass systems are promising for visible [1] and near-infrared [2] luminescence applications. However, glass systems containing lead are designated as toxic raw materials, and they are rather eliminated from various practical applications due to their hazardous effect on health and environment. Therefore, oxide and oxyfluoride phosphate glasses belonging to lead-free glass family [3] are recommended for numerous applications in optoelectronics. In present work, two selected oxyfluoride lead-based and lead-free phosphate glasses containing europium ions have been studied. Structural and optical aspects for glass samples varying with fluoride modifier concentration have been examined using X-ray diffraction and luminescence spectroscopy. The experimental results for lead-free glass systems demonstrate that low-concentrated samples with fluoride modifiers are fully amorphous. The major crystalline phases were identified as MPO_4 (where M = La, Y or Gd) in glass samples containing higher-concentrated fluoride modifiers LaF_3, YF_3 and GdF_3 [4]. Additionally, the second crystalline phase $GaPO_4$ was formed in glass samples with YF_3 and GdF_3, which quite well collaborates with the results obtained for Eu^{3+}-doped lead phosphate glasses modified by PbF_2 [5]. The changes of red-to-orange luminescence intensity ratios R/O (Eu^{3+}) and measured lifetimes for the $^5D_0$ excited state of Eu^{3+} ions are presented and discussed as a function of concentration of fluoride glass-modifiers.

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Compositional engineering of 2D perovskites via Cd substitution and its impact on optical and scintillation properties

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Two-dimensional (2D) Ruddlesden–Popper hybrid perovskites have emerged as promising candidates for next-generation scintillators due to their strong excitonic effects and tunable emission properties [1]. In this work, we investigate the impact of Cd^{2+} substitution on the optical and scintillation behavior of $(BA)_2PbBr_4$ single crystals. High-quality pristine and Cd-alloyed $(BA)_2Pb_{0.6}Cd_{0.4}Br_4$ crystals were synthesized via slow solution evaporation and systematically characterized. Structural analysis confirms successful incorporation of Cd into the lattice while preserving the layered framework, accompanied by lattice distortion and bandgap reduction. Optical measurements reveal the emergence of a secondary emission band at 431 nm in the Cd-alloyed crystal. Time-resolved photoluminescence indicates modified recombination dynamics. Under X-ray excitation, temperature-dependent radioluminescence exhibits altered negative thermal quenching behavior and a higher activation energy for thermal quenching, indicating improved resistance to nonradiative losses [2]. Scintillation measurements under γ-ray excitation demonstrate a ~20% increase in light yield, reaching 11,000 photons/MeV, along with a significantly faster decay time (21.7 ns) compared to the pristine crystal. These results highlight Cd alloying as an effective strategy for engineering emission dynamics and enhancing timing performance in low-dimensional perovskite scintillators, offering potential for fast radiation detection and imaging applications.

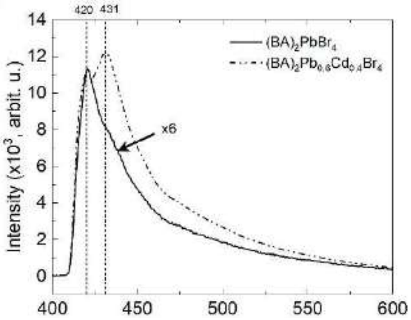

Fig. 1. Steady-state PL, where the intensity of $(BA)_2PbBr_4$ was scaled by a factor of 6 to facilitate comparison with the Cd-alloyed sample.

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Pressure-induced phase transitions in $BaGa_2Ge_2O_8:Eu^{3+}$, a potential pressure marker

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Pressure is a fundamental physical parameter that affects all properties of matter, including the internal structure of materials and, therefore, their optical properties. Most luminescent manometers exhibit continuous spectral responses across broad range of increased pressure, limiting precision of pressure determination. Pressure-induced structural phase transition overcomes this limitation by abrupt, discontinuous changes in local symmetry, crystal field strength, and electronic structure, thereby providing well-defined and reliable spectral pressure markers at specific pressure value.[1] The Eu^{3+} ion can be useful optical probes for detecting pressure-induced phase transitions, it combines strong luminescence intensity with exceptional sensitivity of the $^5D_0 \rightarrow {}^7F_j$ radiative transitions to local symmetry changes in the host lattice, thereby enabling precise identification of phase transition pressure through pronounced spectral changes. Pressure-dependent vibrational Raman spectroscopy was employed as a method for structural changes detection, revealing modifications in phonon modes, where emergence or disappearance of modes confirm the pressure-induced phase transition of the host. Next, the luminescence spectroscopy, as a fast and non-invasive method, was employed to observe changes in emission spectra of Eu^{3+} ions with very high precision and accuracy.

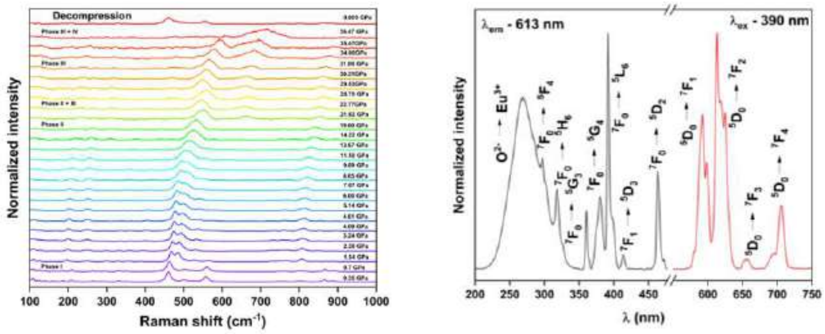

Figure 1: (a) Pressure-dependent Raman spectra (0-36.47 GPa) showing phase transitions, (b) Photoluminescence excitation and emission spectra of $BaGa_2Ge_2O_8:Eu^{3+}$.

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Visual luminescence thermometry based $KGaGeO_4$: Ce^{3+}, Cr^{3+}

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Developing luminescent thermometers for visual thermal imaging involves designing luminescent materials whose emission properties in the Vis spectral range change with temperature. To achieve this, it is necessary to employ a phosphor exhibiting at least two emission bands within the visible spectral range, each characterized by a distinctly different temperature dependence. In this context, the combination of Cr^{3+} ion emission, associated with the ^2E /$^4T_2 \rightarrow {}^4A_2$ electronic transitions in the red region, and Ce^{3+} ion emission, originating from the $5d \rightarrow 4f$ transition in the blue-green region, appears particularly promising. The differing mechanisms governing the depopulation of the excited states of these ions enable a thermally induced change in the color of the emitted light [1]. The combination of these two dopants makes the constructive of a ratiometric luminescence thermometric which enhances sensitivity.

In this work, we investigate $KGaGeO_4$: Ce^{3+}, Cr^{3+} thermometer, where Ce^{3+} occupies dodecahedral sites and generating a broad $5d \rightarrow 4f$ emission while Cr^{3+} resides at the octahedral position, enabling dual emission where intensity ratio $\Delta = I(Ce^{3+})/I(Cr^{3+})$ provides ratiometric method for accurate temperature sensing. The relative sensitivity tunes through excitation conditions. Both visible emissions enable observable color changes with temperature making suitable for visual readable thermometry. These findings demonstrate that Ce^{3+}, Cr^{3+} doped $KGaGeO_4$ is a promising platform for high performance optical thermometry.

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Modelling electron structure of double halide perovskites doped with transition metals

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Conventional DFT calculations of band structures and density of states in highly heterogeneous doped supercells are computationally expensive. This work proposes an evolutionary framework for host–dopant compound design along with recommended parameters for efficient DFT validation. A hybrid parallel genetic algorithm [1] combining an island model for rival generations' creation and slave-master model for highly efficient parallel fitness evaluation was deployed. It implemented machine-learning derived Bartel tolerance factor [2], dopant-host Shannon radii relation and band gap prediction with graph networks [3-4] for fitness calculations. Most prospective candidates of double halide perovskites for doping with transition metals to achieve broadband NIR emission had their band structures and projected density of states evaluated using spin-aware DFT+U [5-7]. Finally, discussion of results and an outline for future work is presented.

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Tunable Luminescence by B-site Substitution in $Cs_2NaInCl_6$

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A series of double halide perovskites (DHPs) with the general composition $Cs_2Ag_{0.2}Na_{0.4}In_{0.6}X_{0.4}Cl_6$ (X = Si, Ti, Zr) was synthesized and characterized, including studies of photoluminescence (PL), temperature-dependent photoluminescence excitation (PLE), and luminescence kinetics. The materials were synthesized via a hydrothermal method. The phase purity and elemental composition of the synthesized perovskites were confirmed by X-ray diffraction (XRD) and scanning electron microscopy (SEM), equipped with energy-dispersive X-ray spectroscopy (EDS), which demonstrated that the samples corresponded to the specified stoichiometry. The PL spectra exhibit a systematic shift toward the lower-energy region with substitution from Si to Zr, correlating with the progressive increase in the ionic radii of the substituting cations. All samples display broad, asymmetric emission bands, characteristic to self-trapped excitonic (STE) states. Temperature-dependent PL measurements reveal a gradual decrease in emission intensity with increasing temperature for all samples. The maximum emission intensity is observed in the range of 160–200 K, corresponding to optimal conditions for radiative recombination, whereas the lowest intensity is recorded at 80–100 K, where radiative centers are effectively frozen. An increase in temperature is accompanied by a red shift of the PL bands across all compositions. In the Ti-doped DHP, a pronounced blue shift at low temperatures is observed, which can be attributed to the involvement of $Ti4^+$–related electronic states. An analysis of the activation energy of thermal luminescence quenching and the results of time-resolved spectroscopy revealed the activation of thermal processes in the titanium-containing sample and their rapid decay, whereas replacing titanium with silicon leads to more stable luminescence in the crystal under study. Thus, the enhanced luminescence characteristics of double-halide perovskites doped with Ti, Si, and Zr highlight their potential for advanced photonic and optoelectronic applications.

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Photocurrent Measurements Using Precision LED Excitation Systems Across a Broad Spectral Range

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Photocurrent spectroscopy is a powerful technique for investigating charge generation, carrier transport, and photoresponse mechanisms in optically active materials. The accuracy and reproducibility of such measurements strongly depend on the precise control of excitation conditions, particularly when studying wavelength-dependent phenomena or transient photoelectric processes.

In this work, we present dedicated LED excitation systems designed for photocurrent characterization over a broad spectral range extending from the ultraviolet to the near-infrared. The developed drivers provide accurate control of excitation parameters, including optical intensity, pulse duration, and repetition rate, enabling both steady-state and time-resolved photocurrent measurements. Stable operation with well-defined temporal profiles allows the investigation of dynamic processes such as carrier trapping, recombination, and transport kinetics in a wide variety of photoactive materials.

The flexibility of the platform enables straightforward implementation of spectrally resolved photocurrent experiments using interchangeable LEDs covering different wavelength ranges. This approach offers a compact, energy-efficient, and cost-effective alternative to conventional monochromator-based excitation systems while maintaining high experimental reproducibility. The capability to perform pulsed excitation further extends the applicability of the system to transient photocurrent studies and the determination of characteristic response times.

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Spectroscopic investigation of luminescence in Cr^{3+}– doped $Sr_2Ga_{(1-x)}In_xSbO_6$ double perovskite

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Cr^{3+}-doped materials have attracted significant attention as broadband near-infrared emitters due to their characteristic d–d transitions and strong dependence on the local crystal field. The spectroscopic properties of Cr^{3+}-doped $Sr_2Ga_{(1-x)}In_xSbO_6$ double perovskites were investigated as a function of composition and temperature. Optical absorption measurements revealed a host band-to-band transition, with the band gap systematically decreasing with increasing indium content, indicating modifications of the electronic structure. Photoluminescence studies showed a broad emission band typical of Cr^{3+} ions in a weak crystal field, attributed to the spin-allowed $^4T_2 \rightarrow {}^4A_2$transition. For x = 0.0, the emission maximum is located at ~820 nm and shifts to ~920 nm with increasing indium content, consistent with a reduction of crystal field strength due to lattice expansion. Excitation spectra exhibit a UV band related to host absorption and two characteristic Cr^{3+} transitions ($^4A_2 \rightarrow {}^4T_1$ and $^4A_2 \rightarrow {}^4T_2$), which also shift with increasing x, confirming the weakening of the crystal field. Temperature-dependent measurements reveal typical thermal broadening of the emission band. The x = 0.0 sample shows the highest thermal stability, maintaining emission up to 420 K and retaining about 50% intensity at 500 K, whereas indium-containing samples exhibit significant quenching around 350 K. Luminescence decay measurements were performed for all compositions, spectroscopic results will be presented separately to further elucidate the relationship between structure and optical properties.

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Development from a multimodal up-converting luminescent thermometer into a ratiometric visual optical power density meter based on Er^{3+},Yb^{3+} emission

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This work shows that temperature-dependent changes in the spectroscopic properties of the $Na_3Sc_2(PO_4)_3$:Er^{3+},Yb^{3+} can be efficiently exploited for multimodal remote temperature sensing [1]. As illustrated, $Na_3Sc_2(PO_4)_3$:Er^{3+},Yb^{3+} exhibits multiple ratiometric sensing approaches, utilizing the emission intensity ratios of (i) $^2H_{11/2} \rightarrow {}^4I_{15/2}$ and $^4S_{3/2} \rightarrow {}^4I_{15/2}$; (ii) $^2H_{9/2} \rightarrow {}^4I_{13/2}$ and $^4S_{3/2} \rightarrow 4I_{15/2}$; and (iii) green-to-red emission intensity ratio with corresponding maximum relative sensitivities reaching 2.8% K^{-1}, 3% K^{-1}, and 1.8% K^{-1}. The combination of temperature-dependent changes in the green-to-red emission intensity ratio of Er^{3+} ions and the enhanced optical heating of $Na_3Sc_2(PO_4)_3$:Er^{3+},Yb^{3+} at higher Yb^{3+} concentrations facilitates the establishment of a visual optical power density sensor, achieving relative sensitivities of S_{Rx} = 1.0 % W^{-1} cm^2 and S_{Ry} = 0.9 % W^{-1} cm^2 at 15 W cm^{-2}, as determined from CIE 1931 chromaticity coordinates. This work presents the first reported example of a visual luminescent optical power density sensor. In addition, $Na_3Sc_2(PO_4)_3$:Er^{3+},Yb^{3+} is shown to be effectively applicable for two-dimensional optical power density imaging, allowing spatial mapping of power distribution across an illuminated filed.

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Tunable Short-Wave Infrared Ni^{2+} Emission via Crystal Field Engineering

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Phosphor-converted infrared light-emitting diodes (pc-LEDs) are emerging as attractive alternatives to conventional semiconductor-based infrared emitters, as well as traditional infrared light sources such as tungsten halogen lamps and laser diodes, offering improved thermal stability, broader spectral coverage, and enhanced versatility. In particular, broadband short-wave infrared (SWIR) emitters operating within the 900 – 1700 nm range are highly desirable for applications in spectroscopy, anti-counterfeiting, optical communications, and noninvasive biomedical imaging.Among transition-metal activators, Ni^{2+} is especially promising because of its broad SWIR emission spanning approximately 1000 – 1700 nm. Moreover, Cr^{3+}/Ni^{2+} codoped systems exhibit enhanced luminescence due to efficient energy transfer between both ions. Here, we investigate $MgGa_2O_4:Cr^{3+},Ni^{2+}$ phosphors modified by Al^{3+}, Sn^{4+}, and In^{3+} cation substitution [1,2] to elucidate the influence of crystal field strength on the optical properties and thermal stability of Ni^{2+} emission. The study combines high-pressure spectroscopy, temperature-dependent luminescence measurements, and luminescence kinetics analyses. Crystal field engineering is achieved through both external pressure applied using a diamond anvil cell and chemical pressure induced by substitution with smaller Al^{3+} ions or larger Sn^{4+} and In^{3+} ions. Increasing Al^{3+} concentration and applying high-pressure increases the crystal field strength, leading to a blueshift of the Ni^{2+} spin-allowed $^3T_2 \rightarrow {}^3A_2$ emission. In contrast, Sn^{4+} and In^{3+} incorporation weakens the crystal field and induces a pronounced redshift of the broadband Ni^{2+} emission. The results demonstrate that cation substitution offers an effective strategy for tailoring broadband Ni^{2+} SWIR emission while balancing spectral tunability and luminescence efficiency.

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The effect of lithium excess on the persistent luminescence and thermoluminescence performance of undoped and Cr^{3+}-doped $Li_{1+x}Ga_5O_8$ spinel

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Lithium-gallium spinel ($LiGa_5O_8$) activated with rare-earth (RE) or transition metal (TM) ions is a known crystalline phosphor having long-lasting persistent luminescence (PersL), thermally stimulated luminescence (TSL) and mechanoluminescence (ML) properties. In particular, when activated with Cr^{3+}, it exhibits persistent luminescence in the deep red spectral region at about 700 nm. When undoped, the $LiGa_5O_8$ spinel demonstrates an efficient broad-band intrinsic photoluminescence (PL) in the violet-blue spectral region at about 400 nm, however, having very poor PersL at room temperature. The radiation storage properties allowing the PersL, TSL and ML of the material are caused by intrinsic point defects, such as cation antisites, cation and oxygen vacancies that are highly probable in this spinel compound (see e.g. [1]). Recently, we have shown the possibility of tuning the optical band gap, crystal structure and persistent luminescence performance of Cr^{3+}-doped $LiGa_5O_8$ spinel by partially replacing Ga with Al and/or In [2]. The present work aims to go further and to get a better insight into the nature of the intrinsic point defects responsible for the charge trapping and their targeted modification with the purpose of improving the PersL and TSL properties of the material. In particular, the effect of lithium excess on the PersL and TSL properties of the $Li_{1+x}Ga_5O_8$-based phosphors has been studied in detail. For this purpose, a few series of $LiGa_5O_8$-based compounds with different Li/Ga ratios, nominally undoped as well as doped with Cr^{3+} ions, have been synthesised by the solid-state reaction method and characterised in detail using powder XRD and luminescence techniques.

The obtained results demonstrate that the modification of the $LiGa_5O_8$ host lattice by the Li excess has a high potential for tuning and improving the PersL and TSL properties of undoped and Cr^{3+}-doped material. The most striking thing is that the Li excess allows to get a quite efficient blue-emitting persistent phosphor based on the undoped $Li_{1+x}Ga_5O_8$ spinel.

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Spectroscopic properties of Y_2SiO_5 single crystals doped with Yb^{3+} ions for quantum memory applications

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Y_2SiO_5 crystal is an effective host material for rare earth dopants [1]. $^{171}Yb^{3+}$:Y_2SiO_5 single crystals grown by the Czochralski method are considered as promising systems for quantum technologies [2]. In this work Y_2SiO_5 single crystals doped with various concentrations of Yb^{3+} ions were grown using µ-PD technique [3,4]. The phonon energy of Y_2SiO_5:Yb^{3+} single crystals were characterized using µ-Raman spectroscopy. The absorption spectrum Y_2SiO_5:Yb^{3+} displays a pronounced band centred at 978.44 nm, characteristic of the $^2F_{7/2}\rightarrow{}^2F_{5/2}$ transition of Yb^{3+} in an oxide host. In addition to this near-infrared absorption, broad absorption bands centred at approximately 571, 601, and 663 nm are observed. These bands exhibit full widths at half maximum of about 40 nm, and their intensities increase systematically with increasing Yb^{3+} concentration. Emission spectra were measured using an FLS1000 spectrophotometer with Xe-lamp excitation. The emission intensity depends on the position along the crystal rod from which the sample was cut. A clear trend is observed for samples doped at 50 ppm of Yb^{3+} ions: the emission and excitation intensities are highest for the sample taken from the beginning of the rod, intermediate for the central part, and lowest for the sample taken from the later growth stage. The same observation concerns the excitation spectra. The same positional dependence is observed in the emission decay time measurements. The decay curves can be reasonably described by mono-exponential functions, although the average lifetimes obtained using different fitting approaches show slight variations. These differences remain small and are not considered significant within the experimental uncertainty.

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Spectroscopic properties of Sr_2CeO_4 nanocrystals revisited

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Structure of Sr_2CeO_4 is characterized by chains of edge-sharing CeO_6 distorted octahedra [1]. Under excitation with UV light this crystal exhibits blue-white intense Stokes emission, which is due to Ce^{4+} - O^{2-} charge transfer (CT) transition [1,2]. At the same time the irradiation of Sr_2CeO_4 with a focused IR laser beam leads to broadband anti-Stokes white emission; this observation was tentatively ascribed to intervalence charge transfer between Ce^{3+} - Ce^{4+} pairs [3]. This interpretation was supported by the results of ab initio calculations performed for independent $(CeO_6)^{9-}$ and $(CeO_6)^{8-}$ clusters embedded in Sr_2CeO_4 lattice [3]. Whereas the intervalence charge transfer (IVCT) emission was obtained within ab initio approach, where the standard scaling of the ab initio vibrational frequencies turned out to be crucial, the Ce^{4+} - O^{2-} CT transition energies were highly overestimated within ab initio approach [3]. This work presents experimental spectra of Sr_2CeO_4 nanocrystals covering absorption, anti-Stokes emission as well as observed for the first time, Stokes IR emission induced by IR laser light. The interpretation of the observed spectra is revisited in the light of new ab initio calculations going beyond the minimal embedded clusters and independent Ce centers approximations.

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Crystal field engineering of Cr^{3+} luminescence in Zn^{2+}/Zr^{4+}-modified $Gd_3Ga_5O_{12}$

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Broadband near-infrared (NIR) emitters are important for applications such as biomedical diagnostics, security, night vision, and non-destructive analysis. Phosphor-converted LEDs (pc-LEDs) are promising NIR sources, but their performance is limited by low quantum efficiency and poor thermal stability. Therefore, the development of materials with tunable, broadband NIR emission remains essential.

In this study, we investigate Cr3+-doped Gd3Ga5O12 (gadolinium gallium garnet, GGG) modified by Zn2+/Zr4+ substitution. Partial replacement of Ga3+ with Zn2+ and Zr4+ alters the crystal field around Cr3+, thereby tuning its luminescence properties.

A series of polycrystalline phosphors with nominal composition Gd3Ga5-2xZnxZrxO12:0.05Cr3+ (x = 0–1) were synthesized via a conventional solid-state reaction method at 1300 °C for 6 h in air. Phase formation were verified using powder X-ray diffraction, confirming successful incorporation of Zn2+ and Zr4+ into the garnet lattice. The optical properties were analyzed by diffuse reflectance spectroscopy, photoluminescence spectroscopy, and luminescence decay analysis.

The results reveal that Zn2+/Zr4+ co-substitution induces a noticeable red shift in both absorption and excitation bands associated with Cr3+ ions, indicating a modification of the crystal field strength. As the substitution level increases, the broadband NIR emission shifts from ~730 nm to ~805 nm under 450 nm excitation. Simultaneously, a significant broadening of the emission band is observed, with the full width at half maximum (FWHM) increasing from approximately 100 nm to 180 nm.

These changes result in enhanced spectral coverage across the NIR region, which is advantageous for broadband NIR applications. The findings demonstrate that cation co-substitution in garnet hosts is an effective approach for tuning Cr3+ luminescence and improving the performance of NIR phosphors for pc-LED technologies.

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Quantitative Elemental Analysis Using Laser-Induced Breakdown Spectroscopy and 1D Convolutional Neural Networks

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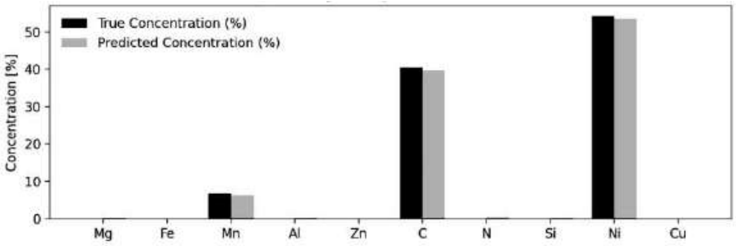
Laser-Induced Breakdown Spectroscopy (LIBS) is a powerful analytical technique for elemental analysis, however the manual interpretation of complex spectral datasets remains a significant challenge [1]. This work presents a machine learning-based framework designed to automate and enhance the prediction of elemental composition directly from LIBS spectra. To overcome the scarcity of large, annotated experimental datasets, training data was generated synthetically using NIST Atomic Spectra Database.

Rather than limiting the task to binary element detection, we address the more demanding problem of concentration estimation across a broad spectral window (200–1000 nm). We propose a customized 1-Dimensional Convolutional Neural Network (1D CNN) that efficiently captures spectral features characteristic of atomic emission. To manage problem complexity and stabilize the training process, the model is initially evaluated on a representative subset of 10 elements.

The figure below presents the results of the proposed model for a representative LIBS spectrum. The comparison between true and predicted concentrations shows that the model accurately reproduces the elemental composition of the sample.



The result of the proposed model on a spectrum of a sample consisting of carbon (C), manganese (Mn) and nickel (Ni).

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P23 | **I. I. Kindrat**

Effect of Ag co-activation on luminescence of Dy^{3+} ions in lithium tetraborate glasses

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The spectroscopic properties of lithium tetraborate ($Li_2B_4O_7$) glasses activated with Dy and co-activated with Dy and Ag were studied using optical absorption and photoluminescence (emission, excitation, decay kinetics, quantum yield) techniques [1]. The optical absorption spectra of the $Li_2B_4O_7$:Dy and $Li_2B_4O_7$:Dy,Ag glasses exhibit several characteristic $4f$ – $4f$ transitions associated with Dy^{3+} ($4f^9$, $^6H_{15/2}$) ions.

The luminescence emission spectra of the investigated glasses upon excitation at 349 nm show two strong bands at 481 nm and 574 nm, two weaker bands at 662 nm and 753 nm corresponding to the $^4F_{9/2} \rightarrow {}^6H_{15/2}, {}^6H_{13/2}, {}^6H_{11/2}, {}^6H_{9/2}$ transitions of Dy^{3+} ions as well as a weak band at 452 nm attributed to a phonon side band of the emission at 481 nm. The luminescence excitation spectra of the $Li_2B_4O_7$:Dy and $Li_2B_4O_7$:Dy,Ag glasses exhibit numerous narrow bands corresponding to $4f$ – $4f$ transitions of Dy^{3+} ions with the most intense band at 349 nm ($^6H_{15/2} \rightarrow {}^6P_{7/2}$ transition).

The luminescence emission spectrum of the $Li_2B_4O_7$:Dy,Ag glass upon excitation at 268 nm shows that the intense Dy^{3+} emission bands are superimposed on two very broad weakly resolved bands peaking near 398 nm and 523 nm, which are attributed to isolated Ag^+ ions and small non-plasmonic molecule-like Ag nanoclusters (Ag_m^{n+} centres). The luminescence excitation spectrum also exhibit two bands related to these Ag centres.

The luminescence decay lifetime of Dy^{3+} ions in the $Li_2B_4O_7$:Dy and $Li_2B_4O_7$:Dy,Ag glasses slightly exceeds 800 μs. The luminescence decay lifetimes of Ag^+ ions and Ag nanoclusters in the $Li_2B_4O_7$:Dy,Ag glass are 63 μs and 166 μs, respectively.

Integrating-sphere measurements show that the $Li_2B_4O_7$:Dy,Ag glass exhibits a higher luminescence quantum yield than the $Li_2B_4O_7$:Dy glass as a result of the energy transfer from Ag^+ ions and Ag nanoclusters to Dy^{3+} ions. The chromaticity coordinates of the emission of the $Li_2B_4O_7$:Dy,Ag glass are (0.3341, 0.3771), which are very close to those of standard white light. The corresponding correlated colour temperature is 5442 K. The obtained results demonstrate that $Li_2B_4O_7$:Dy,Ag glass is a promising luminescent material for white light emission.

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Spectroscopic insights into novel thin electrospun composite membranes based on curdlan, WPI, and synthetic polymers

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Thin electrospun composite membranes based on whey protein isolate (WPI), curdlan, and selected synthetic polymers were successfully fabricated as novel biomaterials for potential applications in tissue engineering. Owing to their fibrous architecture, high surface-to-volume ratio, and tunable physicochemical properties, such membranes are considered promising candidates for supporting cell adhesion, proliferation, and tissue regeneration.

The present work is focused on the detailed physicochemical characterization of the obtained membranes, with particular emphasis on spectroscopic analysis. Fourier Transform Infrared Spectroscopy (FTIR) was employed to investigate the chemical structure, intermolecular interactions, and possible changes resulting from the electrospinning process. Additionally, spectral deconvolution of selected FTIR bands was performed to provide deeper insight into molecular organization and interactions between WPI, curdlan, and synthetic polymer components.

The obtained results contribute to a better understanding of structure–property relationships in electrospun biomaterials and may support the further development of functional membranes for biomedical applications.

This research was funded by the National Science Centre, Poland, under the SONATA 19 project entitled A new generation of scaffolds based on curdlan and whey protein isolate obtained by electrospinning for the treatment of cartilage, bone, and osteochondral defects (Grant No. UMO-2023/51/D/NZ7/01677).

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Nanomaterials with Tunable Optical Properties for Advanced Functional Applications

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Nanomaterials with tunable optical properties constitute one of the most rapidly developing groups of advanced functional materials due to their unique physicochemical characteristics and wide application potential. In particular, plasmonic nanostructures based on noble metals have gained considerable attention because of their ability to interact with electromagnetic radiation, leading to phenomena such as localized surface plasmon resonance (LSPR), enhanced light absorption, and improved optical sensitivity. These properties make them promising candidates for numerous applications in modern materials science, nanotechnology, biomedicine, sensing, imaging, catalysis, and theranostic systems [1]. Among various nanostructured systems, core-shell architectures offer exceptional opportunities to precisely modulate optical responses through controlled engineering of both the metallic core and the surrounding shell. Silica-coated plasmonic nanoparticles, including $Au@SiO_2$ and $Ag@SiO_2$, are particularly attractive due to their improved colloidal stability, enhanced biocompatibility, protection of the metallic core against aggregation or oxidation, and facile surface functionalization. Furthermore, the silica shell enables fine-tuning of interfacial interactions and optical behavior while maintaining the plasmonic properties of the metallic nanoparticles [2].

The current research focuses on the synthesis and comprehensive characterization of plasmonic core-shell nanomaterials based on silica-coated gold and silver nanoparticles. Structural and optical characterization was conducted using spectroscopic and microscopic techniques. The obtained results demonstrate that the designed $Au@SiO_2$ and $Ag@SiO_2$ core-shell nanostructures enable effective modulation of their optical properties and confirm their potential as multifunctional nanoplatforms for advanced technological and biomedical applications.

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Spectroscopic insights into the structural transitions of bovine serum albumin induced by sodium dodecyl sulfate

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Understanding the mechanisms of protein structural transformations induced by external factors is essential for elucidating fundamental molecular processes in living organisms. Surfactants are particularly useful in these studies because they induce conformational changes at millimolar concentrations, in contrast to the molar concentrations required by urea or guanidine. Protein–surfactant systems offer a unique opportunity to monitor simultaneous, time-dependent changes in secondary and tertiary structures, their coupling, and their dependence on solvent conditions. Early kinetic studies were initiated in the 1980s by Kunio Takeda and colleagues [1,2] and more recently continued by Daniel Otzen and collaborators [3].

In our study, we investigate SDS-induced unfolding of bovine serum albumin (BSA) by combining steady-state spectroscopy and kinetic stopped-flow measurements. Secondary structure changes are monitored by far-UV CD, tertiary structure by near-UV CD, and the local environment of aromatic residues by intrinsic fluorescence.

Steady-state CD shows far-UV signal saturation near ∼12 mM SDS, while near-UV CD changes little over a wide SDS range. These observations suggest that major secondary-structure rearrangements are largely completed before tertiary packing, which converges to a relatively uniform aromatic environment once SDS binding is established. In contrast, fluorescence is highly sensitive below the CMC, indicating that SDS monomers disrupt tertiary packing even before detectable secondary-structure changes. Ionic strength has little effect on steady-state CD but significantly affects fluorescence kinetics. At constant SDS concentration, NaCl content alters reaction rates and amplitudes, maximally delaying slow relaxation phase at ∼75 mM, which indicates the kinetic stabilization of a long-lived intermediate.

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High-Pressure Spectroscopic Measurements in the Condensed Matter Spectroscopy Division, Universityof Gdańsk

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High pressure is a powerful thermodynamic parameter that enables continuous tuning of interatomic distances and electronic interactions in condensed matter systems. Combined with optical spectroscopy, it provides valuable insight into the relationships between crystal structure, electronic states, and luminescent properties of materials.

This poster presents the high-pressure spectroscopic capabilities available in the Condensed Matter Spectroscopy Division at the University of Gdańsk. Measurements are performed using diamond anvil cells, allowing pressures of up to 40 GPa to be generated. The experimental infrastructure enables photoluminescence, photoluminescence excitation, Raman, and time-resolved emission spectroscopy studies under high pressure over a broad spectral range extending from the ultraviolet and visible to the near-infrared region. In addition to high-pressure experiments, the available infrastructure enables spectroscopic measurements over a wide temperature range (10–400 K), allowing combined pressure- and temperature-dependent investigations.

The presented facilities are applied to investigations of a wide variety of functional materials, including transition-metal- and rare-earth-doped phosphors for visible and infrared photonics. High-pressure spectroscopy is used to study crystal-field interactions, electron–phonon coupling, phase transitions, energy transfer mechanisms, and non-radiative relaxation pathways. Selected examples demonstrating the potential of pressure as a tool for tailoring and understanding the optical properties of condensed matter systems will be discussed.

The poster aims to provide an overview of the available instrumentation and to highlight opportunities for collaborative research involving high-pressure optical spectroscopy.

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Electronic structure and luminescence mechanisms in $Cs_2Ag_xNa_{1-x}InCl_6$ alloys

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The crystals of lead-free halide perovskites family, and in particular $Cs_2Ag_xNa_{1-x}InCl_6$ (CANIC), have been actively studied in recent years as promising luminescent materials with a wide range of practical applications. In order to expand the potential applications of CANIC, it is crucial to be able to engineer the luminescent properties of these compounds. This is particularly important in the spectral region near the edge of the fundamental absorption, where their intrinsic photoluminescence (PL) of CANIC is excited. Successful engineering of the CANIC properties requires an understanding of their optical and luminescent processes at the level of atomic and electronic structure.

In this work, we perform theoretical calculations using the DFT method to determine the electronic structure of the $Cs_2Ag_xNa_{1-x}InCl_6$ ($x = 0, 0.1, \ldots 1$) alloys and of the defect-containing crystals $Cs_2NaInCl_6$:Ag, $Cs_2NaInCl_6$:Sb i $Cs_2Ag_{0.4}Na_{0.6}InCl_6$:Bi in order to elucidate the nature of their luminescence and explain the formation of PL excitation spectra. The calculations were performed using the supercell approach. For each x in $Cs_2Ag_xNa_{1-x}InCl_6$, the structures with minimal energies (i.e. the most favorable to exist in reality) were found using machine learning (ML). In this approach, a cluster expansion (CE) model was constructed using the ICET Python package to replace computationally intensive DFT calculations. The CE model was trained on 90 DFT-calculated $Cs_2Ag_xNa_{1-x}InCl_6$ structures with random distributions of Na/Ag on cationic lattice positions and validated via leave-one-out cross-validation (LOOCV). The trained and validated CE model was later used as an efficient surrogate energy model within a simulated annealing method to predict the lowest-energy Na/Ag orderings at each x.

All structures predicted by ML were subjected to further geometrical optimization by DFT method. The optical spectra were calculated only for the structures with the lowest total energy among all configurations modelled for each x value. The calculations were performed using the DFT-based band-periodic pseudopotential method implemented in the CASTEP program. To overcome the underestimation of the band gap energies E_g by the PBE functional, the optical (inter-band) absorption spectra were calculated using the GGA-PBE plus Hubbard U (GGA + U) approach.

The origin of luminescence in $Cs_2Ag_xNa_{1-x}InCl_6$ alloys, both pure and doped with Bi and Sb ions is discussed using results of the calculations and available experimental data.

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P29 | **N. Majewska**

NIR-responsive phosphors for anti-counterfeiting applications

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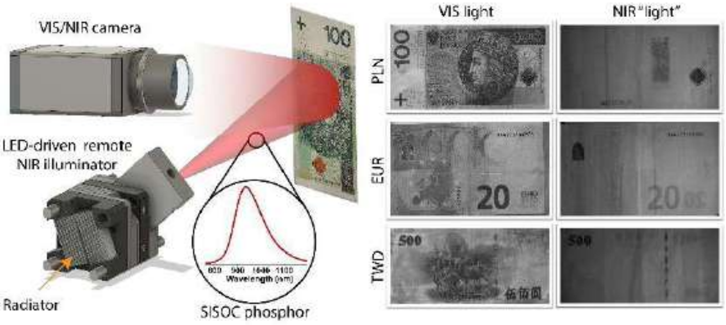
Chromium-activated oxide double perovskites are emerging as promising broadband near-infrared emitters, but achieving strong NIR emission together with high thermal stability remains a key challenge. In this work, we investigate site-engineered Sr$_{2(1-x)}$Ba$_{2x}$InSbO$_6$ doped with Cr^{3+} and demonstrate how symmetry control of the host lattice governs crystal-field strength, local disorder, and the photophysical behavior of chromium ions. Synchrotron X-ray diffraction and Raman spectroscopy reveal a continuous structural evolution from monoclinic Sr2InSbO6 to an almost cubic Ba2InSbO6, leading to a systematic infrared shift of the NIR emission. Temperature-dependent luminescence shows that Sr-rich compositions exhibit outstanding thermal stability, exceeding that of recently reported chromium-activated chloride double perovskites. Configuration-coordinate analysis identifies self-trapped-exciton-assisted relaxation as the dominant nonradiative pathway, while crossover and autoionization mechanisms are excluded, providing a unified microscopic picture of thermal quenching in oxide double perovskites. Finally, exploiting the robust NIR performance of Sr2InSbO6 doped with chromium, we demonstrate a remote LED-driven NIR illuminator in which the phosphor is spatially separated from the excitation source to reduce thermal load. The device delivers intense and uniform NIR emission and enables visualization of hidden security features in banknotes, highlighting its potential for compact anti-counterfeiting applications.



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Energy Transfer Mechanisms of Gd^{3+}→Ce^{3+}→Tb^{3+} and Ce^{3+}→Tb^{3+}→Eu^{3+} in Mixed $Lu_{1-x}Gd(Y)_xAlO_3$ Perovskites

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Mixed perovskite single crystalline films of the $Lu_{1-x}Gd_xAlO_3$ and $Lu_{1-x}Y_xAlO_3$ systems co-doped with Ce^{3+}, Tb^{3+}, and Eu^{3+} were investigated as advanced luminescent materials for scintillation and color-tunable phosphor applications. These hosts are of particular interest due to their high density, structural stability, and favorable electronic environment for rare-earth ion emission centers. The present work focuses on elucidating the mechanisms of competitive energy transfer processes involving Gd^{3+} and Ce^{3+} ions as a sensitizer and Tb^{3+}/Eu^{3+} as activators.

The films of perovskites under study were synthesized using the Liquid Phase Epitaxy technique, enabling precise control of dopant incorporation and crystal quality. Spectroscopic characterization was performed under vacuum ultraviolet (VUV) excitation using synchrotron radiation at the P66 beamline of the PETRA III storage ring (DESY, Hamburg) (Fig.1). This approach allowed direct probing of the UV-VUV excited states of Gd^{3+}, Ce^{3+}, Tb^{3+}, and Eu^{3+} ions, providing detailed insight into their excitation pathways and energy transfer channels.

The emission properties reveals an efficient cascade Gd^{3+}→Ce^{3+}→Tb^{3+} energy transfer, evidenced by a systematic reduction of Gd^{3+} and Ce^{3+} emission intensity accompanied by a corresponding enhancement of Tb^{3+} green luminescence (Figs.1a,1b). In ternary Ce^{3+}–Tb^{3+}–Eu^{3+} systems, an additional cascade transfer Ce^{3+}→Tb^{3+}→Eu^{3+} is observed, leading to pronounced yellow-red emission from Eu^{3+} ions (Fig.1a,1c). This process is accompanied by simultaneous quenching of both Ce^{3+} and Tb^{3+} emissions, confirming the role of Tb^{3+} as an intermediate energy relay state.

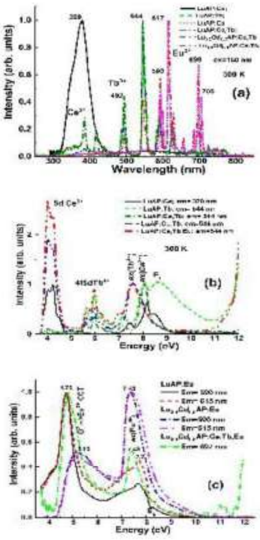

Fig. 1. Emission (a) and excitation spectra of Tb^{3+} (b)and Eu^{3+} (c) luminescence in the studied perovskite films, recorded under synchrotron radiation (SR) excitation in accordance with the figure legends.

Time-resolved luminescence measurements further substantiate the presence of efficient non-radiative energy migration pathways, consistent with resonant and cross-relaxation mechanisms between rare-earth centers. The reciprocal intensity evolution of Ce^{3+}, Tb^{3+}, and Eu^{3+} emissions under selective excitation demonstrates strong spectral tunability governed by dopant composition and energy level alignment within the perovskite host lattice.

The integration of synchrotron-based VUV spectroscopy with time-resolved optical analysis provides a comprehensive description of excited-state dynamics in these multi-doped mixed perovskites. The results highlight their potential as highly efficient, composition-tuneable luminescent materials for applications in advanced scintillators, radiation detection systems, and multi-colour photonic devices.

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Luminescent properties of Ce^{3+}, Tb^{3+} and Eu^{3+} doped $Lu_{2-x}Gd_xSiO_5$; x=0-0.75 single crystalline films

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Single crystalline films (SCFs) of Ce-, Tb-, and Eu-doped $Lu_{2-x}Gd_xSiO_5$ (LGSO; $x = 0–0.75$) orthosilicates have attracted significant attention as promising scintillating screens for 2D and 3D microimaging applications based on conventional X-ray and synchrotron radiation (SR) techniques [1,2]. However, the properties of these materials are strongly influenced by their composition, dopant concentration, and preparation conditions.

The aim of this report is to investigate the luminescent properties of Tb^{3+}, and Eu^{3+} doped $Lu_{2-x}Gd_xSiO_5$ SCFs additionally codoped with Ce ions, as a function of Gd content ($x = 0–0.75$) using cathodoluminescence and luminescence spectroscopy under SR excitation.

SCFs of Ce-, Tb-, and Eu-doped LGSO with different Gd contents ($x = 0–0.75$) were prepared by the liquid phase epitaxy (LPE) method using melt solutions based on a $PbO–B_2O_3$ flux in an air atmosphere on YSO substrates at temperatures of 960–980 °C.

Using conventional and advanced luminescence spectroscopy under synchrotron radiation (SR) excitation, we compared the emission spectra, excitation spectra, and luminescence decay kinetics of Ce-, Tb-, and Eu-doped $Lu_{2-x}Gd_xSiO_5$ with different Gd contents in the $x = 0–0.75$ range. We found that the luminescent properties of these SCFs are governed by a complex interplay between the Ce^{3+} $5d^1 \rightarrow 4f$ emission and the energy transfer processes from Gd^{3+} cations to Ce^{3+}, Tb^{3+}, and Eu^{3+} ions, respectively.

The differences observed in the emission spectra and decay kinetics of LGSO:Ce, LGSO:Tb, and LGSO:Eu SCFs are attributed to variations in the efficiency of $Gd^{3+}\rightarrow Ce^{3+}$, $Gd^{3+}\rightarrow Tb^{3+}$, and $Gd^{3+}\rightarrow Eu^{3+}$ energy transfer, depending on the relative occupancy of Lu/Gd crystallographic sites by the dopant ions, which affects the excitation pathways of Tb^{3+} and Eu^{3+} luminescence.

We also identified the significant role of Pb-flux-related impurities in the excitation processes of Ce^{3+}, Tb^{3+}, and Eu^{3+} luminescence in LGSO hosts with different Lu/Gd ratios. The obtained results provide insight into the energy transfer mechanisms in doped LGSO SCFs and demonstrate their potential for application in scintillating screen detectors.

This work was realized within the Polish NCN No 2022/47/I/ST8/02600 project.

[1] A. Cecilia, e. a. Radiation Measurements, 62, 28-34, 2014.
[2] R. Zheng, e. a. Journal of Crystal Growth, 627, 127523, 2024 .

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Development and characterization of K_2SO_4:Cu,Na phosphor for OSL method

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The study explores the impact of thermal processing and dopant concentration on the optically stimulated luminescence (OSL) efficiency of a newly developed K_2SO_4:Cu,Na phosphor [1-3]. This phosphor demonstrates high sensitivity as a radiation detector under infrared stimulation (IRSL). K_2SO_4:Cu,Na exhibits very high sensitivity for IRSL, and the addition of sodium as a co-dopant significantly enhances its dosimetric properties. Investigations involving OSL, thermoluminescence (TL), and X-ray diffraction (XRD) were conducted. The samples were synthesized with varying concentrations of the dopants and subjected to controlled thermal treatments to assess their effects on luminescence properties. The results reveal that both the dopant concentration and the annealing conditions (temperature and duration) play a critical role in the OSL signal of the phosphor. Optimal dopant concentrations (0.1 mol% Cu and 2 mol% Na) and thermal treatments (1000°C, 4 h) were identified, leading to the highest OSL efficiency. The most sensitive compositions were those with 0.1 mol% Cu and 2-3 mol% Na, while samples with 4 mol% Na showed reduced sensitivity but exhibited enhanced signal stability (lower fading). The OSL decay and glow curve shapes varied depending on the sodium concentration, which is attributed to the different contributions of traps responsible for the signal and the significant role of sodium in shaping the trapping structure and recombination pathways. The material demonstrated high sensitivity, with minimum detectable doses in the sub-milligray range. These findings offer valuable insights for the design and optimization of the K_2SO_4:Cu,Na phosphor for use in radiation dosimetry applications.

[1] R. Majgier and A. Chruścińska (2025) J. Lumin. 286, 121444.
[2] R. Majgier (2026) Radiat. Meas. 191, 107603.
[3] R. Majgier and G. Okada (2026) Luminesc. 41, e70457.

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Ferroelectric control of second-harmonic generation in monolayer MoS_2 on periodically poled $LiNbO_3$

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Monolayer (1L) transition metal dichalcogenides (TMDs) have attracted significant interest for nanophotonic and nanoelectronic applications due to their unique electronic and optical properties. The intrinsic broken inversion symmetry of these monolayers gives rise to strong second-order nonlinearities, making them particularly interesting for nonlinear frequency conversion processes. In addition, their atomic-scale thickness makes them highly sensitive to the local environment, enabling efficient control of light–matter interactions through integration with ferroelectric platforms [1,2].

In this work, we investigate the influence of ferroelectricity on the second-harmonic generation (SHG) response of monolayer molybdenum disulfide (1L-MoS_2) transferred onto a periodically poled $LiNbO_3$ (PPLN) substrate. Spatially resolved micro-SHG experiments reveal that the alternating ferroelectric domain structure of the substrate induces a pronounced spatial modulation of the 1L-MoS_2 SHG signal. Furthermore, this modulation exhibits a clear dependence on the intensity, wavelength, and polarization state of the fundamental beam light. The results are explained by a domain-dependent photoinduced charge transfer processes at the 1L-MoS_2/PPLN interface, which induce a selective enhancement of the second-order susceptibility, $\chi^{(2)}$ of the monolayer. These results establish a new route to manipulate and enhance the nonlinear optical response of two-dimensional materials in integrated photonic systems, paving the way for advanced photonic functionalities.

[1] Ramírez M. O. et al. (2024) Advanced Optical Materials 12, 2400624.
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Eu concentration effects on the radio-photoluminescence properties in Eu:$Na_2BaSr(PO_4)_2$ ceramics

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Radio-photoluminescence (RPL) is a radiation-induced luminescence phenomenon that has attracted considerable attention for applications in optical memory devices and high-resolution radiation imaging. A key advantage of RPL dosimeters is that they allow repeated readouts without loss of the accumulated dose information [1]. Despite these attractive features, the number of reported RPL materials remains limited, and the exploration of new materials with superior RPL properties remains necessary. In this study, we focused on Eu-doped $Na_2BaSr(PO_4)_2$ ceramics for a new RPL material and demonstrated their pronounced RPL phenomenon. We will report on the Eu concentration dependence of their RPL properties.

Figure 1 shows the photoluminescence (PL) spectra of the 0.3% Eu-doped sample. Following irradiation, a new broad emission band emerges around 470 nm due to the 5d-4f transition of Eu^{2+} ions. This irradiation-induced reduction from Eu^{3+} to Eu^{2+} directly confirms the RPL phenomenon. Figure 2 shows the dose response curve of PL intensity for the 0.3% Eu-doped sample. The sample exhibits excellent linearity above the threshold, demonstrating outstanding performance with a remarkably low detection limit of 6.0 mGy.

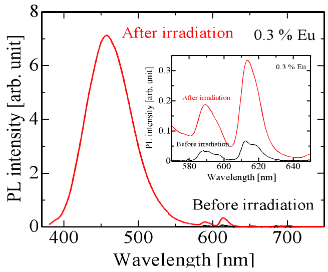

Figure 1 PL emission spectra of the 0.3% Eu-doped $Na_2BaSr(PO_4)_2$ sample before and after X-ray irradiation.

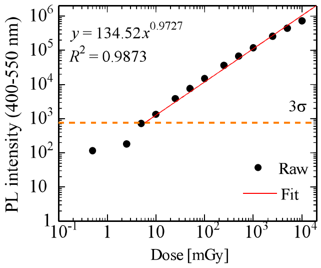

Figure 2 Dose response curve of PL intensity for the 0.3% Eu-doped $Na_2BaSr(PO_4)_2$ sample after X-ray irradiation.

[1] G. Okada, et al. (2021) J. Ceram. Soc. Jpn., 129, 419–424.

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Mechanistic origin of room-temperature phosphorescence in a coumarin derivative: role of tautomerism and spin–orbit coupling

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Room-temperature phosphorescence (RTP) [1] in purely organic systems remains a challenging phenomenon due to inherently weak spin–orbit coupling and efficient non-radiative deactivation channels. Understanding the microscopic mechanisms governing population and decay of triplet states is therefore essential for rational design of efficient emitters. Here, we present a combined spectroscopic and theoretical study of excited-state processes in a 4-hydroxycoumarin derivative (16C [2]), focusing on the origin of its RTP emission. Steady-state and time-resolved measurements performed in liquids and in a rigid poly(vinyl alcohol) (PVA) matrix reveal a transition from dominant fluorescence in solution to long-lived phosphorescence in the immobilized system, with emission lifetimes reaching $\sim 10^{-1}$–10^{0} s and observable afterglow. To elucidate the underlying mechanism, quantum-chemical calculations (DFT and TD-DFT) were employed to analyze the electronic structure, excited-state energetics, and spin–orbit coupling between singlet and triplet states. The results indicate that efficient intersystem crossing occurs via coupling of the lowest singlet excited state of mixed ππ*/charge-transfer character with low-lying triplet states of nπ* nature, in agreement with the El-Sayed rule. Importantly, the accessibility of these pathways is strongly modulated by keto–enol tautomerism, with the diketo form providing favorable conditions for triplet-state population. The combined experimental and theoretical analysis demonstrates that RTP in this system arises from the interplay between electronic structure, tautomeric equilibrium, and environmental restriction of molecular motions.

These findings provide a mechanistic framework for understanding phosphorescence in metal-free systems and offer guidelines for tuning excited-state dynamics in organic luminophores.

[1] DOI:10.1088/2050-6120/ad9885.
[2] DOI: Int. J. Mol. Sci. 2025, 26, doi:10.3390/ijms26147015.

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High-Pressure Raman Spectroscopy and Optical Properties of $Cs_2NaInCl_6$:X (X = Cr, Mo)

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Raman spectroscopy is a powerful method for studying vibrations in solids, molecules, and crystals. It provides direct information about lattice dynamics, local structure, chemical bonding, and structural changes under external conditions. In high-pressure experiments, Raman spectra are especially useful because they can reveal phonon shifts, symmetry changes, and possible phase transitions. For this reason, Raman spectroscopy is an important tool for understanding how materials respond to compression and for linking structural changes with optical properties.

In recent years, perovskite materials have attracted great attention because of their interesting structural and optical properties. Among them, halide double perovskites are especially promising because they can offer better chemical stability and lower toxicity than many lead-based perovskites. These materials are also attractive host lattices for luminescent ions, including transition metals, which can strongly modify their emission properties. As a result, double perovskites are now considered an important group of materials for optical and spectroscopic applications.

In this work, we mainly focus on the basic luminescence properties of $Cs_2NaInCl_6$:X (X = Cr, Mo), especially its emission and excitation spectra. The studied materials show broadband near-infrared emission with a maximum in the 950–1000 nm range, which is related to the presence of Cr^{3+} or Mo dopant ions in the double perovskite host. We then investigate the high-pressure Raman spectra in order to understand how lattice vibrations change under compression and how these changes are related to the optical response of the material.

In addition, we show that 3D printing is a useful tool for high-pressure research. It allows fast and low-cost fabrication of custom parts for the pressure setup, improves repeatability, and simplifies experimental preparation.

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Luminescent and electrical properties of Mg^{2+} or Zr^{4+} co-doped $LiGa_5O_8$:Mn^{2+},Cr^{3+} phosphors

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The study of spinel oxides is attracting considerable attention due to their unique chemical and physical properties and potential applications in phosphors, lasers, and optoelectronic components, etc. Gallate spinel doped with manganese and chromium ions exhibits a diverse set of luminescent properties, regulated by site coordination, valence state, and lattice defects. $LiGa_5O_8$ is a promising host material due to its diverse coordination environments and large number of defects. Due to their similar ionic radii, Li^+ and Ga^{3+} can readily substitute for each other in octahedral sites, leading to the formation of intrinsic defects, such as oxygen vacancies and Li/Ga antidefects.

In this work, $LiGa_5O_8$:Mn^{2+} phosphors co-doped with Cr^{3+} and Mg^{2+}/Zr^{4+} were synthesized by a high-temperature solid-state reaction method. The structural, optical, and electrical properties of the obtained materials were investigated using X-ray diffraction, photoluminescence and photoluminescence excitation spectroscopy, afterglow measurements, and impedance spectroscopy.

The X-ray diffraction results confirmed the formation of the $LiGa_5O_8$ spinel phase. Photoluminescence studies revealed the coexistence of green Mn^{2+} emission, assigned to the $^4T_1 \rightarrow {}^6A_1$ transitions, and red Cr^{3+} emission associated with the $^2E \rightarrow {}^4A_2$ transitions. The persistent luminescence behavior was found to depend on excitation conditions and temperature, indicating the involvement of both shallow and deep trapping states in charge storage and release. Additional co-doping with Mg^{2+} or Zr^{4+} mainly affected the redistribution of intensities among the elementary emission bands. Impedance spectroscopy further showed that the electrical response of $LiGa_5O_8$-based phosphors can be tuned by controlled co-doping with Mn^{2+}/Cr^{3+} and Mg^{2+}/Zr^{4+} ions, reflecting changes in carrier concentration, defect-related conductivity, and charge-transport mechanisms.

These results demonstrate that co-doping with transition-metal and divalent or tetravalent cations enables control over both the luminescent and electrical properties of $LiGa_5O_8$, making this material a promising candidate for optoelectronic applications.

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Color-Tunable Luminescence of Dy-, Tb-, and Eu-Doped Borate Glasses for Phosphor Applications

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Rare-earth-doped borate glasses are promising phosphor materials for solid-state lighting due to their high optical transparency, chemical stability, and homogeneous dissolution of luminescent activators, especially rare-earth ions. In this work, color-tunable borate glass phosphors based on the B_2O_3–ZnO–SrO–CaO–MgO system doped with Dy^{3+}, Tb^{3+}, and Eu^{3+} ions were synthesized and studied for potential applications in light-emitting devices.

The glass samples were prepared by the conventional melt-quenching method using high-purity starting materials, followed by annealing at 450–500°C to reduce internal mechanical stresses and stabilize the amorphous network. Physical characterization showed systematic changes in density and molar volume upon rare-earth doping, indicating the successful modification of the host borate matrix with activator ions. The influence of rare-earth ion type, concentration, co-doping strategy, and excitation wavelength on the optical and photoluminescent properties of the obtained glasses was analyzed. UV–Vis–NIR absorption spectroscopy revealed characteristic intra-configurational 4*f*–4*f* transitions of Dy^{3+}, Tb^{3+}, and Eu^{3+} ions. Judd–Ofelt analysis of selected samples provided information on the local symmetry, covalency of rare-earth–ligand bonds, and radiative transition probabilities. Photoluminescence studies demonstrated that Dy^{3+}-doped glasses had characteristic blue and yellow emission bands associated with transitions from the $^4F_{9/2}$ excited state to the $^6H_{15/2}$ and $^6H_{13/2}$ levels. This enables near-white light emission under excitation at 350 nm, which corresponds to the $^6H_{15/2} \rightarrow {}^6P_{7/2}$ transition. Tb^{3+}-doped samples produce green emission, mainly due to $^5D_4 \rightarrow {}^7F_J$ transitions, while Eu^{3+} ions provide intense orange-red emission dominated by the hypersensitive $^5D_0 \rightarrow {}^7F_2$ transition.

Co-doping with Dy^{3+}/Tb^{3+} and Dy^{3+}/Eu^{3+} enables controlled tuning of the emission color via energy-transfer processes and selective excitation. In particular, Dy^{3+} can act as a sensitizer for Tb^{3+} emission, significantly increasing green luminescence intensity, whereas Dy^{3+}/Eu^{3+} co-doping allows the emission to be shifted from cold-white or near-white toward orange-red depending on the excitation wavelength and dopant ratio. The calculated CIE 1931 chromaticity coordinates confirm that the emission color of the synthesized borate glasses can be tuned over a broad spectral range, including near-white, green, and red regions.

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Compositional Effects on Dosimetric Properties of Potassium Aluminophosphate Glasses

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Phosphate glasses are promising dosimeter materials for radiation detection due to their excellent optical properties and compositional flexibility [1]. Dosimetry using thermally stimulated luminescence (TL) offers high sensitivity and a wide dose-response range. In this study, we prepared potassium aluminophosphate glasses with varying potassium-to-phosphorus (K/P) ratios to evaluate the compositional effects on their dosimetric properties. By analyzing the optical and TL characteristics, we aim to clarify how the K-P ratio influences the trap levels and luminescence behaviors of these glasses.

Photoluminescence (PL) quantum yield (QY) measurements showed that the QY decreased with increasing the K/P ratio, suggesting that changes in the glass network modified the relaxation pathways. In contrast, TL properties exhibited the opposing trend. As shown in Figure 1, the TL glow curves after 100 mGy X-ray irradiation indicate that the TL intensity remarkably increased with the K/P ratio, suggesting that a higher K/P ratio promotes the formation of trapping centers. Furthermore, Figure 2 shows that the samples exhibited excellent linear dose-response behavior over the range of approximately 10 to 1000 mGy. These results demonstrate that increasing the K/P ratio is an effective way to enhance the TL dosimeter performance, despite the reduction in PL QY. Additional dosimetric characteristics, including fading and reproducibility, will be reported in detail during the presentation.

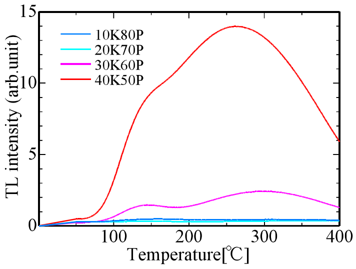

Figure 1 TL glow curves of Ce:K2O–Al2O3–P2O5 glasses after X-ray irradiation.

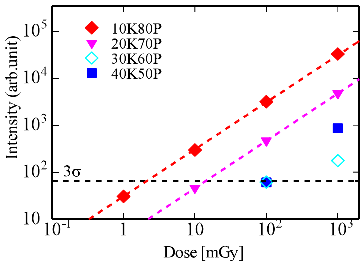

Figure 2 Relationships in TL intensity vs irradiation doses of Ce:K2O–Al2O3–P2O5 glasses.

[1] Y. Miyamoto, et al. (2011) Radiat. Meas., 46, 1480–1483.

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Photoluminescence enhancement of Mn^{2+} via Ti^{4+} co-doping in calcium hexaaluminate phosphor

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Mn^{2+}-doped green phosphors are gaining attention as a sustainable and cost-effective alternative to rare-earth-based materials for applications such as white LEDs (W-LEDs), optical temperature sensing, and persistent luminescence (PersL) materials. Typically, achieving strong Mn^{2+} luminescence requires either synthesis under a reducing atmosphere or sensitization using rare-earth ions.

In this study, we investigate the effect of co-doping $CaAl_{12}O_{19}$:Mn phosphor with tetravalent Ti^{4+} on its optical properties. Our results demonstrate that such co-doping strategy significantly enhances the intensity of green Mn^{2+} emission.

Spectroscopic analysis shows that $CaAl_{12}O_{19}$:Mn synthesized under ambient air exhibits green Mn^{2+} emission at 520 nm and red Mn^{4+} emission at 655 nm under visible-light excitation. Co-doping with Ti^{4+} significantly enhances the Mn^{2+} green emission intensity, leading to more than a tenfold enhancement. Ti^{4+} co-doping completely suppresses Mn^{4+} emission, resulting in a bright green phosphor with a single emission band and PLQY of 65%, achieved without the need for reducing synthesis conditions. The enhanced emission is primarily attributed to the suppression of non-radiative energy transfer from Mn^{2+} to Mn^{3+}/Mn^{4+}quenching centers. The reduction of Mn^{3+} and Mn^{4+} to Mn^{2+} oxidation state has been confirmed by the diffuse reflectance spectroscopy. EPR studies have demonstrated that Mn^{2+} occupies single tetrahedral site an its concentration increases upon co-doping with Ti^{4+}.

Overall, this study establishes co-doping with Ti^{4+} as a viable approach for controlling manganese oxidation states in $CaAl_{12}O_{19}$ to achieve bright green photoluminescence.

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Excitation Energy Transport in Confined Nanoscale Geometries: Theory and Monte Carlo Modeling

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Non-radiative transport of electronic excitation energy, including Förster Resonance Energy Transfer (FRET) and excitation energy migration, plays a key role in the optical properties of nanoscale systems and has numerous applications in bioimaging, biosensing, photonics, and nanotechnology. While classical theoretical models of energy transport were developed mainly for macroscopic and effectively infinite media, their direct application to confined nanoscale geometries is limited.

In this work, theoretical and numerical studies of excitation energy transport in nanostructures of spherical and cylindrical symmetry are presented. Analytical models describing donor fluorescence decay were developed for systems involving Förster-type energy transfer, excitation energy migration within donor ensembles, and combined migration–transfer processes. Particular attention was devoted to hybrid core–shell nanostructures, where chromophores are distributed within the shell volume or attached to the nanoparticle surface.

The proposed models were validated using Monte Carlo simulations based on a step-by-step stochastic algorithm adapted to finite nanoscale geometries. The simulations enabled investigation of the influence of molecular distribution, confinement effects, and geometry on the efficiency and dynamics of excitation energy transport.

The presented results contribute to bridging the gap between experimental studies of nanoscale systems and the theoretical description of excitation energy transport in confined geometries.

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Concentration-dependent luminescence and scintillation properties of Tb-doped KGd(PO_3)$_4$ glasses

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Glass scintillators are attractive radiation detection materials because of their high formability, large-area processability, and low fabrication cost. However, their light yield is generally lower than that of single-crystal scintillators due to structural disorder and defect-related energy loss in the glass network. To address this issue, we have focused on a crystal-stoichiometric composition design, in which the glass composition is based on that of a known efficient luminescent crystal. In this study, Tb-doped KGd(PO_3)$_4$ glasses were prepared, and the effects of Tb concentration on their luminescence and scintillation properties were investigated.

Fig. 1 shows the photoluminescence (PL) spectrum of the Tb-doped glass sample. All the Tb-doped samples showed characteristic Tb^{3+} emission arising from the $^5D_4$–^7F_J transitions under excitation of the host Gd^{3+} ions. The emission intensity and quantum yield changed systematically with Tb concentration, indicating that the luminescence process was strongly influenced by the balance between Gd-to-Tb energy transfer and concentration quenching. The scintillation spectra also showed intense Tb^{3+} emission under X-ray excitation (Fig. 2), and the light yield reached a maximum for the 1.0% Tb-doped sample, with a value of 5500 ph/MeV. Detailed concentration dependences of the emission spectra, decay profiles, and light yield will be discussed in the presentation.

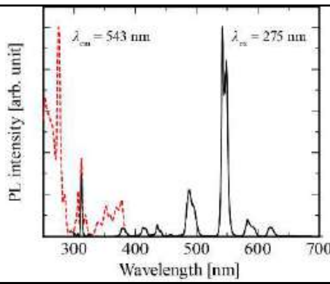	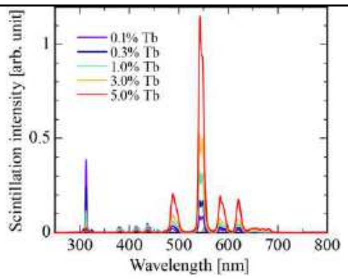
Figure 1 PL spectra of 3.0% Tb-doped KGd(PO_3)$_4$ glass sample.	Figure 2 X-ray induced scintillation spectra of Tb-doped KGd(PO_3)$_4$ glass samples.

[1] G. Lakshminarayana, et al., (2009) J. Alloys Compd., 476, 720–727.

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Defects by Design: Modulating the Spectral Response of Perovskite $LaAlO_3:Fe^{3+}$

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NIR LED emitters are widely used, among others, in medical diagnostics for deep tissue imaging and in therapies supporting tissue regeneration. $LaAlO_3:Cr^{3+}$ is one of the highly efficient phosphors used in medical imaging with NIR LEDs [1]. Since the emission maximum of Cr^{3+} in the aforementioned material occurs at approximately 740 nm, the aim of this work was an attempt to synthesize a phosphor using the same $LaAlO_3$ host matrix, which would exhibit an emission shifted further into the long-wavelength region of the spectrum. For this purpose, $LaAlO_3$ doped with Fe^{3+} ions was obtained, and studies were conducted to investigate the effects of synthesis parameters and host structure modifications through co-doping with B^{3+}, Mg^{2+}, Bi^{3+}, Na^{+}, Ga^{3+}, or Sr^{2+} ions. The obtained results demonstrated that the position of the emission band maximum in the NIR region depends on the synthesis temperature, the ionic radius of the co-dopant relative to the substituted matrix ion, and the co-dopant concentration. This indicates that the investigated parameters allow for the modulation of the emission properties of the studied material within a certain range.

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[1] L. Lu, M. Sun, T. Wu, Q. Lu, B. Huang Chem. Commun., 2021,57, 9366-9369

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Effect of Na co-doping on the OSL properties of K_2SO_4:Ce

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Potassium sulfate doped with cerium (K_2SO_4:Ce) has been recognized to exhibit optically stimulated luminescence (OSL) with emission in the green spectral region, making it a promising candidate for radiation dosimetry applications[1-3]. Previous studies have shown that co-doping with alkali metal ions (e.g., Na^+) can significantly enhance luminescence efficiency in various OSL phosphors, including sulfate-based systems [4-6]. In this work, sodium (Na) was introduced as a co-dopant to investigate its influence on the OSL intensity of K_2SO_4:Ce.

A series of samples with varying concentrations of Ce and Na were synthesized using a controlled preparation method, followed by thermal treatment at 1000 °C for 4 hours to ensure proper crystallization and dopant incorporation. The study focused on optimizing the relative concentrations of Ce and Na to achieve maximal OSL signal intensity. An optimal combination of Ce and Na concentrations yielding the highest luminescence efficiency was identified. The findings provide insight into defect engineering in sulfate-based phosphors and contribute to the development of improved OSL materials.

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Optical signatures of molecular mechanisms in synergistic Amphotericin B systems

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Fungal infections and the ever-increasing resistance of fungi to available drugs are a significant problem in modern medicine, which is driving the search for new effective antifungal drugs for scientists in many fields. A synergistic effect between existing drugs and other bioactive compounds, including both natural and synthetic compounds, may offer an opportunity. However, the key challenge lies in understanding the molecular mechanisms responsible for this synergistic effect.

Our studies have demonstrated the potential of these new compounds to produce synergistic effects when combined with amphotericin B. This work focuses on a spectroscopic approach to analyzing synergistic mechanisms, based on the analysis of optical effects and their correlation with molecular interactions. The studies were conducted on systems containing the gold standard among antifungal antibiotics, amphotericin B. Spectroscopic analysis demonstrated that absorption spectroscopy (UV-VIS) allows for monitoring the state of antibiotic aggregation through characteristic band shifts and changes in the spectral profile. Monomer-aggregate equilibrium analysis for synergistic systems and comprehensive characterization of molecular organization changes were also conducted using other methods, including synchronous spectral measurements, time-resolved single photon counting (TCSPC), circular dichroism (CD), and dynamic light scattering (DLS) measurements. Interpretation of the obtained results was supported by quantum mechanical modeling methods (DFT and TD-DFT), which allowed us to determine how the compounds interact most favorably with AmB in solution.

The obtained results confirmed that for an effective synergistic system to form, partial deaggregation of the antibiotic is necessary. The use of such broad research methods allowed us to determine the preliminary mechanism of synergy with amphotericin B. In the future, these methods may constitute a universal tool for accelerating the search for synergistic antifungal systems or for the rational design of new synthetic compounds with promising properties.

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Scintillation Characteristics of $LaNbO_4$ Single Crystals

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Phosphors exhibiting intrinsic luminescence require no impurities to act as luminescence centers, and homogeneous crystal growth is possible, making them suitable for scintillators in terms of high light yield and high energy resolution. Rare-earth niobates exhibit intrinsic luminescence owing to $[NbO_4]^{3-}$. In particular, because $LaNbO_4$ has a narrow band gap (~4.8 eV) and congruently melts at a low temperature (~1650 °C), $LaNbO_4$ is suitable for scintillators [1,2]. In this study, $LaNbO_4$ single crystals were synthesized, and their luminescence properties were investigated. The as prepared sample and the samples subjected to oxidation and reduction annealing are referred to as the As-prepared, O_2, and H_2 samples, respectively.

Figure 1 shows the X-ray-induced scintillation spectra of the synthesized $LaNbO_4$ single crystals. All the crystals exhibited an emission peak and shoulder at approximately 410 and 480 nm, respectively. This luminescence is attributed to charge transfer between Nb^{5+} and O^{2-} [3]. Compared with the As-prepared sample, the luminescence intensity of the O_2 sample increased, whereas that of the H_2 sample decreased. To quantitatively reveal the effect of annealing, the ^{137}Cs-γ irradiated pulse height spectra of each sample were measured, as shown in Fig. 2. A clear photoelectric absorption peak was observed in all the samples. The light yields were calculated by referring to a commercial Ce-doped Gd_2SiO_5 (Ce-GSO: 7000 ph/MeV). The light yields were 8700, 9400, and 7300 ph/MeV for the As-prepared, O_2, and H_2 samples, respectively. The increase of light yield in the O_2 sample is attributed to the suppression of oxygen defects.

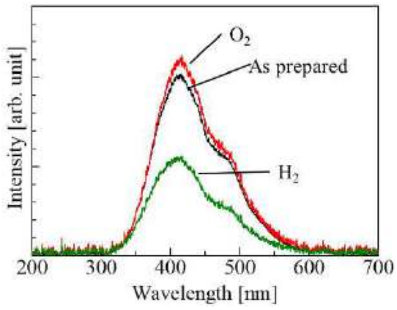

Fig. 1. X-ray-induced scintillation spectra of $LaNbO_4$ single crystals.

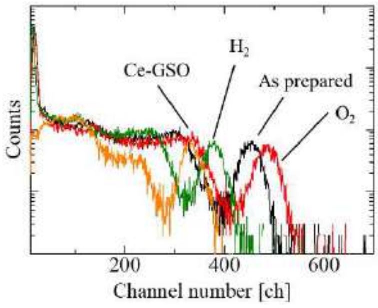

Fig. 2. ^{137}Cs irradiated pulse height spectra of $LaNbO_4$ single crystals and Ce-GSO.

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Optical Labeling with Artificial Intelligence Using Infrared-Responsive Functional Textiles

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In this study, we address the above-said challenges by utilizing a straightforward sol-gel technique for synthesizing a SiO_2/Al_2O_3 monolith (SAM) binary coating using a singular di-sec-butoxyaluminoxytriethoxysilane (DBATES) precursor.[1] The compact structure of the binary coating protects Ag_2S quantum dots (QDs) from external factors such as moisture and oxygen, thereby enhancing their stability. Furthermore, we successfully modified the initial long-chain dodecanethiol ligand to create a hydrophilic SAM surface (Ag_2S@SAM), which improves adhesion to PALF-lyocell yarn. To achieve uniform particle size, the Ag_2S@SAM composite was subjected to a ball-milling process (defined as Ag_2S@SAM-B). Unlike traditional physical printing methods, we integrated fluorescent materials into textiles using a chemical cross-linking technique.[2] This procedure involves using carboxymethyl cellulose sodium salt (CMC) as a dispersant and citric acid (CA) as a cross-linking agent, significantly improving compatibility between Ag_2S QDs and the PALF. After the cross-linking process, the fibers were blended and transformed into fluorescent yarns via conventional industrial yarn production line which involves several processes such as carding, roving drawing, and spinning, resulting in enhancing stability and distribution of the fluorescent PALF into the yarns. Additionally, we explore the potential for SWIR markers to be detected using an infrared camera employing hyperspectral imaging for image recognition and artificial intelligence (AI)-based automatic classification. We developed a two-dimensional convolutional neural network (2D-CNN) to analyze the SWIR images, resulting in an enhancement of AI recognition accuracy to 87% through our algorithms. Finally, we present a comprehensive manufacturing process for integrating fluorescent materials into textiles and demonstrate SWIR image recognition capabilities.

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Eu concentration effects on radio-photoluminescence properties of Eu: $NaSrPO_4$ ceramics

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Radio-photoluminescence (RPL) is a phenomenon where the number of radiation-induced luminescence centers is proportional to the absorbed dose, making it possible to estimate the radiation dose by measuring the luminescence intensity. In recent years, RPL has been expected to find applications not only in radiation dosimetry but also in optical memory devices and high-resolution radiation imaging. Unlike dosimeters using thermally stimulated luminescence (TSL) or optically stimulated luminescence (OSL), RPL dosimeters have the advantage of being able to be read repeatedly while retaining the exposure information. However, the variety of materials exhibiting RPL is limited, and the search for high-performance materials is required. We have previously reported on the excellent RPL properties of Eu-doped $NaCaPO_4$. In this study, we evaluated the RPL properties of $NaSrPO_4$ ceramics, in which Ca was substituted with Sr.

Figures 1 and 2 show the photoluminescence (PL) spectrum of the 0.3 % Eu-doped sample before and after X-ray irradiation. Before irradiation, emission derived from the 4*f*–4*f* transition of Eu^{3+} ions was observed at an emission wavelength of 615 nm with an excitation wavelength of 394 nm (Fig. 1). In contrast, after irradiation, a new emission band attributed to Eu^{2+} appeared at 450 nm under excitation at 280 and 340 nm (Fig. 2). This result suggests RPL centers were likely generated by X-ray irradiation, as evidenced by the characteristic emission appearing under 340 nm excitation. In this presentation, we report on the RPL properties in detail, including the dependence on Eu concentration.

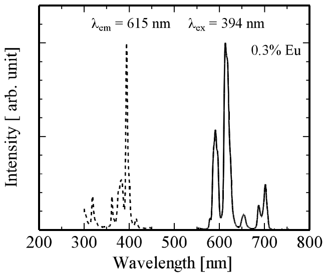

Figure 1 PL spectrum of 0.3% Eu-doped $NaSrPO_4$ ceramic before X-ray irradiation.

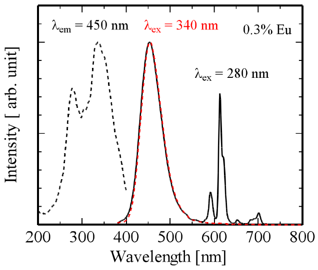

Figure 2 PL spectrum of 0.3% Eu-doped $NaSrPO_4$ ceramic after X-ray irradiation.

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Dipole-Driven Photodetection in 0D/2D Heterostructures Enabled by Ligand Engineering and Insulating Interlayers

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Short-wave infrared (SWIR) photodetectors based on colloidal PbS quantum dots (QDs) have emerged as a cost-effective alternative to traditional semiconductor technologies. [1] However, the mechanisms responsible for photocurrent generation in QD/graphene hybrid systems are still not fully understood. In this work, PbS QDs capped with different ligands, including PbS-OA, PbS-$PbBr_2$, and PbS-EDT, are synthesized to systematically investigate the effect of ligand length. FTIR and GISAXS analyses reveal that the ligand type significantly influences the structural ordering of the QD films.To further probe the charge transfer process, a 10 nm Al_2O_3 insulating layer is inserted between the graphene and QD layers, effectively suppressing direct charge transfer and enabling the identification of a dipole-driven detection mechanism. For devices incorporating short-chain $PbBr_2$ ligands, the insertion of Al_2O_3 leads to a decrease in detectivity (from 5.5×10^{12} to 1.2×10^{12} Jones) along with an accelerated response speed, suggesting that photocurrent generation is dominated by carrier extraction. In contrast, PbS-EDT-based devices exhibit minimal changes after Al_2O_3 insertion, indicating that dipole-induced Fermi level modulation is the dominant mechanism.These findings demonstrate that ligand length plays a crucial role in determining the transition between extraction-driven gain and dipole-driven modulation, providing valuable insights for the design of high-performance, fast, and stable QD/graphene SWIR photodetectors.

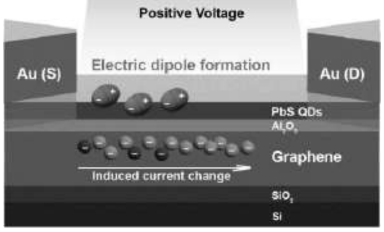

Figure 1. Schematic diagram of depicting the proposed operation model of PbS QDs/graphene photodetector.

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Crystal Structure as a Knob: Modulating Blue-to-UV Upconversion Performance in Pr^{3+}-Doped $REBO_3$ (RE = Y, La, Lu) Phosphors

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The development of Pr^{3+}-based phosphors that efficiently convert blue light into ultraviolet (UV) radiation [1] is a critical challenge for the realization of innovative UV sources, such as phosphor-converted UV LEDs (pc-UV-LEDs). In this work, we present a systematic investigation of Pr^{3+}-doped rare-earth orthoborates $REBO_3$, (where RE = Y, La, Lu) as blue-to-UV upconversion phosphors. We exploit the structural diversity of this family— which contain aragonite-type ($LaBO_3$), pseudo-wollastonite-type (π-$LuBO_3$ and YBO_3), and calcite-type (β-$LuBO_3$) crystal structures [2]—to tune the upconversion performance. Utilizing UV photoluminescence spectroscopy and temperature-dependent time-resolved measurements, we systematically evaluate how the crystallographic environment of the Pr^{3+} ion influences the energy positioning of the $4f^15d^1$ levels [3], the Stokes shift of the UV luminescence, and the thermal quenching temperature (T_{50}). These spectroscopic findings are correlated with the recorded blue-to-UV upconversion spectra to identify the optimal host structure, thereby establishing rational design principles for high-efficiency upconverters. Finally, the practical potential of the selected materials is demonstrated by observing blue-to-UV upconversion under excitation from a commercial 450 nm LED, supporting their applicability in pc-UV-LED devices.

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Structure and optical properties of agarose-based hydrogels

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Recent trends in hydrogel science have spurred extensive research on eco-friendly, biodegradable materials that are safe for health and the environment. Agarose is among the most widely used polysaccharides in molecular biology and biotechnological applications, as well as in the medical, cosmetic, and food industries, because it forms strong gels even at low concentrations. Agarose is transparent in the visible range, making it a potential material for optical fibers, e.g. [1]. The simple method of fiber production and the edibility of agar/agarose make it possible to obtain inexpensive, biocompatible devices suitable for in vivo imaging and light delivery. Importantly, agarose exhibits intrinsic photoluminescence (PL); thus, this property can be used to monitor the state of the gels.

The structure and morphology of the hydrogel were studied during the drying process in an electron microscope chamber. Observations have shown that the fabricated samples, with a thickness of ~4 mm, retain water for several hours. The gel structure changes very slowly over nearly 20 min during drying.

A broad band extending from 375 to 675 nm was observed in the PL spectra of a freshly prepared agarose gel under UV excitation. The profile of the emission spectrum changes slightly during storage under normal conditions due to water loss. This result indicates a complex origin of the emission, that can be caused by presence of multiple luminescence centers. Water coming out of the gel is accompanied by a change in the shape of the long-wavelength band luminescence band. Photoluminescence studies show that the water content of a gel can, in principle, be controlled by monitoring the change in the spectral characteristics of the gel's intrinsic luminescence.

Acknowledgements. The study was financed by the National Research Foundation of Ukraine (project № 2025.07/0341)

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Correlation between tungsten coordination, structure, and optical properties of P_2O_5–WO_3–Na_2O glasses

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Phosphate-based glasses have attracted significant attention as functional materials due to their low melting temperatures, high solubility of rare-earth elements, and flexible glass network structures. In such glasses, tungsten may behave as either a network former or a network modifier, giving rise to distinct structural units, such as tetrahedral WO_4 and octahedral WO_6 species. The coexistence and possible interconversion between tetrahedral and octahedral WO_x units significantly affect the short-range order of the glass network, which can be reflected in characteristic features of infrared (IR) and Raman spectra, as well as in the photoluminescence properties of the materials. The incorporation of rare-earth ions, namely Eu^{3+}, into tungsten-containing phosphate glasses further expands their functional potential.

In the present work, a series of glasses in the P_2O_5-WO_3-Na_2O-Eu_2O_3 system was prepared to elucidate the effect of WO_3 on the structural and luminescence properties of the glasses. Detailed IR and Raman spectroscopic analyses were performed to identify changes in phosphate and tungstate structural units. The presence of WO_6 units is confirmed throughout the entire compositional range, while the relative contribution of WO_4 groups increases with WO_3 content. This result indicates a coexistence of different tungsten-oxygen polyhedra and progressive modification of the glass network. Diffuse reflectance analysis also revealed the formation of absorption bands associated with WO_4 and WO_6 units, and a pronounced reduction in both direct and indirect optical band gaps, even at low WO_3 concentrations. The peculiarities of the Eu^{3+} ions' emission have been used to evaluate the influence of tungsten-related species on excitation energy transfer and luminescence efficiency. The evolution of photoluminescence excitation spectra and the increase in the asymmetry ratio with WO_3 content indicate a growing distortion of the Eu^{3+} local environment, consistent with phosphate network depolymerization and an increasing participation of tungsten-oxygen units. This behavior reflects significant changes in network connectivity and electronic structure induced by tungsten incorporation into the glass network.

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Optical and mechanical properties of cellulose-based nanocomposites embedded with luminescent oxides

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Cellulose and its derivatives can be used as an alternative to plastics in electronics. Related HT technology is called as “paper electronics”. An incorporation of some dopants/fillers into the cellulose matrix allows developing advanced composites, and nanocomposites are among them, suitable for the opto-electronics needs, e.g. for elaboration of luminescent materials, etc [1].

Cellulose matrix can be filled with luminescent particles, carbon or semiconductor quantum dots, coordination complexes, or inorganic phosphors in order to transform the absorption and emission properties of the material.

Here we studied hybrid cellulose based nanocomposites containing simultaneously Ca $CaAl_2O_4$:Eu,Dy; $SrAl_2O_4$:Eu,Dy, and $Sr_{0.95}Ca_{0.05}(SO_4)$:Mn oxides. The noted composites revealed long-lasting photo- and mechano-luminescence with the spectral bands mainly extended in blue, green and red regions of the light, respectively. The samples containing $LiTaO_3$:Pr oxide also showed a red color long-lasting photo- and mechano-luminescence. If to combine the emissions of the noted oxides with intrinsic – blue luminescence of cellulose, it is possible to perform white emission of such a composite system. Concentration dependencies of intensity, spectra, and decay of the luminescence of such produced cellulose composites were studied. Correlation of optical, including luminescent, and color characteristics with mechanical properties of the composites has been discussed, too.

The developed cellulose-based materials can be useful as substrates in flexible paper electronics or as active light-transforming elements of optical devices.

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[1] Chornii V., Nedilko S.G., Lazarenko M. et al. [2025] Renew. Mater., 653.

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Morphology and physical properties of porous oxide materials elaborated from relative glasses

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The studied porous materials were prepared on the basis of a phosphate-molybdate glass, the manufacturing procedure of which can be found in the work [1]. A certain amount of glass was ground to a fine powder with grain sizes of 10 - 50 μm. A homogeneous mixture of the aforementioned powder with polyvinyl acetate (PVAc) powder was prepared by grinding and then compounded. After that, the obtained pelletized material was annealed at a temperature of ~ 450 C for 4 hours. Further slow cooling to room temperature took place in the same furnace for 18 hours. In this way, a concentration (by PVAc) series of the samples was prepared.

Infrared absorption and Raman spectroscopy were applied to study the structure of the material produced and also to reveal residual traces of PVAc.

A micro hardness measurements showed that the hardness values became strongly lower if compared to the glass pre-cursor samples.

A number of various SEM images showed a formation of the large size, 10 - 50 мкм, pores, while a network of the nanosized pores (10 - 30 nm) was found too.

The volt-ampere characteristics of the manufactured tablets were measured in the direction transverse to their planes in the range from -50 to +50 V and vice versa. The peculiarities of V-A dependences and their correlation with structural and morphological characteristics have been discussed.

The tablets filled with luminescent $SrAl_2O_4$:Eu,Dy oxides allowed visualization of the pores in luminescent microscopes. Moreover luminescent spectroscopy showed the changes in the photoluminescence spectra if compare to the spectra of the ”free” luminescent oxide. Thus manifesting an interaction between oxide and glass-ceramics matrix.

Acknowledgements. The authors are grateful to Kateryna Terebilenko, Doctor of Chemical Sciences (Taras Shevchenko National University of Kyiv) for kindly providing phosphate-molybdate glass for the experiments.

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Spectroscopic properties of Cr^{3+}:YGG ceramics

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Cr-doped materials find an application as NIR LEDs, solid state lasers, luminescent thermometry, etc.. However, the presence of parasitic processes, such as energy transfer, can reduce the performance of such devices. One such process is the energy-transfer "chain" phenomenon, in which the absorbed energy by one ion is transferred among the multiple Cr^{3+} ions before being emitted or transferred to a luminescence quenching center. This phenomenon can also induce changes in the emission spectra.

It was shown earlier that an increase in Cr^{3+} concentration led to a redshift of the emission of Cr^{3+}:YGG nanocrystals, while the crystal field strength remains nearly unchanged [1]. These changes were observed at low temperatures, whereas at room temperature the emission spectra remain similar. This behavior has been attributed to the energy-transfer "chain" phenomena. The presence of Cr^{3+} ions in a weak crystal field among interacting ions promotes emission from these sites, resulting in a redshifted emission.

The proposed energy transfer chain phenomenon was used to explain changes in Cr^{3+} emission in nanopowders [1] and nanoceramics [2]. However, the observed patterns could be attributed to the inhomogeneous microstructure of the investigated nanomaterials. Therefore, it remains unclear whether similar behavior occurs in bulk materials. If the proposed hypothesis is valid, a similar pattern should be observed in bulk materials with the same compositions [1].

In this work, we present a detailed study of the spectroscopic properties of Cr^{3+}:YGG ceramics doped with 0-5 at.% of Cr^{3+}. It was shown that increasing the Cr^{3+} concentration results in a redshift of the emission spectra, consistent with earlier results for the nanopowders of the same compositions [1]. These spectral changes are interpreted in terms of energy transfer between Cr^{3+} ions occupying octahedral sites with different local crystal-field strengths. The results support the existence of multiple inequivalent Cr^{3+} centers in the YGG ceramic and indicate that excitation energy migration between them plays an important role in shaping the overall luminescence spectra.

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Adaszyński Marek	**O11**	
Afandiyev Fikrat		
Anders Krzysztof		**P3**
Bachiri Abdellah	**O30**	
Back Michele	**IL18**, O14	
Baran Anna		
Bartosiewicz Karol	**IL6**	
Barzowska Justyna	IL5, O26	
Basheer Ayisha		**P4**
Bausá Luisa	**IL26**	P33
Bednarkiewicz Artur	**IL2**	
Behera Mitrabhanu	O1	**P5**
Bojarski Piotr		P25, P41
Borysiuk Viktor		**P51**, P53
Boutinaud Laurence		
Boutinaud Philippe	**IL24**	
Carneiro Neto Albano	**IL29**	
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