PRE ATAM 2020

Wrocław, Poland, 13th - 15th October 2020

Symposium on Advanced Technologies and Materials

13-15/10/2020

preATAM 2020 Online Symposium

Book of Abstracts

FOREWORD

Dear Participants and Speakers of preATAM2020!

We are extremely glad and happy that you have taken part in our conference preATAM2020! We would like to thank you all once again for sharing your brand new research!

We would specifically like to thank our speakers!

Wilfried BLANC, Georges BOULON, Luís CARLOS, Agata KAMIŃSKA, Gerd MEYER, Anja-Verena MUDRING, Mark RÜMMELI, Huy Q. TA, Bruno VIANA

your speeches reminded all of us how much our lives are driven by scientific news!

We would also like to congratulate our winners!

Nina Kaczorowska for "*Energy conversion processes in rare earth ternary vanadates doped with Bi^{3+} ions" and* **Zhuorui Lu** for *"Nanoparticles elongation in silica optical fiber induced by drawing process – A morphology study".*

And a special congratulation to **Gabriella Tessitore** for "*The key role of intrinsic lifetime dynamics from upconverting nanosystems in Multiemission Particle Velocimetry"*

The PreATAM 2020 had the main priority to gather scientist around the globe to build up a community being able to unitedly elaborate on science. This particular symposium grew in a unique idea of establishing the opportunity to bring together scientists working in different areas – chemist, physicists and engineers, whose main research topic is to develop efficient optical materials, 2D layers and miniaturized photonic devices.

The host and organizer of the meeting, Łukasiewicz Research Network – PORT Polish Center for Technology Development provided us with the possibility to meet virtually.

We have been delighted to welcome you at our conference!

In this place to, we would love to invite you to the next edition of our conference ATAM 2021.

preATAM2020 organizing committee

ORGANIZERS

preATAM2020 honorary chairs

Alicja Bachmatiuk, Łukasiewicz – PORT

She defended her master's thesis in chemical technology at the Szczecin University of Technology in 2005, in 2009 she obtained her Ph.D. degree at the same university. She obtained a postdoctoral degree in chemical sciences at the Warsaw University of Technology in 2017. She completed a postdoctoral fellowship at IFW Dresden, Germany, as a scholarship holder of RTN Marie Curie and the Alexander von Humboldt Foundation (2009-2012). She worked as a Research Professor (2013-2015) at Sungkyunkwan University, Suwon, South Korea. Since 2013 she has been conducting research on the production and characterization of two-dimensional materials, including graphene in cooperation with Polish and foreign research units. From 2015 she is a visiting professor at Soochow University, Suzhou, China. Winner of the Ministry of Education's scholarship for outstanding young scientists (2016), implemented 3 research grants (Alexander von Humboldt, FNP Homing Plus, NCN Sonata). Currently, the manager of three research grants from the National Science Center, FNP and National Center for Research and Development.

Joanna Cybińska, Łukasiewicz – PORT

Joanna Cybińska, Ph.D. is the Leader Advanced Materials Synthesis Group [AdMat Group] in Łukasiewicz Research Network – PORT Polish Center for Technology Development. Graduated from the Faculty of Chemistry at the University of Wroclaw, her reseach activitiy is mainly concentrated on the on synthesis and optical investigations of inorganic luminophors, including crystals, but also nanomaterials, doped with lanthanide ions as luminescent centers. She has been one of the Handling Editors of Optical Materials (Elsevier). She was secretary of many International conferences including : Excited States of Transition Elements and Workshop on Luminescence (ESTE2010 and ESTE2016), International Conference on Luminescence and Optical Spectroscopy of Solids (ICL14), International Conference on Rare Earth Materials (REMAT) Advances in Synthesis, Studies and Applications, REMAT2013 and IS-OM8th.

ORGANIZERS

preATAM2020 honorary chairs

Symposium Chair – Kacper A. Prokop

During my bachelor studies of Medical Chemistry at the Department of Chemistry, University of Wrocław, I joined the Luminescent Materials Group under the supervision of dr Joanna Cybińska. Earning my first academic degree on the research focused on Nd3+-doped LuPO4 micro and nanopowders allowed me to be recognised locally (finalist in the Golden Medal in Chemistry 2019 contest awarded by Institute of Physical Chemistry Polish Academy of Science) and internationally (Congratulations of the Jury for a poster presentation at the Photoluminescence in Rare Earths: Photonic Materials and Devices, 2019, Nice). Currently my passion for science is being developed as studying a master degree in Medical Chemistry at the University of Wrocław and working at Łukasiewicz – PORT.

Scientific Secretary – Jakub Pawłów

My adventure with luminescent materials has begun during my bachelor studies at the Faculty of Chemistry at the University of Wrocław. On the second year of studying Medicinal Chemistry under the supervision of dr. Joanna Cybińska, I started working in the Luminescent Materials Group. Thanks to this cooperation, my bachelor thesis on YPO4 micro-powders doped with Nd3+ ions was created. The research on this compound was extended and the results were presented at international conferences in Wrocław and Nice. Now I am broadening my scientific horizons researching for a master's degree at the University of Wrocław and working in Łukasiewicz – PORT.

Scientific Secretary – Maria Zdończyk

During my master's studies, I joined the Luminescent Materials Group, where my supervisor was Dr. Joanna Cybińska. I worked in projects concerning luminescent dyes, ionic liquids for photonics, and lanthanide orthophosphates nanoparticles during my studies. After the first year of studies, I received a scholarship from the Minister of Science and Higher Education for outstanding scientific achievements.I am currently researching orthophosphates nanoparticle synthesis and organic dyes while working in the Łukasiewicz – PORT.

INVITED SPEAKERS

Wilfried BLANC
French National Centre for Scientific Research – CNRS, France
Institut de Physique de Nice, France
Doctor of physics, CNRS Research Director working at Fibre Optics and Applications Team of Institut of Physiquein Nice, France. He received the PhD degree at University Claude Bernard in Lyon. His main interests are the design and analysis of rare-earth-doped silica optical fibers for applications as transmission fibers and amplifying fibers for telecommunications, high-power fiber lasers, silica-based fibers containing nanoparticles of composition adapted to the intended application. In 2019 he was one of Co-chair of 8th International Workshop on Photoluminescence in Rare Earths: Photonic Materials and Devices (PRE) organized in Nice.

Georges BOULON
Claude Bernard University Lyon1, France
Professor at Institut Lumière Matière (ILM), UMR5306 Université Claude Bernard Lyon1 (UCBLyon1) and CNRS in France. Doctor honoris causa of the Autonomous University of Madrid and University Rovira i Virgili, Tarragona in Spain as well as University of Wrocław, Poland. An honorary member of the Academy of Sciences, Literature and Art in Lyon, a visiting Professor at Tohoku University in Sendai in Japan and Oklahoma City University, the University of Wisconsin-Madison in USA and Distinguished Professor at Shanghai Institute of Optics and Fine Mechanics, CAS, China. He is physicist specializing in atomic and molecular spectroscopy of luminescent materials. His main interests are focused structural and spectroscopic studies of d-and f-elements-doped inorganic optical materials in the form of single crystals, polycrystalline transparent ceramics and glasses with potential applications for lasers, phosphors, scintillators.

Luís CARLOS,
University of Aveiro, Portugal
Professor at the Department of Physics, University of Aveiro and correspondent member of the Lisbon Academy of Sciences (Physics) and Brazilian Academy of Sciences (Chemistry). Since 2009 he has been the vice-director of CICECO – Aveiro Institute of Materials at Aveiro, Portugal. His scientific work is focused on inorganic hybrids, silicates, nanocrystals and metal organic frameworks; applications of organic–inorganic hybrids in solid-state lighting and integrated optics, and nanoparticles as new probes for multimodal imaging.

INVITED SPEAKERS

Agata KAMIŃSKA,
Cardinal Stefan Wyszynski University, College of Science, Poland
Polish Academy of Science, Poland

Associate Professor at Institute of Physics, Polish Academy of Sciences and at Cardinal Stefan Wyszynski University, College of Science, where since 2017 she is the Head of Physics Department. She is involved in a spectroscopic study of semiconductors (especially nitride and oxide layers or heterostructures), and rare earth ions doped materials (both dielectrics and semiconductors). As a main research tool she use high-pressure technique, i.e. high-pressure spectroscopy in diamond anvil cell.

Gerd MEYER,
Royal Institute of Technology, Sweden
Universität zu Köln, Germany

Professor at the KTH Royal Institute of Technology, Stockholm, Sweden. Most of his life he spent as a Chair of Inorganic Chemistry at the University of Cologne. He has been a Fellow of the Royal Society of Chemistry since 2009 and a member of the American and German Chemical Societies. His scientific achievements are rich in transition and rare earth metals halide coordination chemistry. The interests of Prof. Meyer include evaluation of properties of solids, their optical and magnetic properties as well as structure determination.

Anja-Verena MUDRING,
Stockholm University, Sweden

Professor at the Department Of Materials And Environmental Chemistry at Stockholm University, Sweden. Her main scientific interests focus on green chemistry and rear earth metals research. The thorough development of new environment friendly synthesis and luminescence materials stays in great agreement with her research motto. She strongly believes that fusing theory with practice truly allows to understand the fundamental structure-property relationships with the aim to design new materials for energy related applications.

INVITED SPEAKERS

Mark RÜMMELI,
Soochow Univeristy, USA
Wuhan University, China
Polish Academy of Sciences, Poland

Professor of chemistry, he spent several years working in the Leibniz Institute for Solid State and Materials Science, Dresden, in Germany, where he was responsible for founding the Molecular Nanostructures Group. Currently he works as a full professor at the College of Energy & at the Soochow Institute for Energy & Materials Innovations (SIEMIS), at Soochow University, in China. Professor Mark H. Rümmeli has published many papers appearing in leading journals such as Science and Nature Nanotechnology. His areas of interest are the synthesis of nano-materials and electron beam materials science.

Huy Q. TA,
Leibniz Institute for Solid State and Materials Research Dresden (IFW-Dresden), Germany

Postodoctoral research fellow under the Alexander von Humboldt fellowship at the Leibniz Institute for Solid State and Materials Research Dresden (IFW-Dresden), Germany. He obtained his Ph.D. in Chemistry at the Polish Academy of Sciences, Poland in 2017. His research focuses on the synthesis and characterization of 2D materials as well as their in-situ interaction with electron beams at the atomic level in the high resolution electron microscopes.

Bruno VIANA,
PSL Research University,
Chimie ParisTech – CNRS, France

Doctor of Materials Science, CNRS Research Director, currently a Senior Scientist in the Material Sciences Department (IRCP Laboratory) and Associate Professor at Chimie-ParisTech – PSL in Paris, France. Visiting professor at Kyoto University and the South China University of Technology. He specializes in materials for laser, scintillation and bioimaging using persistent luminescence nanomaterials. Author of several scientific papers as well as book chapters on materials for photonic. Since 2014 he is responsible of the renowned CNRS research network CMDO+. He organized and co-chaired many international conferences like ICOM devoted to physics of optical materials and devices, or other workshops and symposia.

TIMETABLE

	October 13th	October 14th	October 15th
11:00-12:30	***12:30 Opening**	Online poster session	Online poster session
13:00	**Anja-Verena MUDRING**	**Mark RÜMMELI**	**Bruno VIANA**
14:00	**Gerd MEYER**	**Wilfried BLANC**	**Agata KAMIŃSKA**
15:00	**Luís CARLOS**	**Huy Q. TA**	**Georges BOULON**
16:00-16:15			**Closing**

PROGRAM

13.10.

Anja-Verena MUDRING: Ionic Liquids as a Critical Enabling Technology for Meeting Current and Future Needs in Energy

Gerd MEYER: Titanium Halides and Kinfolk

Luís CARLOS: It's Getting Hot in Here: Intracellular Temperature Sensing Through Light Emission

14.10.

Mark RÜMMELI: Lab in a S/TEM

Wilfried BLANC: Nanoparticles in optical fibers: a stimulating oxymoron

Huy Q. TA: Stranski Krastanov and Volmer Weber CVD Growth Regimes to Control Stacking Order in Bilayer Graphene

15.10.

Bruno VIANA: Materials for scintillation and bioimaging. Focus on the control of the kinetics

Agata KAMIŃSKA: Application of high pressure spectroscopy in the study of rare earth doped garnets

Georges BOULON: Examples of Nd^{3+} spectroscopy: the $4f^3$ intra-configurational transitions in Lu_2O_3 ceramics for laser source and the $4f^25d$-$4f^3$ interconfigurational transitions in $20Al(PO_3)_3$-$80LiF$ glass as potential neutron scintillator

Ionic Liquids as a Critical Enabling Technology for Meeting Current and Future Needs in Energy

Anja-Verena Mudring, [a)]

[a)] Physical Materials Chemistry; Dept. of Materials and Environmental Chemistry, Svante Arrhenius väg 16c, SE-18541 Stockholm; anja-verena.mudring@mmk.su.se

Energy consumption is one of the most challenging issues that humankind is facing. Approximately 20% of the world´s energy is used for lighting. It is therefore important to reduce the energy consumption of lighting devices and increase their efficiency. For that reason, the old incandescent lamp which has been used for illumination for over 130 years is being phased out around the world. The most common replacement are CFLs (compact fluorescent lamps), which have certain drawbacks related to the mercury content. LEDs (light emitting diodes) have become competitive for illumination as energy efficient lighting sources. Thus, there is a significant driving force to look for improved, alternative lighting sources and technologies. The discovery of OLEDs (organic light-emitting diodes) marks a significant progress in this direction. However, one of the major drawbacks of OLEDs for lighting applications is their complex device architecture and air-sensitivity which makes them expensive to manufacture and prone to de-composition. The alternative, LECs (light emitting electrochemical cells) can be as simple as being only composed of a light emitting material sandwiched between two electrodes (one reflective electrode: widely the cathode and a second transparent electrode: usually the anode to allow light to exit the device) and LECs are promising as a low cost large area future lighting technology which allows overcoming the problems of OLEDs. However, still efficient emitter materials that have a significant lifetime need to be provided for this technology to enter the market.

The talk will show how for each of the advanced lighting technologies, such as CFLs, LEDs and LECs, ionic liquids allow for a major improvement. Specific focus will be put on the synthesis of new emitter materials using ionic liquid technologies.

References:

[1] J. Namanga, V. Smetana, H. Pei, N. Gerlitzki, A.-V. Mudring, Fluorinated cationic iridium(III) complex yielding an exceptional efficient and long term stable red light emitting electrochemical cell, ACS Energy Mat., **2020**, 3, 9271-9277. DOI: 10.1021/acsaem.0c01600.

[2] J. Namanga, V. Smetana, N. Gerlitzki, **A.-V. Mudring**, Efficient and long lived green light emitting electrochemical cells, Adv. Func. Mat., **2020**, 30, 1909809. DOI: 10.1002/adfm.201909809.

Titanium Halides and Kinfolk

Gerd H. MEYER, [a]

[a] *Department of Chemistry, Royal Institute of Technology (KTH), Teknikringen 42, 114 28 Stockholm, Sweden;*
gerdm@kth.se

After the discovery that lead(II) halide perovskites, for example $CsPbBr_3$ and derivatives, can play an important role in solar cell technology, many laboratories around the World are vigorously performing research aiming at substitutes and better performing inorganic or inorganic/organic hybrid compounds. Starting with a report on $Cs_2[TiBr_6]$, a survey of binary, ternary and higher complex titanium halides in the oxidation states +4, +3, +2 as well on mixed-valence halides and compounds with an undefined oxidation state of titanium is given. Most of the highlighted compounds have been synthesized and structurally characterized by my students during my career at the Universities of Gießen, Hannover and Ko ln (Cologne). Neighboring elements, titanium's kinfolk, are included in the survey, almost all of the early transition metals up to group 7, with a special emphasis on cluster compounds. The survey ends up with a remark on $Cs_2[\{Mo\}_6I_{14}]$, a dark red cluster complex compound which can act as a light harvester in all-inorganic solar cells.

It's Getting Hot in Here: Intracellular Temperature Sensing Through Light Emission

Luis D. CARLOS, [a)]

[a)] A Phantom-g, CICECO-Aveiro Institute of Materials, Physics Department, University of Aveiro, Campus Universitário de Santiago, 3810-193 Aveiro, Portugal;
lcarlos@ua.pt

The emergence of luminescent nanothermometry during the last decade opened up the possibility of measure thermal flows at spatial scales below 10 µm, unreachable by conventional electrical methods [1]. Diverse phosphors capable of providing a contactless thermal reading through their light emission properties have been examined, e.g., polymers, DNA or protein conjugated systems, organic dyes, quantum dots, and trivalent lanthanide (Ln^{3+}) ions incorporated in organic-inorganic hybrids, multifunctional heater-thermometer nanoplatforms, upconverting, downconverting and downshifting nanoparticles. The implementation of these Ln^{3+}-based phosphors (with an emphasis in upconverting nanoparticles) as ratiometric thermometers was extensively reviewed in the past five years [1].

In the last couple of years, the focus of luminescence thermometry has gradually shifted from the fabrication of more sensitive nanoarchitectures towards the use of the technique as a tool for thermal bioimaging and the unveiling of properties of the thermometers themselves and their local surroundings, as, for instance, the instantaneous ballistic velocity of Brownian nanocrystals suspended in both aqueous and organic solvents [2].

After a general perspective of the work done on luminescence nanothermometry since the explosion of the field at one decade ago, the lecture will be focused on a recent example [3] illustrating the potential of the technology to measure the intracellular temperature.

References:

[1] C. D. S. Brites, S. Balabhadra, L. D. Carlos, Adv. Opt. Mater., Vol. 7, **2019**, 1801239
[2] C. D. S. Brites, X. Xie, M. L. Debasu, X. Qin, R. Chen, W. Huang, J. Rocha, X. Liu, L. D. Carlos, Nature Nanotech., Vol. 11, **2016**, 851.
[3] R. Pin ol, J. Zeler, C. D. S. Brites, Y. Gu, P. Te llez, A. N. Carneiro Neto, T. E. da Silva, R. Moreno-Loshuertos, P. Fernandez-Silva, A. Isabel Gallego, L. Martinez-Lostao, A. Martínez, L. D. Carlos, A. Milla n, Nano Lett,Vol.. 20/9, **2020**, 6466.

Lab in a S/TEM

Mark H. RÜMMELI [a)]

[a)] *Soochow Univeristy, USA*
[b)] *Wuhan University, China*
[c)] *Polish Academy of Sciences, Poland*

A key feature of my research is to develop a transmission electron microscope (TEM) into an atomic-scale laboratory to fabricate, modify and characterize samples so that crucial structure property studies and synthesis studies can be conducted in high spatial resolution and high temporal resolution. Thus, the core of this presentation will look at a variety of electron beam driven chemical reactions and electron beam engineering techniques in which we can fabricate and manipulate nano-materials.

Nanoparticles in optical fibers: a stimulating oxymoron

Wilfried BLANC[a], Zhuorui LU[a], Jorel FOURMONT[b], Isabelle MARTIN[c], Hugues FRANCOIS SAINT-CYR[d], Martiane CABIE[e], Thomas NEISIUS[e], Carlo MOLARDI[f], Daniele TOSI[f], Franck MADY[a], Mourad BENABDESSELAM[a], Franck PIGEONNEAU[g], Stéphane CHAUSSEDENT[b], Christelle GUILLERMIER[h]

[a]Université Côte d'Azur, CNRS, Institut de Physique de Nice, UMR7010, 06108 Nice, France; [b] Laboratoire de Photonique d'Angers (LphiA)- EA 4464, Université d'Angers, 49045 Angers Cedex 01, France; [c]CAMECA Instruments Inc., 5470 Nobel Drive, Madison, WI, 53711, USA; [d] Thermo Fisher Scientific, 5350 NW Dawson Creek Drive, Hillsboro, OR, USA; [e]Aix Marseille Université, CNRS, Centrale Marseille, FSCM, CP2M, Marseille, France; [f]Nazarbayev University, Department of Electrical and Computer Engineering, 010000 Nur-Sultan (Astana), Kazakhstan; [g]MINES ParisTech, PSL Research University, CEMEF - Centre for material forming, UMR 7635, 06904 Sophia-Antipolis, France; [h]Carl Zeiss SMT, Inc., One Corporation Way, Peabody, MA 01960 USA
wilfried.blanc@inphyni.cnrs.fr

Since the ground-breaking discovery done in the 1960s by Charles K. Kao, the perfect glass, i.e. the most transparent glass, drives the development of optical fibers. Meanwhile, to overcome some limitations imposed by the silica glass, one recent strategy consists of embedding nanoparticles in the core of the optical fiber [1]. However, nanoparticles and silica glass have different refractive indices, leading to light scattering. To avoid this issue, it was required to prepare the smallest nanoparticles. Despite the promising interest for such fibers, scarce results were published over the last 20 years. During this presentation, we will discuss on the role of the drawing step as an efficient top-down fabrication process to control the shape and the size of the nanoparticles. Then, we will analyze the chemical composition of nanoparticles demonstrating that we need to reconsider the doxa ”the smallest, the better” [2]. We also present some results taking advantage of light scattering to promote new fiber sensors [3]. All these results give new insights to the development of nanoparticles-containing optical fibers.

References:

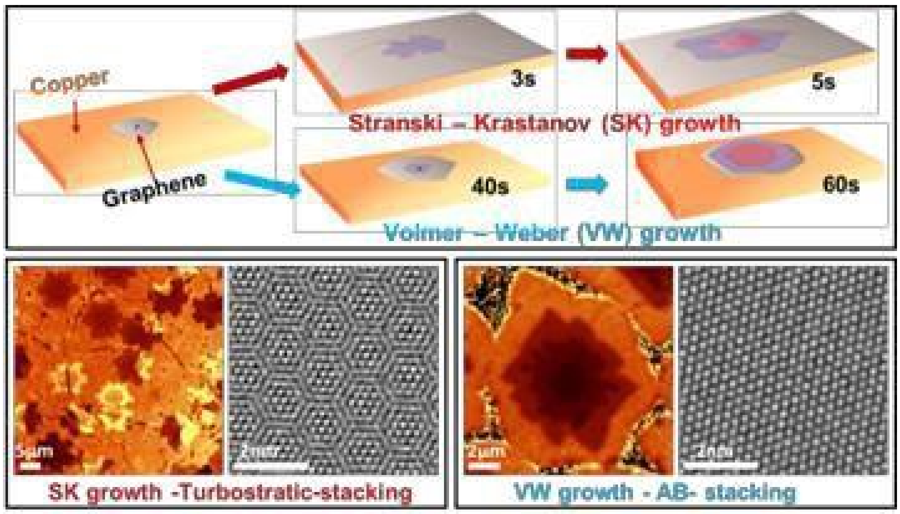
[1] A. Veber et al., Nano-structured optical fibers made of glass-ceramics, and phaseseparated and metallic particle containing glasses, Fibers, Vol. 7, 2019, 105.
[2] W. Blanc et al., Compositional changes at the early stages of nanoparticles growth in glasses, J. Phys. Chem. C, Vol. 123, 2019, 29008-29014.
[3] D. Tosi et al., Enhanced backscattering optical fiber distributed sensors: tutorial and review, IEEE Sensors, accepted, doi; 10.1109/JSEN.2020.3010572.

Stranski-Krastanov and Volmer-Weber CVD Growth Regimes to Control Stacking Order in Bilayer Graphene

Huy Q. TA, [a)]

[a)] *IFW Dresden, P.O. Box 270116, D-01171 Dresden, Germany.*
q.h.ta@ifw-dresden.de

Aside from unusual properties of mono-layer graphene, bi-layer has been shown to have even more interesting physics, in particular allowing bandgap opening with dual gating for proper interlayer symmetry. Such properties, promising for device applications, ignited significant interest in understanding and controlling the growth of bi-layer graphene. Here we systematically investigate a broad set of flow rates and relative gas ratio of CH_4 to H_2 in atmospheric pressure chemical vapor deposition of multi-layered graphene. Two very different growth windows are identified. For relatively high CH_4 to H_2 ratios, graphene growth is relatively rapid with an initial first full layer forming in seconds upon which new graphene flakes nucleate then grow on top of the first layer. The stacking of these flakes versus the initial graphene layer is mostly turbostratic. This growth mode can be likened to Stranski-Krastanov growth. With relatively low CH_4 to H_2 ratios, growth rates are reduced due to a lower carbon supply rate. In addition bi, tri and few-layer flakes form directly over the Cu substrate as individual islands. Etching studies show that in this growth mode subsequent layers form beneath the first layer presumably through carbon radical intercalation. This growth mode is similar to that found with Volmer-Weber growth and was shown to produce highly oriented AB-stacked materials. These systematic studies provide new insight into bi-layer graphene formation and define the synthetic range where gapped bilayer graphene can be reliably produced.



Materials for scintillation and bio-imaging, Focus on the control of the kinetics

Bruno VIANA, [a]

[a] *PSL University IRCP Chimie-ParisTech,*
11 Rue P&M Curie, 75005 Paris, France
bruno.viana@chimie-paristech.fr

In medical imaging, the development of luminescent materials in various shapes (from single crystals to nanoparticles) requires perfect materials with high fluorescence intensity but also with careful control of the defects which could affect the kinetic of the luminescence. For instance, afterglow should be avoided in the scintillator crystals in order to obtain clear and fast images in widely developed PET scan imaging and CT tomography (gamma rays and X-rays imaging respectively). The defects/traps must be carefully controlled to avoid room temperature detrapping and afterglow emission which alter the images. Furthermore, on the opposite case, there is a recent large interest for materials with long afterglow luminescence, also called persistent luminescence.

Persistent luminescence is a singular property of some materials which are able to store the excitation or light irradiation energy at intrinsic traps or defects before slowly emitting photons within several hours. Several new applications are envisioned with these materials such as emergency signing, luminous painting, etc. Recently this concept was also proposed for the development of new optical imaging modalities. At nanoscale, deep red and near-infrared persistent luminescence nanoparticles enable highly sensitive in vivo optical detection and complete avoidance of tissue autofluorescence. Persistent luminescence can be activated in vivo through living tissues using highly penetrating low energy photons, for that purpose with proposed recently an optimized material [1]. Surface functionalization of this photonic probe can be adjusted as well as the wavelength of the optical stimulation to favour multiple challenging biomedical applications [2].

References:

[1] Pan, Z., Castaing, V., Yan, L., Zhang, L., Shao, K., Zheng, Y. , Duan, C., Liu, J., Richard, C., Viana, B., Facilitating Low-Energy Activation in the Near-Infrared Persistent Luminescent Phosphor $Zn_{1+x}Ga_{2-2x}Sn_xO_4:Cr^{3+}$ via Crystal Field Strength Modulations, Journal of Physical Chemistry, Vol. 124, **2020**, 8347-8358.

[2] [2] Liu, J., Lécuyer, T., Saguin, J., Mignet, N., Scherman, D., Viana, B., Richard, C., Imaging and therapeutic applications of persistent luminescence nanomaterials, Advanced Drug Delivery Reviews, Vol. 138, **2019**, 193-210

Application of high-pressure spectroscopy in the study of rare-earth doped garnets

Agata KAMINSKA, [a),b)]

[a)] *Cardinal Stefan Wyszynski University, Faculty of Mathematics and Natural Sciences. School of Exact Sciences, Dewajtis 5, 01 815 Warsaw, Poland*

[b)] *Institute of Physics, Polish Academy of Sciences, Aleja Lotnikow 32/46, PL 02668 Warsaw, Poland*

agata.kaminska@uksw.edu.pl

Garnet crystals with various dopants are nowadays attracting a lot of attention due to their advantageous optical properties by which these compounds can be widely used as phosphors, scintillators or laser crystals. Especially important in this field are the garnets doped with rare-earth ions, which can be easily grown using various methods.

One of the most important issues in a deep understanding of the mechanisms of RE dopant luminescence is to determine the location of its energy levels with respect to the valence and conduction bands of the host crystal, and a detailed investigation of the involved energy transfer processes. Since the application of pressure affects both the strength of the crystal field experienced by the dopant ion and the energy structure of the crystal matrix , high-pressure spectroscopy is very well suited for these purposes.

In this work, the results of high-pressure studies of $Gd_3Ga_5O_{12}$(GGG),$Y_3Ga_5O_{12}$:Ce (YGG:Ce)and $Y_3Al_5O_{12}$(YAG) crystals doped with Nd, Yb or Ce ions will be presented. First, the influence of pressure on the intra-configurational 4f → 4f transitions of Yb^{3+} ions will be shown[1]. Then theorigin of the removal of splitting of the $^4F_{3/2}$ level of Nd^{3+}dopant in GGG by applying the pressure will be discussed[2]. Finally, the pressure-induced pronounced increase of the luminescence efficiency of Ce^{3+}doped GGG and YGG will be analysed[3, 4]. A model explaining this effect will be discussed.

References:

[1] Kamińska, A., Biernacki, S., Kobyakov, S., Suchocki, A., Boulon, G., Ramirez, M. O., Bausa, L., Phys. Rev. B 75, **2007** 174111-1-5

[2] Kamińska, A., Buczko, R., Paszkowicz, W., Przybylinska, H., Werner Malento, E., Suchocki, A., Brik, M., Durygin, A., Drozd, V., Saxena, S., Phys. Rev. B 84, **2011**, 075483 1 6

[3] Kamińska, A., Dużyńska, A., Berkowski, M., Trushkin, S., Suchocki, A., Phys. Rev. B 85, **2012** , 155111-1-10

[4] Wittlin, A., Przybylińska, H., Berkowski, M., Kamińska, A., Nowakowski, P., Sybilski, P., Ma, Chong Geng, Brik, M.G. G., Suchocki, A., Opt. Mater. Express 5, **2015**, 1868-1880

Examples of Nd^{3+} spectroscopy : the $4f^3$ intra-configurational transitions in Lu_2O_3 ceramics for laser source and the $4f^25d$-$4f^3$ inter-configurational transitions in $20Al(PO_3)_3$-80LiF glass as potential neutron scintillator.

Georges BOULON [a], **Yannick GUYOT** [a], **Malgorzata GUZIK** [b], **Nobuhiko SARUKURA** [c], **Melvin EMPIZO** [c], **Akira YOSHIKAWA** [d]

[a] Institute Light-Matter, Claude Bernard/ Lyon1University and CNRS, Univ Lyon, Villeurbanne 69622, France
[b] Faculty of Chemistry, University of Wroclaw, u. Joliot-Curie 14, Wroclaw 50-383, Poland
[c] Institute of Laser Engineering, Osaka University, 2-6 Yamadaoka, Suita, Osaka 565-0871, Japan
[d] Institute for Materials Research, Tohoku University, 2-1-1 Katahira, Aoba-ku, Sendai 980-8577, Japan
georges.boulon@univ-lyon1.fr

The main objective of this communication is to report two examples of Nd3+ ion spectroscopy in different types of solids.

First, Nd3+-doped Lu_2O_3 laser ceramics, of high thermal conductivity, fabricated by the non-conventional Spark Plasma Sintering (SPS) technique in which the 4f3 intra-configurational transitions of both C_2 and C_{3i} sites and of C_2–C_{3i} and C_2–C_2 Nd3+ pairs have especially been analyzed, as well as the first feasibility of the laser oscillation inside the main C_2 site showing two close $4F_{3/2} \rightarrow 4I_{11/2}$ lines at 1076.3 and 1080.5 nm, respectively [1-3].

Secondly, the different inter-configurational 4f25d and intra-configurational 4f3 transitions of Nd3+-doped $20Al(PO_3)_3$-80LiF (APLF) glass. The most important property of this glass is that they exhibit electric-dipole allowed 4f25d → 4f3 ($4I_{9/2}$) broadband emission around 187 nm (VUV) with decay times of ~ 5.0 ns [4]. Since these decay times are faster than known Pr3+ [5] and Ce3+-doped APLF glasses [6], the Nd3+-doped APLF glass can be ranked as one of the advanced potential scintillator materials to detect neutrons.

References:

[1] G. Alombert-Goget, Y. Guyot, M. Guzik, G. Boulon, A. Ito, T. Goto, A. Yoshikawa, M. Kikuchi, Opt. Mater., Vol. 41, **2015**, 3-11.
[2] G. Toci, M. Vannini, M. Ciofini, A. Lapucci, A. Pirri, A. Ito, T. Goto, A. Yoshikawa, A. Ikesue, G. Alombert-Goget, Y. Guyot, G. Boulon, Opt. Mater. Vol. 41, **2015**, 12–16.
[3] M. Guzik, G. Alombert-Goget, Y. Guyot, J. Pejchal, A. Yoshikawa, A. Ito, T. Goto, G. Boulon, J. Lumin., Vol. 169, **2016**, 606–611.

[4] M. J. F. Empizo, Y. Minami, K. Yamanoi, T. Shimizu, M. Yoshimura, N. Sarukura, T. Murata, A. Yamaji, A. Yoshikawa, M. Guzik, Y. Guyot, G. Boulon, M. Cadatal-Raduban, J. Alloys Compd. submitted on September 25, **2020**

[5] M. J. F. Empizo, M. Cadatal-Raduban, T. Murata, Y. Minami, K. Kawano, K. Yamanoi, T. Shimizu, N. Sarukura, M. Guzik, Y. Guyot, G. Boulon, J. Lumin., Vol. 193, **2018**, 13-21.

[6] Y. Minami, J. L. Gabayno, V. C. Agulto, Y. Lai, M. J. F. Empizo, T. Shimizu, K. Yamanoi, N. Sarukura, A. Yoshikawa, T. Murata, M. Guzik, Y. Guyot, G. Boulon, J. A. Harrison, M. Cadatal-Raduban, J. Non-Cryst. Solids, Vol. 521, **2019**, 119495.

PREATAM2020 POSTER SESSION

14.10 preATAM2020 Poster Session

P5 – Nina Kaczorowska – *Energy conversion processes in rare earth ternary vanadates doped with* Bi^{3+} *ions*

P7 – Luidgi Giordano – *Charging ZGSO:*Cr^{3+} *Persistent Luminescence using* $NaGdF_4:Yb^{3+},Er^{3+}$ *Upconversion*

P16 – Teng Zheng – *Huge Enhancement of* Sm^{2+} *Luminescence via* Eu^{2+} *codoping in Strontium Tetraborates – Studies under High Pressure and Temperature conditions*

P18 – Kacper Prokop – *Ionic liquid assisted synthesis routes for fabrication of fine nanocrystalline* Nd^{3+}*-doped* $LuPO_4$ *optical material*

P27 – Małgorzata Sójka – *Exploiting the bandgap engineering to finely control dual-mode* $Lu_2(Ge,Si)O_5:Pr^{3+}$ *luminescence thermometers*

P31 – Teresa Delgado – *Analysis of traps, extinction coefficient and role of* Dy^{3+} *and* B^{3+} *in the persistent phosphor* $SrAl_2O_4:Eu^{2+}, Dy^{3+}, B^{3+}$

P44 – Magdalena Wilk-Kozubek – *Convenient Route to Heterometallic Group 4–Zinc Precursors for Binary Oxide Nanomaterials*

P12 – Maria Zdończyk – *Impact of the synthesis method on the properties of* Nd^{3+}*-doped* $GdPO_4$ *nanoparticles*

P26 – Nikola Cichocka – *Synthesis and optical properties of* $Y_3Al_5O_{12}$ *grown by microwave driven hydrothermal technique*

P34 – Przemysław Woźny – *Lanthanide-doped pressure sensors based on inorganic materials*

P40 – Justyna Zeler – *2D Intracellular temperature mapping of cancer cells using* Eu^{3+}/Sm^{3+}*-based polymeric micelles*

P43 – Israel Assuncao – *The Influence of the Odd-Even Effect of Aliphatic Dicarboxylate Ligands on the Photoluminescent Properties of Europium Complexes*

P51 – Adrian Patej – *Synthesis and spectroscopic studies of pyrophosphate* $K_2SrP_2O_7$ *doped with* Eu^{3+} *and* Eu^{2+} *ions*

P52 – Yen Pham – *Lanthanide Complexes with N-Phosphorylated Carboxamide as UV Converters with Excellent Emission Quantum Yield and Single-Ion Magnet Behavior*

P2 – Natalia Stopikowska – *Development of a luminescent nanothermometer, useful in the near infrared range, using non-thermalized levels of* Yb^{3+} *and* Tm^{3+} *ions*

P13 – Irina Buchinskaya – *Mechanosynthesis of nanocrystalline fluorides*

P37 – Miguel A. Hernandez-Rodriguez – *Trivalent Lanthanide based Silicon arrays for Molecular Logic and Computing through Physical Inputs*

P45 – Natalia Jurga – *The influence of the synthesis route on the physicochemical properties of core-shell* $NaYF_4:Yb^{3+},Er^{3+}/NaYF_4$ *nanoparticles and their water colloids*

P46 – Joanna Jedoń – *The effect of dose on thermoluminescence of* $ScPO_4:Eu^{3+}$ *ceramic*

P48 – Dominika Przybylska – *Luminescent nanocolloids based on Sr2LuF7 and* Sr_2ScF_7 *doped with* Ln^{3+} *(Ln=* Er^{3+}, Tm^{3+}, Yb^{3+}*)*

P53 – Jakub Pawłów – *Structural and spectroscopic properties investigation of Nd3+- doped* YPO_4 *nano and micro-powders obtained by various methods of synthesis*

P1 – Constantin Buyer – $NaY[SO_4]_2 \cdot H_2O$*: A potential precursor for new phosphors*

P6 – Małgorzata Skwierczyńska – *Magnetic-upconverting cellulose fibers for anti-counterfeiting purposes*

P8 – Wiktoria Lipińska – *The synergistic effect of the bimetallic Au-Cu nanostructures onto the optical and photoelectrochemical performance*

P9 – Adrian Olejnik – *Laser – assisted manufacturing of nanopatterned Au-Ti structures and their characterization towards glucose sensing*

P11 – Runowski Marcin – *Optical sensing of pressure in a vacuum range – conversion of luminescent thermometers into vacuum sensors*

P29 – Rahul Kumar Sharma – *Secondary Nucleation Controlled Luminescence Behavior of* RE^{3+}*-Doped* BaF_2 *Nanocrystals*

P35 – Łukasz Duda – *UV-induced fabrication of diffraction grating in hybrid organic-inorganic* SiO_2-TiO_2 *thin films*

15.10 preATAM2020 Poster Session

P15 – Cuma Tyszkiewicz – *Low loss and high refractive index waveguide films fabricated using sol-gel method and dip-coating technique*

P24 – Yogendra Nath Chouryal – *Catalytic/Photocatalytic Activity of Phase Tuned* In_2S_3 *Nanocrystals*

P25 – Tetiana Kirish – Cu_2ZnSnS_4 *nanoparticles for inkjet printing technology*

P32 – Łukasz Marek – *Glasses and glass-ceramics based on* TeO_2 *for potential applications in photovoltaic*

P49 – Anna Siudzińska – *Optimizing measurement parameters for HRTEM studies of 2D transition metal dichalcogenides*

P36 – Piotr Pala – *Design and simulation of the grating coupler dedicated to low refractive index contrast integrated photonic circuits*

P3 – Jerzy J. Langer – *UV-VIS-NIR emission of polypyrrole-graphite diod electrically powered*

P23 – Dmitry Permin – *IR-transparent* MgO-Y_2O_3 *composite ceramics by Hot pressing and Spark plasma sintering*

P28 – Katarzyna Wal – *Multifunctional versatile 2D layered materials and changes in their physicochemical properties upon modifications*

P30 – Gabriella Tessitore – *The key role of intrinsic lifetime dynamics from upconverting nanosystems in Multiemission Particle Velocimetry*

P38 – Bartłomiej Potaniec – SiO_2*-based glasses obtained by the sol-gel method, doped with organic dyes from the chalcone group*

P39 – Paulina Potok – *The characterization of nickel complexes of α5 domain from mycobacterial SmtB/BigR4 transcription regulators, a histidine mutations study*

P42 – Karolina Gemza – *Experimental setup for measurement of SU-8 waveguides excitation quality*

P54 – Krzysztof Lis – *The capability of graphene on improving the electrical conductivity and anti-corrosion properties of copper wires*

P4 – Stanislav Balabanov – *Sesquioxide ceramics for magneto-optical applications*

P10 – Zhuorui Lu – *Nanoparticles elongation in silica optical fiber induced by drawing process – A morphology study*

P19 – Nikodem Sokołowski – *High localization of excitons in a large-area WS_2 monolayer*

P21 – Leonardo Francisco – *Development of Rare-Earth-Doped Hybrid Materials Towards Luminescence Enhancement*

P22 – C.H. Wong – *Room temperature p-orbital magnetism in carbon chains*

P41 – Kamila Startek – *Hybrid sol-gel layers on elastic substrate with potential use in photonics*

P14 – Magdalena Szkuta – Hard coal chemical looping combustion study in microreactor

P17 – Borys Winczura – *Study of Janina hard coal chemical looping combustion process in microreactor-GC system enabling environment protection*

P20 – Kamil Misztal – *Influence of ammonia water on charge-carrier lifetime in MoS2 studied by microwave photoconductivity decay*

P33 – Marta Fiedot-Toboła – *Pectin as a biopolymer used in different functional materials synthesis*

P47 – Edyta Środa – *Numerical study of bent shallow rib waveguides based on the SiO_2:TiO_2 material platform*

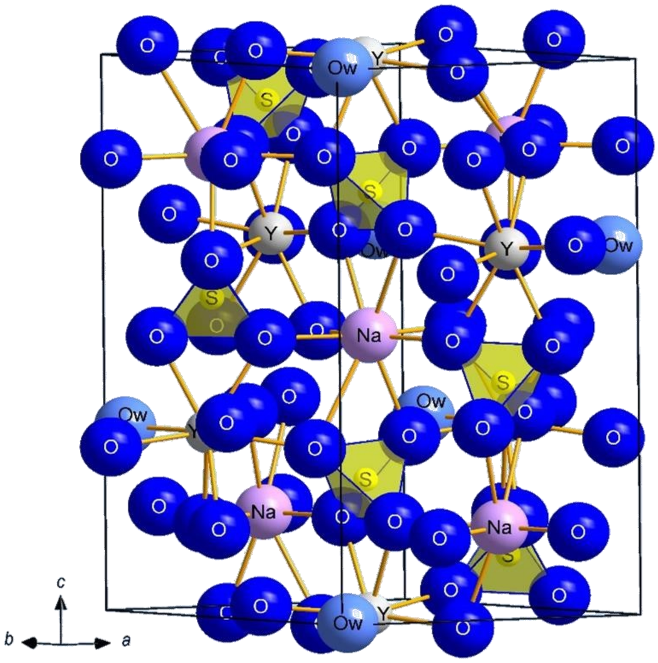
P50 – Maciej Czajkowski – *Early stage studies of oblique helicoidal cholesteric phase for tunable liquid crystal lasers*

P55 – Daria Hlushchenko – *Sol-gel glass photonic microlasers doped with Rhodamine 6G*

P1: $NaY[SO_4]_2 \cdot H_2O$: A potential precursor for new phosphors

Constantin BUYER, [a] **Thomas SCHLEID**, [a]

[a] *University of Stuttgart, Institute for Inorganic Chemistry, Pfaffenwaldring 55, Stuttgart/D*
constantin.buyer@iac.uni-stuttgart.de



Colorless crystals of water soluble $NaY[SO_4]_2 \cdot H_2O$ were obtained via hydrothermal synthesis from a 1:1-molar mixture of $Na_2[SO_4] \cdot 10\ H_2O$ and $Y_2[SO_4]_3 \cdot 8\ H_2O$ (250 mg in 2 ml water) in a 50 ml teflon autoclave after 24 hours at 190 °C.
According to single-crystal X-ray diffraction (Mo-Kα, κ-CCD) the absolute structure (CSD2016596) could be solved in the trigonal space group $P3_221$ (no. 154) with a = 682.24(5) pm and c = 1270.65(9) pm (Z = 3) as isotypic with $NaCe[SO_4]_2 \cdot H_2O$ [1]. Y^{3+} is surrounded by nine oxygen atoms (eight from sulfate anions and one from water) with distances between 237 and 248 pm in the shape of a tricapped trigonal prism. Na^+ has eight oxygen neighbors arranged like a square antiprism, all stemming from sulfate anions (d(Na–O) = 235 – 254 pm (6×) + 288 pm (2×)). Planes with Y^{3+} (3a site) and Na^+ cations (3b site) are alternating along [001] and the same planes contain all oxygen atoms, while the S^{6+} centers of the sulfate anions (d(S–O) = 146 – 148 pm, ∢(O-SO) = 105 – 112°) reside in between (see Figure). O_W represents the oxygen atoms of the water molecules (d(Ow–H) = 98 pm, ∢(H-Ow-H) = 114°; d(Ow–Y) = 238 pm).
After filtering off the product of the autoclave synthesis, however, $NaY[SO_4]_2 \cdot H_2O$ can be found as pure phase. It loses water at temperatures above 180 °C. Eu^{3+}-doped samples of $NaY[SO_4]_2 \cdot H_2O$ and its anhydrous variety are emitting red light upon excitation with UV radiation.

References:

[1] Lindgren O., The Crystal Structure of Sodium Cerium(III) Sulfate Hydrate, $NaY[SO_4]_2 \cdot H_2O$. *Acta Chem. Scand.*, A31, **1977**, 591–594.

P2: Development of a luminescent nanothermometer, useful in the near infrared range, using non-thermalized levels of Yb^{3+} and Tm^{3+} ions

[a)] <u>Natalia Stopikowska</u>, [a)] Marcin Runowski, [a)] Przemysław Woźny, [a)] Szymon Goderski, [a)] Stefan Lis

[a)] Adam Mickiewicz University, Faculty of Chemistry, Uniwersytetu Poznańskiego 8, 61-614, Poznań, Poland natalia.stopikowska@amu.edu.pl

Temperature has a significant impact on many spectroscopic properties of materials, such as: intensity of emission, bands intensity ratios, luminescence lifetimes, efficiency of energy and charge transfer processes, as well as structural and morphological changes resulting from the interaction of a high density photon laser beam on the product [1-3].

Inorganic orthorombic YVO_4:20%Yb^{3+}, 0.5% Tm^{3+}, was obtained using a hydrothermal method and post-synthesis thermal treatment. The resulting material showed after the laser excitation in the NIR range (near infrared□□□=975 nm, visible to the naked eye, blue up-conversion luminescence originating from thulium ions. The temperature dependence of its luminescence properties was investigated in the range 300–344.5 K. It was observed that the intensity of all thulium ion bands decreases with increasing temperature. The band derived from ytterbium was unchanged. Luminescence intensity ratio (LIR) analysis was performed and R^2 was determined using a linear fit. The best relative sensitivity (S_r) at 313 K was achieved for the 940/452 band intensity ratio and it was 1.58 % K^{-1} . For the remaining band ratios, these values were: 0.82 % K^{-1} (940/474 nm), 0.93 % K^{-1} (940/650) nm and 0.81 % K^{-1} (940/800 nm). The optimal value of the temperature resolution (δT) at 312 K was observed for the 940/800 nm band ratio and it was 0.22 K. Due to the fact that the range of the 940/800 nm bands shows a high signal intensity, satisfactory relative sensitivity and very good temperature resolution, it was recommended to develop a temperature sensor based on this band ratio [4].

References:

[1] Runowski M., Stopikowska N., Szeremeta D., Goderski S., Skwierczyńska M., Lis S., ACS Appl. Mater. Interfaces Vol. 11, 2019, 13389–13396.

[2] Brites C.D.S., Lima P.P., Silva N.J.O., Millan A., Amaral V.S., Palacio F., Carlos L.D., Nanoscale Vol. 4, 2012, 4799–4829.

[3] Jaque D., Vetrone F., Nanoscale Vol. 4, 2012, 4301–4326.

[4] Stopikowska N., Runowski M., Woźny P., Goderski S., Lis S., J. Lumin. Vol 228, 2020, 117643

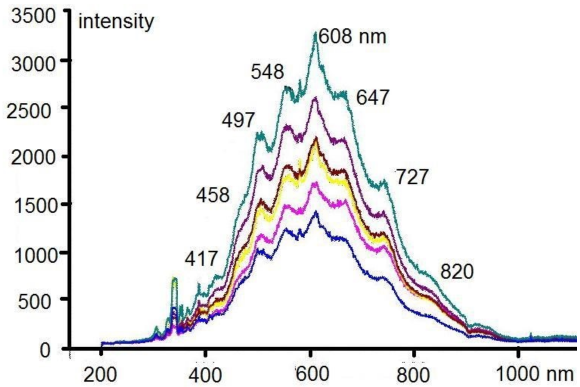
P3: UV-VIS-NIR emission of polypyrrole-graphite diod electrically powered

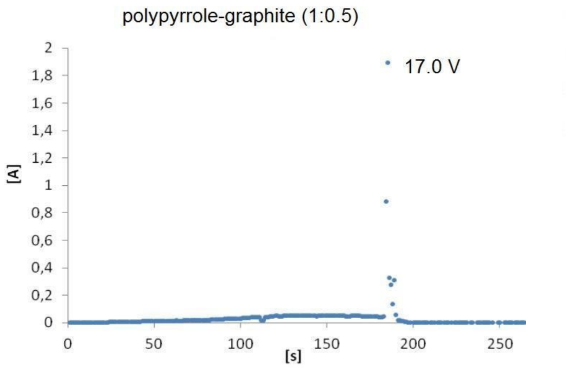
Justyna SIEDLECKA, Jerzy J. LANGER,

Laboratory for Materials Physicochemistry and Nanotechnology
Faculty of Chemistry, A. Mickiewicz University, Poznań, Poland
orsel@sigmaxi.net

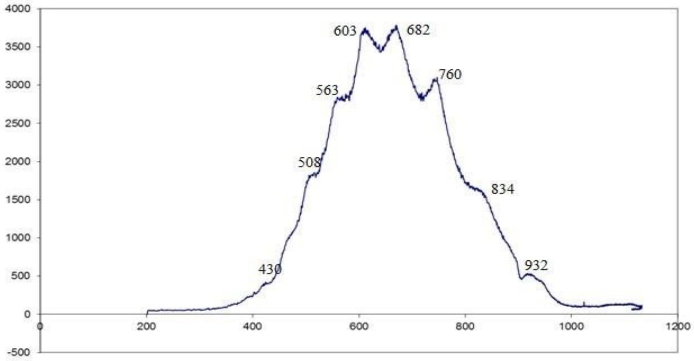
Polypyrrole with added graphite can emit light, like polyaniline [1], at the voltage range of 3-20 V, of different intensity and nature (pulsed <1 s or continuous 6-60 s), white - often orange-yellow in color. Graphite content influences the emission spectrum.

Electroluminescence of the sample polypyrrole-graphite (1: 0.5)





The electric current flow [A] vs. time [s]



Electroluminesence of polypyrrole-graphite

(1: 1)

References:

[1] Kalisz, M.; Golczak, S.; Frąckowiak, E.; Langer, K. and Langer*, J. J. , Laser action induced in a nanostructured polyaniline LED,. , *J. Mater. Chem. C* 4, **2016,** 6634-40.

P4: Sesquioxide ceramics for magneto-optical applications

Stanislav BALABANOV, **Maxim IVANOV, Dmitry PERMIN, Elena ROSTOKINA**

G.G. Devyatykh Institute of Chemistry of High-Purity Substances of the Russian Academy of Sciences

Balabanov@ihps-nnov.ru

The search for new crystalline materials for laser applications is one of the priority areas of modern materials science. In recent years, the ceramic approach to the creation of new magneto-optical media has been noted as the most promising, and a number of optical ceramics with unique characteristics have already been created on its basis. Such media for use in Faraday insulators should have a high Verdet constant and thermal conductivity, low absorption, and scattering coefficients at operating wavelengths and be potentially available for production in tens and hundreds of millimeters.

In this work, the synthesis techniques of magneto-optical ceramics based on Dy_2O_3, Ho_2O_3, Er_2O_3, and Gd_2O_3 were developed and a set of studies on their characteristics was carried out. Techniques of the production of highly dispersed powders of Dy_2O_3, Ho_2O_3, Er_2O_3, and Gd_2O_3 by the method of self-propagating high-temperature synthesis (SHS) and technique of introducing of lanthana and yttria sintering additives into the nanopowders at the SHS stage were developed. Samples of $(Ho_{1-x}La_x)_2O_3$, $(Er_{1-x}La_x)_2O_3$ x= 0.03, 0.05, 0.07, 0.1, $(Dy_{0.95-y}Y_yLa_{0.05})_2O_3$ y= 0.05, 0.1, 0.15, 0.25 transparent ceramics were made by vacuum sintering. $(Gd_{1-z}Y_z)_2O_3$, z= 0.2, 0.3 optical ceramics was fabricated by hot pressing. Ceramics of $(Dy_{0.7}Y_{0.25}La_{0.05})_2O_3$, $(Ho_{0,95}La_{0,05})_2O_3$, $(Er_{0,95}\ La_{0,05})_2O_3$, and $(Gd_{0.8}Y_{0.2})_2O_3$ have a transparency of more than 70% in the visible range and close to theoretically achievable (about 80%) in the mid-IR.

The most promising for use as magneto-optical materials are ceramics of $(Dy_{0.7}Y_{0.25}La_{0.05})_2O_3$ and $(Ho_{0,95}La_{0,05})_2O_3$ compositions. The values of the Verdet constants of Ho_2O_3 and Dy_2O_3 ceramics in the visible range are 1.3 and 2 times higher than those of the terbium gallium garnet (TGG), the most commonly used material of Faraday isolators. Also, compared with materials based on terbium oxide, which has strong resonant absorption at wavelengths greater than 1.4 μm, holmium oxide can be used as a magneto-optical media at wavelengths of about 1.5 μm and 3 μm (for Er^{3+} ionbased lasers) , and dysprosium oxide at wavelengths in the region of 2 μm (for lasers based on Tm^{3+}, Ho^{3+} ions).

ACKNOWLEDGMENT

The study was funded by the Russian Science Foundation (research project No. 18-1300355).

P5: Energy conversion processes in rare earth ternary vanadates doped with Bi^{3+} ions

Nina KACZOROWSKA, Agata SZCZESZAK, Stefan LIS

Adam Mickiewicz University, Faculty of Chemistry, Department of Rare Earths, ul. Uniwersytetu Poznańskiego 8, 61-614 Poznań, Poland

nina.kaczorowska@amu.edu.pl

The phenomenon of upconversion (UC) has been studied in variety of hosts [1-2]. This process is based on the sequential absorption of at least two low energy photons and the resulting emission of visible light, finding its application in e.g. photovoltaics or bioimaging [3-4]. In contrast, the downconversion process involves the quantum cutting of one photon with higher energy into several photons with lower energy [5]. In order to enhance both energy conversion processes, a variety of ions could be used, including non-lanthanides. The trivalent bismuth ion (Bi^{3+}) is known for improving the crystallinity as well as the luminescence intensity in Yb/Bi/Ln systems [6]. Herein, the Bi^{3+}-related physicochemical properties enhancement of the hydrothermally-derived ternary vanadates is described in detail. The uniform $Ba_2LaV_3O_{11}$ structures were synthesized using a facile hydrothermal method. Due to the increased concentration of Bi^{3+}, the structural and luminescent properties are improved, e.g. the elongated luminescence lifetime decay or tuned emission color. These features were characterized using XRD, TEM, ICP-OES and spectroscopic methods.

References:

[1] Bloembergen N., Solid State Infrared Quantum Counters. *Physical Review Letters,* 2, **1959**, 84–85.

[2] Kaczorowska N., Szczeszak A., Lis S., Synthesis and tunable emission studies of new up-converting $Ba_2GdV_3O_{11}$ nanopowders doped with Yb^{3+}/Ln^{3+} ($Ln^{3+} = Er^{3+}$, Ho^{3+}, Tm^{3+}). *Journal of Luminescence,* 200, **2018**, 59-65.

[3] Yang D., Ma P., Hou Z., Cheng Z., Li C., Lin J., Current advances in lanthanide ion (Ln^{3+})based upconversion nanomaterials for drug delivery. *Chemical Society Reviews,* 44, **2015**, 1416-1448.

[4] van Sark W. GJHM, de Wild J., Rath J. K., Meijerink A., EI Schropp R., Upconversion in solar cells. *Nanoscale Research Letters,* 8, **2013**, 81-90.

[5] Wong K.L., Bu nzli J.C.G, Tanner P.A., Quantum yield and brightness. *Journal of Luminescence*, 224, **2020,** 117256.

[6] Zhao M., Li G., Zheng J., Li L., Yang L., Fabrication of assembled-spheres YVO_4:(Ln^{3+}, Bi^{3+}) towards optically tunable emission. *CrystEngComm*, 14, **2012**, 2062-2070.

P6: Magnetic-upconverting cellulose fibers for anti-counterfeiting purposes

<u>Małgorzata SKWIERCZYŃSKA</u> [a)] Przemysław WOŹNY [a)], Marcin RUNOWSKI [a)], Piotr KULPIŃSKI [b)], Stefan LIS [a)]

[a)] Adam Mickiewicz University, Faculty of Chemistry, Department of Rare Earths, Uniwersytetu Poznanskiego 8, 61-614, Poznan, Poland; [b)] Lodz University of Technology, Department of Mechanical Engineering, Informatics and Chemistry of Polymer Materials, Zeromskiego 116, 90-924, Lodz, Poland; malgorzata.skwierczynska@amu.edu.pl

Counterfeiting of valuable documents, currency and high-quality clothing is a growing problem due to the development of technologies and their easy accessibility. Therefore, actions should be taken to prevent falsification of cellulose based products (i.e. fibers, papers). Protection of such products can be achieved by modifying the materials with nanoparticles exhibiting specific properties, e.g. luminescent or magnetic, which can act as unique “fingerprints”. [1.2]

Here we present the preparation and photophysical characterization of bifunctional cellulose fibers. The presence of modifier nanoparticles (NPs) in the cellulose matrix guarantees the properties of the fibers. The modifier NPs were core/shell type nanostructures, having a magnetic core covered by an inner silica shell and an external upconversion shell, consisted of yttrium oxyfluoride doped with lanthanide(III) ions. The response to the applied external magnetic field and the bright lumincescence are provided by the magnetite core and the external shell, respectively. The fibers were prepared by means of the dry-wet spinning method, with the use of N-methylmorpholine-N-oxide (NMMO) as a direct solvent of cellulose. The synthesis of the modifier NPs involves the deposition of the lanthanides-doped fluorides on the magnetic core/shell surface. The magnetic, spectroscopic, structural, morphological and surface properties of the synthesized products were investigated.

References:

[1] Skwierczynska, M., Runowski, M., Goderski, S., Szczytko, J., Rybusin ski, J., Kulpinski, P., Lis, S., Luminescent–Magnetic Cellulose Fibers, Modified with Lanthanide-Doped Core/Shell Nanostructures. *ACS Omega,* 3, **2018,** 10383–10390.

[2] Skwierczynska, M., Runowski, M., Kulpin ski, P., Lis, S., Modification of cellulose fibers with inorganic luminescent nanoparticles based on lanthanide(III) ions. *Carbohydrate Polymers,* 206, **2019,** 742–748.

[3] Skwierczynska, M., Wozny, P.,; Runowski, M., Perzanowski, M., Kulpinski, P., Lis, S., Bifunctional magnetic-upconverting luminescent cellulose fibers for anticounterfeiting purposes. *Journal of Alloys and Compounds,* 829, **2020,** 154456154464.

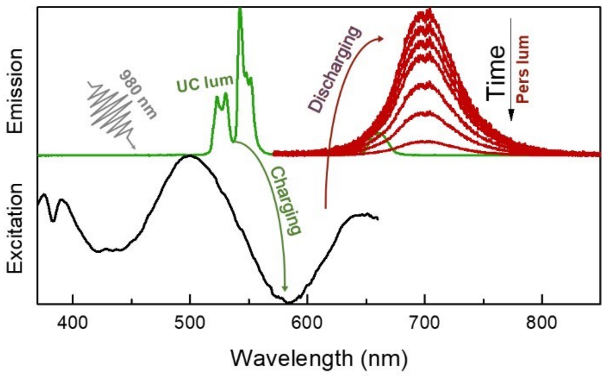
P7: Charging ZGSO:Cr^{3+} Persistent Luminescence using $NaGdF_4$:Yb^{3+},Er^{3+} Upconversion

<u>Luidgi GIORDANO</u>, [a),b)] Bruno VIANA, [b)] Lucas C. V. RODRIGUES,[a)]

[a)] Department of Fundamental Chemistry, Institute of Chemistry, University of Sao Paulo, 05508-000 São Paulo, SP, Brazil; [b)] Chimie ParisTech, Institut de Recherche de Chimie Paris, PSL Research University, CNRS, Paris 75005, France. luidgi@iq.usp.br

In the last few years, studies proposing the usage of upconversion to charge persistent luminescent materials have been proposed. This use can be divided in three main strategies: Direct upconversion charging [1], upconversion pair codoping [2] and radiative energy transfer [3].

In this work, we used radiative energy transfer from $NaGdF_4$:18%Yb^{3+},2%Er^{3+} to excite the persistent luminescent $Zn_{1.33}Ga_{1.34}Sn_{0.33}O_4$:0.5%$Cr^{3+}$ (ZGSO). We show that a 5-minute charging employing excitation in 980 nm can induce the energy storage in defects when both materials are combined, in contrast to the lack of persistence when only in presence of ZGSO.



References:

[1] Chen, Y.; Liu, F.; Liang, Y.; Wang, X.; Bi, J.; Wang, X.J.; Pan, Z., A new upconversion charging concept for effectively charging persistent phosphors using low-energy visible-light diodes. *J. Mater. Chem. C,* 6, **2018,** 8002-8010.

[2] Liu, F.; Liang, Y.; Pan, Z., Detection of up-converted persistent luminescence in the near infrared emitted by the $Zn_3Ga_2GeO_8$:Cr^{3+},Yb^{3+},Er^{3+} phosphor, *Phys. Rev. Lett.,* 113, **2014**, 1-5.

[3] Li, Z.; Huang, L.; Zhang, Y.; Zhao, Y.; Yang, H.; Han, G., Near-infrared light activated persistent luminescence nanoparticles via upconversion, *Nano Res.,* 10, **2017,** 1840-1846.

P8: The synergistic effect of the bimetallic Au-Cu nanostructures onto the optical and photoelectrochemical performance

Wiktoria LIPIŃSKA,[a)] Katarzyna GROCHOWSKA,[a)] Jakub KARCZEWSKI [b)], Jacek RYL,[c)] Katarzyna SIUZDAK,[a)]

[a)] Centre for Plasma and Laser Engineering, The Szewalski Institute of Fluid-Flow Machinery Polish Academy of Sciences, Fiszera 14 St., 80-231 Gdańsk, Poland;
[b)] Faculty of Applied Physics and Mathematics, Gdańsk University of Technology, Narutowicza 11/12, 80-233 Gdańsk, Poland;
[c)]Faculty of Chemistry, Gdańsk University of Technology, Narutowicza 11/12, 80-233 Gdańsk, Poland wlipinska@imp.gda.pl

Nowadays, due to the increasing environment pollution and global warming, the intensified research on materials for energy harvesting and catalytic purification is carrying on. The bimetallic structures composed of noble and non-noble element became more and more explored since they demonstrate a synergistic effect towards utilization of alternative energy sources. Additionally, usage of semi-precious metal decreases the material price and at the same time the high stability of the noble one is exploited. In here, we present the fabrication of nanopatterned Ti foil covered with bimetallic Au-Cu nanostructures and characterization of morphology and structure as well as optical, electrochemical and photoelectrochemical properties. The nanostructure was prepared via following steps: anodization of Ti, chemical etching of as-formed nanotubes, Au and Cu layer deposition by magnetron sputtering and finally thermal treatment at 450°C or 600°C. The mosaic-like morphology of obtained material was confirmed by SEM. The both Au-Cu structures exhibit absorption in the visible range while its shape significantly depends on the thermal annealing conditions. The cyclic and linear voltammetry scans recorded in dark and under electrode illumination indicate both the improvement towards the efficient water splitting and the visible photoresponse. With the support of the XPS spectra analysis, the chemical nature of samples showing the highest photoresponse was characterized [1].

Research is financed by NCN Preludium 2019/35/N/ST5/02604.

References:

[1] Lipińska, W.; Grochowska, K.; Karczewski, J.; Ryl, J.; Cenian, A.; Siuzdak, K.; Thermally tuneable optical and electrochemical properties of Au-Cu nanomosaic formed over the host titanium dimples. *Chemical Engineering Journal,* 399., **2020,** 125673.

P9: Laser – assisted manufacturing of nanopatterned Au-Ti structures and their characterization towards glucose sensing

Adrian OLEJNIK, a),b) Jakub KARCZEWSKI, a) Katarzyna SIUZDAK,b) Katarzyna GROCHOWSKA,b)

a) *Gdańsk University of Technology, 11/12 Narutowicza st., 80-233 Gdańsk, Poland;*
b) *Centre for Plasma and laser Engineering, Polish Academy of Sciences, 14 Fiszera st., 80-231 Gdańsk, Poland; aolejnik@imp.gda.pl*

Due to the rising problem of diabetes as well as the increasing number of people monitoring glucose level during exercises, any new developments in the field of glucose sensing are needed. Among different sensors, electrochemical ones seem to be of particular interest as there are highly reliable and sensible [1]. In our studies, we propose the active element of such sensor that is based on structured titanium foil covered with Au nanoparticles which are formed out of ultra-thin metallic layers by means of nanosecond laser dewetting that can be easily scaled up. Application of different laser working parameters (λ: 266, 355, 532 nm; fluencies: 15-90 mJ/cm^2) enables to obtain a variety of gold nanoparticles configurations confirmed by scanning electron microscopy inspection. Proper optimization of these parameters leads to formation of Au-Ti structures that are characterized by twice as better response than furnace dewetted Au nanoparticles over Ti structured foil [2]. Moreover, the selectivity and mechanical stability of prepared material is maintained. Electrochemical tests in the presence of human serum as well as in artificial sweat and saliva were performed to verify the possible application of electrodes in the real conditions. Obtained results confirmed that fabricated material may be beneficial in future commercial devices.

Research is financed by NCBR via LIDER/2/0003/L-8/16/NCBR/2017 grant.

References:

[1] Hwang, D. W., Lee, S., Seo, M., Chung, T. D. Recent advances in electrochemical nonenzymatic glucose sensors–a review. *Analytica chimica acta*, *1033 (2028)*, 1-34.
[2] Olejnik, A.; Siuzdak, K., Karczewski, J., Grochowska, K., A Flexible Nafion Coated Enzyme – free Glucsoe Sensor Based on Au – dimpled Ti structures. *Electroanalysis, 32(2020) 323-332.*

P10: Nanoparticles elongation in silica optical fiber induced by drawing process – A morphology study

Zhuorui LU, [a,b] **Wilfried BLANC,** [a] **Franck PIGEONNEAU,**[b]

[a] Université Côte d'Azur, CNRS, Institut de Physique de Nice, UMR7010, 06108 Nice, France ;; [b] MINES ParisTech, PSL Research University, CEMEF - Centre for material forming, UMR 7635, 06904 Sophia-Antipolis, France; zlu@univ-cotedazur.fr

Lumiscent properties in optical fibers are usually obtained by incorporating rare earth elements (REE). However, REE has low solubility in silica glass and high phonon energy of the matrix could result in low quantum emission efficiency. In order to achieve a waveguide that could attain stronger REE signal, nanoparticles embedded optical fibers have been designed: REE is encapsulated inside the particles, which are dispersed in silica glass[1].

Reducing Rayleigh scattering by controlling particles size is essential in these nanostructured fibers. But the drawing step necessitates a high temperature at around 2000°C, which can be detrimental for nanoparticles size regulation, when the particles are already in the preform. A brand new approach has been proposed: the top-down method[2]. Here, the high temperature deformation of glass preforms during the drawing step could promote break-ups of large particles into tailored small particles. Noticeable elongation is accompanied along the break-up phenomenon.

In this work, drawing temperature, velocity and tension were taken into account for modifying the particles size and shape. EDX measurements confirm the unity of composition along the fiber. Being rather special, the morphology of these nanoparticles are examined by SEM, it shows a strong relation with drawing tension. These results provide a new way to fabricate nanoparticles embedded optical fibers as well as to tailor their optical properties.

References:

[1] A. Veber et al., Nano-Structured Optical Fibers Made of Glass-Ceramics, and Phase Separated and Metallic Particle-Containing Glasses, *Fibers*, vol. 7, **2019**, 105.

[2] M. Vermillac et al., Fiber-Draw-Induced Elongationand Break-up of Particles Inside the Core of a Silica-Based Optical Fiber, *Journal of the American Ceramics Society*, vol. 100, **2017**, 1814.

P11: Optical sensing of pressure in a vacuum range – conversion of luminescent thermometers into vacuum sensors

Marcin RUNOWSKI, [a] Przemysław WOŹNY, [a] Stefan LIS,[a] Inocencio R. MARTÍN,[b] Víctor LAVÍN[b]

[a]Adam Mickiewicz University, Faculty of Chemistry, Uniwersytetu Poznańskiego 8, Poznań, 61-614, Poland
[b]Departamento de Física, MALTA Consolider Team, and IUdEA, Universidad de La Laguna, Apdo. 456, San Cristóbal de La Laguna, Santa Cruz de Tenerife, E-38200, Spain

Currently the lowest optically determinable pressure values are around 10^2 bar, making the pressure below inaccessible for optical detection. These limitations are related to the fundamental concept of remote pressure sensing, i.e. measurements of physical parameters directly related to the material structure and affected by its pressure-induced compression, e.g. emission line shift, sound velocity, unit cell volume, etc.

Here we show how to overcome these limitations and optically monitor the low pressure values in a vacuum region, totally changing the sensing concept from pressureinduced material compression to light-induced and pressure-governed heating-cooling of the material [1]. In this work we used the unprecedented enhancement (≈20-times) of the laser-induced heating of the upconverting material ($YVO_4:Yb^{3+}-Er^{3+}$) under vacuum conditions, to convert the luminescent thermometer into the optical vacuum sensor (see Fig. 1). We have correlated the variations of pressure in the system with changes of the band intensity ratio (525/550 nm) of Er^{3+} thermally-coupled levels, and applied them for the remote, contactless vacuum sensing.

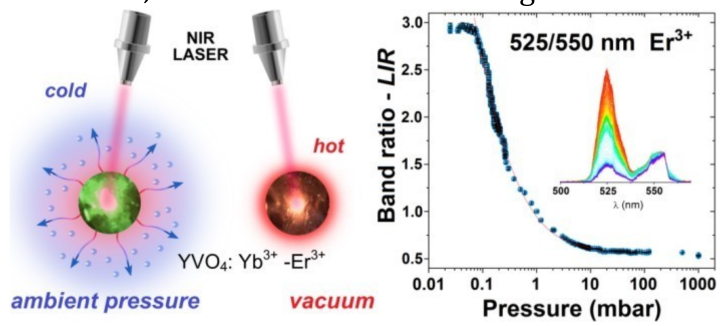


Figure 1. *Luminescent vacuum sensor – vacuum-induced enhancement of the light-to-heat conversion*

References:

[1] Runowski, M.; Woźny, P.; Lis, S.; Lavín, V.; Martín , I. R. Optical Vacuum Sensor Based on Lanthanide Upconversion—Luminescence Thermometry as a Tool for Ultralow Pressure Sensing. *Adv. Mater. Technol.*, 5, **2020**, 1901091.

P12: Impact of the synthesis method on the properties of Nd^{3+}-doped $GdPO_4$ nanoparticles

__Maria ZDOŃCZYK,__ [a), b)] **Magdalena WILK-KOZUBEK,** [b)] **Anja- Verena MUDRING,** [c)] **Joanna CYBIŃSKA** [a), b)]

[a)] University of Wroclaw, Faculty of Chemistry, 14 F. Joliot-Curie Street, 50-383 Wroclaw, Poland; [b)] Łukasiewicz Research Network - PORT Polish Center for Technology Development, 147 Stabłowicka Street, 54-066 Wrocław, Poland; [c)] Stockholm University, Department of Materials and Environmental Chemistry, Svante Arrhenius vag 16 C, 106 91 Stockholm, Sweden

maria.zdonczyk@port.lukasiewicz.gov.pl / maria.zdonczyk@chem.uni.wroc.pl

Rare earth orthophosphates ($REPO_4$) nanoparticles are applicable in drug-delivery carriers, catalysis, sensor or photonic crystals. They can also find an application in medicine, especially in bio-imaging as a safer alternative to fluorides. Lanthanide based NIR emitting phosphors have interesting properties such as sharp emission lines or long luminescence lifetimes. $GdPO_4$ is an appropriate host for trivalent lanthanide ions. One of the lanthanide ions – Nd^{3+} shows efficient NIR luminescence, moreover neodymium ion can be use as structural probe to analyse structural properties [1].

The compound was obtained by three wet synthetic methods - hydrothermal method with the use of an ionic liquid and an oleic acid, as well as with the use of microwaves and an ionic liquid. Studies have shown that each proposed method of synthesis leads to a different morphology of $GdPO_4$:Nd^{3+} grains, what find the consequences in their spectroscopic properties. The conducted studies allow to conclude that the most promising materials are samples obtained with hydrothermal method with use of microwaves and an ionic liquid.

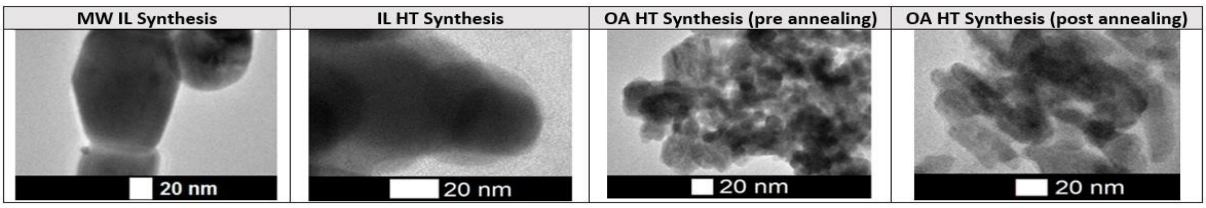


Fig. 1 TEM images of 1% Nd^{3+}-dopped $GdPO_4$ prepared by different synthesis method.

Acknowledgements

We would like to express our gratitude to the National Science Center of Poland for the grant HARMONIA 9 No UMO-2017/26/M/ST5/00563.

References

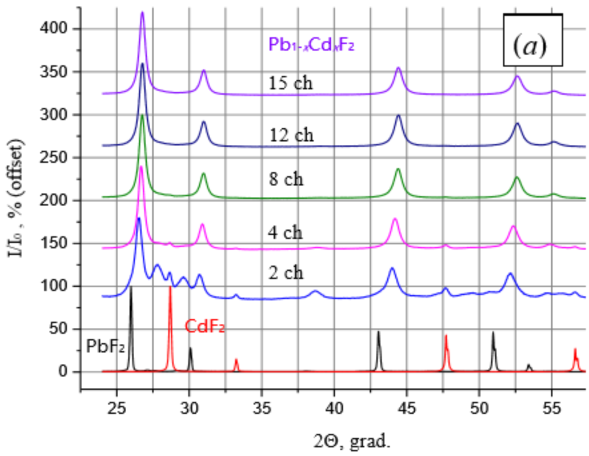
[1] Byrappa K.; Devaraju M.K.; Paramesh J.R.; Basavalingu B.; Soga K., Hydrothermal synthesis and characterization of LaPO4 for bio-imaging phosphors. *Journal of Material Science*, Vol.43, **2008**, 2229–2233.

P13: Mechanosynthesis of nanocrystalline fluorides

Irina BUCHINSKAYA, **Nataliya IVANOVSKAYA**

Shubnikov Institute of Crystallography of Federal Scientific Research Centre "Crystallography and Photonics" of Russian Academy of Sciences, Moscow, Russia
buchinskayaii@gmail.com

Mechanosynthesis is one of the most effective and economical ways to obtain nanomaterials for solid-state electrochemistry. Preparation of nanofluorides is of practical interest. We investigated the possibility of mechanosynthesis of the $Pb_{1-x}Cd_xF_2$ solid solution and RF_2 difluorides in a Retsch PM-200 ball planetary mill in Ar. Samples were successfully obtained by the mechanical milling of the starting materials PbF_2:CdF_2=2:1 and by the reaction $2RF_3 + R^0 = 3RF_2$, R = Yb, Sm, respectively. The resulting products were studied by XRD and SEM techniques, Fig. 1. XRD patterns showed that at the initial stage of grinding, PbF_2 goes into a rhombic polymorphic modification, then a new cubic phase with a lattice parameter a = 5.76(8) A is gradually formed [1].



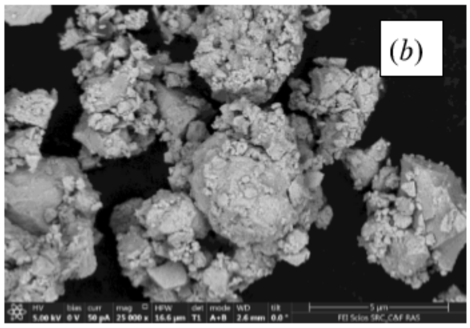


Fig. 1. The dynamics of changes in the XRD patterns from the grinding time (a); SEM image of $Pb_{1-x}Cd_xF_2$ (x = 0.33) (b).

One of the problems of mechanosynthesis is the large heterogeneity of the particle size distribution (10–200 nm). It is solved by fractionation of the product. Another problem of inorganic fluorides mechanosynthesis is their tendency to hydrolysis. The use of inert atmosphere does not completely solve this problem.

References:

[1] Buchinskaya, I. I.; Ivanovskaya, N. A.; Mechanosynthesis of Fluorite Solid Solution in the PbF_2–CdF_2 System. *Crystallography Reports,* 65(6), **2020,** (in press).

P14: Hard coal chemical looping combustion study In microreactor

Magdalena SZKUTA, Artur KREZLAK, Ewelina KSEPKO

a) *Wroclaw University of Science and Technology, Poland*
magdaszkut@wp.pl

Chemical Looping Combustion (CLC) technology is considered as one of the most promising fuel combustion methods for Carbon Capture and Storage purposes. The direct contact between air and fuel is avoided and CO_2 and NO_X emissions from fossil fuel combustion in power generation plants are greatly reduced. This is because oxygen is delivered to fuel by an oxygen carrier (OC), which is typically metal oxide. In the past simple metal oxides for example Mn_2O_3, CuO, CoO, NiO etc. have attracted much attention. The paper shows results on series of bimetallic oxygen carriers. Since they contain both iron and manganese (high concentrations) oxides and it is also of lower production cost compared to cost of pure CoO or pure Mn_2O_3 it might be industrially applicable. The combustion reactions were carried out in a microreactor, while GC was used for evolved gasses analysis. The tests were performed to simulate combustion reaction in real power system both dynamically and isothermally (from 800°C to 950°C) during one cycle. For the oxygen carriers reduction reactions, selected Polish hard coal was used. Theoretical calculations enabled ratio of coal:OC to select. The examinations proved that obtained materials showed both CLC and CLOU properties characteristic.

The study confirmed that the iron-manganese oxides are environmentally friendly materials, and able to operate as oxygen carriers in CLC power plants feed by hard coal.

P15: Low loss and high refractive index waveguide films fabricated using sol-gel method and dip-coating technique

Paweł KARASIŃSKI,[a)] Cuma Tyszkiewicz, [a)] Magda Zięba, [a)] Katarzyna Wojtasik [a)]

[a)] Department of Optoelectronics, Silesian University of Technology, 44-100 Gliwice, ul. B. Krzywoustego 2, Poland;
pawel.karasinski@polsl.pl

Integrated optics is a field of waveguide optoelectronics that deals with the design and fabrication of waveguide structures and systems on flat substrates. Technologies of integrated optics for applications in a telecommunication, operating in the near infrared (~1550 nm), base on SOI or InP [1,2]. Integrated optics however is also applied to fabrication of planar waveguide sensors using the evanescent wave spectroscopy as the measurement technique. In this case waveguide films having high refractive index and good optical properties are also desired, however not only in the near infrared, but also in the visible spectrum range. A high refractive index is necessary to obtain high measuring sensitivity. Recently has been reported SiO_2:TiO_2 waveguide film of refractive index ~1.81 [3].

The presentation will show two-component waveguide films TiO_x:SiO_y fabricated using the sol-gel method and dip-coating technique, having low propagation losses and high refractive index (>1.9) which is similar to Si_3N_4 waveguide films developed by Lionix. Author developed films having good optical properties in both spectral ranges: visible and near infrared. Those films have also high chemical resistance, while their parameters are stable over long periods of time. Elaborated waveguide films form the basis of the material platform for the development of planar waveguide sensing structures using the evanescent wave spectroscopy, for biomedical application.

The presentation describes a fabrication method of waveguide films and the results of theoretical analysis of basic sensing structures. It also shows advantages of the elaborated material platform as well as directions of research explored with its use.

References:

[1] Arakawa, Y.; et al., Silicon photonics for next generation system integration platform. *IEEE Communications Magazine*, Vol. 51 **2013**, 72-77

[2] Smit, M.; et al., An introduction to InP-based generic integration technology. *Semiconductor Science and Technology*, Vol. 29 083001, **2014**, 41pp

[3] Karasiński, P.; et al., Low loss, long time stable sol-gel derived silica-titania waveguide films. *Materials Letters*, Vol. 143, **2015**, 5-7

P16: Huge Enhancement of Sm^{2+} Luminescence via Eu^{2+} codoping in Strontium Tetraborates – Studies under High Pressure and Temperature conditions

Teng Zheng, [a] Marcin Runowski, [a] Przemysław Woźny, [a] Stefan Lis, [a] Víctor Lavín[b]

[a] *Adam Mickiewicz University, Faculty of Chemistry, Umultowska 89b, 61-614 Poznań, Poland;*
[b] *Departamento de Física, MALTA Consolider Team and IUdEA, Universidad de La Laguna, Apdo. Correos 456, E-38200 San Cristóbal de La Laguna, Santa Cruz de Tenerife, Spain; tenzhe@amu.edu.pl*

Multifunctional materials doped with divalent and trivalent rare-earth ions are extensively studied, thanks to their excellent luminescent, magnetic and catalytic properties, *etc* [1]. Pressing materials under high-pressure conditions is often accompanied by interesting changes of physicochemical characteristics, the formation of new phases and materials, unique properties as well as spectroscopic and structural differentiation of substances [2]. Therefore, in order to imitate the compression process under high pressure, it is extremely important to quickly and precisely determine the pressure [3].

Taking advantage of the excellent pressure-sensing properties of the Sm^{2+} ion in the SrB_4O_7 crystal, we demonstrate an enormous enhancement of about 60 times in the emission intensity of Sm^{2+} ions *via* Eu^{2+} ions codoping. This enhancement is induced by energy transfer from Eu^{2+} to Sm^{2+}. The spectral position of the ultra-sharp and most intense $^5D_0 \rightarrow {}^7F_0$ emission line in the material was correlated with the pressure and successfully calibrated up to about 60 GPa. The material exhibits favorable pressuresensing features, i.e. $d\lambda/dp \approx 0.29$ nm/GPa, negligible temperature-dependent shift, narrow and well-separated emission lines, and a strong luminescence signal.

References:

[1] Runowski, M.; Marciniak, J.; Grzyb, T.; Przybylska, D.; Shyichuk, A.; Barszcz, B.; Katrusiak, A.; Lis, S., Lifetime nanomanometry-high-pressure luminescence of upconverting lanthanide nanocrystals-SrF_2:Yb^{3+},Er^{3+}, Nanoscale. 9., **2017**, 16030– 16037.
[2] Zheng, T.; Runowski, M.; Woźny, P.; Lis, S.; Lavín, V., Huge enhancement of Sm^{2+} emission: Via Eu^{2+} energy transfer in a SrB_4O_7 pressure sensor, J. Mater. Chem. C. 8., **2020**, 4810–4817.
[3] Runowski, M.; Woźny, P.; Lis, S.; Lavín, V.; Martín, I., Optical Vacuum Sensor Based on Lanthanide Upconversion—Luminescence Thermometry as a Tool for Ultralow Pressure Sensing, Adv. Mater. Technol. 5., **2020**, 1901091.

P17: Study of Janina hard coal chemical looping combustion process in microreactor-GC system enabling environment protection

Borys WINCZURA, Artur KREZLAK, Ewelina KSEPKO

[a] *Wroclaw University of Science and Technology, Poland*
borys.winczura@gmail.com

The paper contains results of study on a promising combustion technologies known as Chemical Looping Combustion (CLC) and Chemical Looping with Oxygen Uncoupling (CLOU). The main advantage of CLC is a production of highly concentrated CO_2 stream which is obtained after water condensation without any energy penalty for its separation [1]. In CLC direct contact between fuel and air is avoided, while the needed oxygen is delivered from the structure of oxygen carrier (OC), which is typically metal oxide (MeO).

The objective of this work was to examine novel oxygen carrier materials mixed FeMn oxides with selected ZrO_2 support in terms of their practical applications with solid fuel. A series of bimetallic oxygen carriers were prepared by mechanical mixing method. The widely industrially used Polish hard coal namely Janina was mixed with OC with desired ratio and combustion was evaluated. Examinations were carried out in microreactor combined with gas chromatograph. The reactivity tests were performed in high temperatures as high as 950°C. In each temperature 1 OC reduction cycle (1 fuel combustion cycle) was performed. Effect of temperature on combustion efficiency, mechanical and chemical stability were determined. The obtained materials demonstrated good thermal stability.

The microreactor combustion tests revealed that combination of high amounts of iron together with manganese oxides (as active part of oxygen carriers) and additionally some inert such as zirconium oxide, improved stability and enabled avoiding agglomeration tendency. This behaviour was compared to reference material, which was pure Fe_2O_3 with ZrO_2. The stable CLC-CLOU performance, and as prognosed decreased agglomeration tendency (which is an issue for pure Fe_2O_3), suggest that these oxygen carriers might be successfully applied for energy generation hard coal based processes.

References:

[1] Ksepko E, Babinski P, Evdou A, Nalbandian L. Studies on the redox reaction kinetics of selected, naturally occurring oxygen carrier. J Therm Anal Calorim 2015;124:137–50.

P18: Ionic liquid assisted synthesis route for fabrication of fine nanocrystalline Nd^{3+}-doped $LuPO_4$ optical material

Kacper A.Prokop [a), c)] Małgorzata. Guzik,[a),c)] Yannick. Guyot,[b)] Georges Boulon,[b)] Magdalena Wilk-Kozubek,[c)] Marcin Sobczyk,[a)] Anja Verena Mudring,[d)] Joanna Cybińska[a),c)]

[a)]Faculty of Chemistry, University of Wrocław, ul. F. Joliot-Curie 14, 50-383 Wrocław, Poland;

[b)]Institut Lumière Matière (ILM), UMR5306 CNRS- Université Claude Bernard Lyon1, Université de Lyon, 69622 Villeurbanne, France;

[c)]LUKASIEWICZ Res Network PORT Polish Ctr Technol D, 147 Stablowicka St, 54-066 Wroclaw, Poland;

[d)]Stockholm Univ, Dept Mat & Environm Chem, Svante Arrhenius Vag 16C, S-10691 Stockholm, Sweden

kacper2311@gmail.com

The aim of this study was to obtain fine nanoparticles of Nd^{3+}-doped $LuPO_4$ zircon(xenotime)-type orthophosphates (0.5–15 mol%) with using simple lanthanide precursors such as lanthanide nitrates and task-specific ionic liquid (IL) of choline dihydrogen phosphate as the reactant and in-situ nanoparticle stabilizer. The compounds were prepared by hydrothermal and microwave methods. These synthesis routes possess many advantages as they are fast and facile preparation methods of the desired wellcrystallized single phase phosphate nanomaterials of good quality.

In the frame of this work the structural, morphological and spectroscopic investigations of the fabricated powders were performed. The XRD and microscopic (TEM) analysis revealed some influence of synthesis conditions on morphology and nanoparticles size, what is reflected in their spectroscopic properties.

Nd^{3+} ion can be used as structural probe and by applying the low-temperature highresolution techniques like absorption spectroscopy at 4.2K and laser site selective spectroscopy at 77K, detailed structural and spectroscopic studies of Nd^{3+}-doped $LuPO_4$ micro-powders were performed.

In addition, we have focused on the possible application of this material as a thermometer by analysing the thermal dependence of the intensity of emission lines under λ_{ex}=532 nm excitation in the temperature range between 293 and 613 K. Especially, we note that the $^4F_{5/2}$ level is populated by a thermal excitation from the $^4F_{3/2}$ level due to a small energy gap between these levels.

P19: High localization of excitons in a large-area WS_2 monolayer

[a] Nikodem SOKOŁOWSKI, [a] Jan KOPACZEK, [a] Robert KUDRAWIEC

[a] Department of Semiconductor Materials Engineering, Wroclaw University of Science and Technology, Wybrzeże Wyspiańskiego 27, 50-370 Wrocław, Poland
236646@student.pwr.edu.pl

WS_2 belongs to a transition metal dichalcogenides (TMDs) family. In their bulk forms, compounds are layers materials in which there are strong intralayer bonding and weak, van der Waals interlayer bonding. That allows us to obtained monolayers of the TMDs (transition metal layer sandwiched by two chalcogen layers). Change of dimensionality from 3D to 2D significantly influence on electrical, mechanical and optical properties of materials, e.g. WS_2 change fundamental bandgap from indirect to direct, which makes them promising materials for optoelectronic applications. The most popular method to obtain monolayers of TMDs are exfoliation methods but these layers are microscopic and aren't repeatable - what is necessary for the industry. We investigated large-area WS_2 monolayer grown by a chemical vapor deposition method and determined the influence of 3 substrates (silicon, sapphire, glass) on optical properties by photoreflectance and photoluminescence spectroscopy. Photoreflectance spectroscopy is an absorption-like tool for a very sensitive study of direct optical transitions, which is insensitive to defects and related localization of carriers. Photoluminescence spectroscopy relies on detecting light emission from a material. In our study, comparing photoluminescence and photoreflectance spectroscopy we noticed high localization of excitons up to 480K regardless of the substrates. Additionally, the study revealed slightly different energy of optical transitions depending on the substrates (between the glass and sapphire ~28meV at 20K) due to dielectric screening and strain resulting from the different lattice constant of substrates. Temperature-dependence (20-480K) photoreflectance measurement surprising shows an insignificant difference in the temperature coefficient of optical transitions dependence of substrate due to strain associated with different thermal expansion of substrates.

P20: Influence of ammonia water on charge-carrier lifetime in MoS_2 studied by microwave photoconductivity decay

[a] Kamil MISZTAL, [a] Artur HERMAN, [a] Robert KUDRAWIEC

[a] *Department of Semiconductor Materials Engineering, Faculty of Fundamental Problems of Technology, Wroclaw University of Science and Technology*
236564@student.pwr.edu.pl

Transition metal dichalcogenides (TMDs) are semiconductor compounds of general formula MX_2, where M and X means transition metal atom (such as Mo, W) and chalcogen atom (e.g. S, Se), respectively. These materials have attracted wide research interest due to their unique properties and potential applications [1, 2]. Here, we study the influence of ammonia water of diverse concentrations on charge-carrier lifetime in MoS_2 by microwave photoconductivity decay (μ-PCD) method. This technique is widely used for evaluation of lifetime in semiconductors, which depends on concentration of photoexcited carriers. An excess electron-hole pair concentration is created by optical-laser illumination. The photocurrent signal is proportional to the number of excess electronhole pairs integrated over the sample volume and then the change in microwave power reflected from the sample is monitored by oscilloscope [3]. In this study, through the use of various liquids in functionalization surfaces we can modify the decay processes occurring in exfoliated molybdenum disulfide (MoS_2). We show that ammonia water make an impact on these processes – it is an increase lifetime of charge-carriers. Moreover, we suppose that this process is physical due to return of decay to the original state of sample when the water on sample's surface will dry up.

References:

[1] Wang, Q., Kalantar-Zadeh, K., Kis, A. *et al.* Electronics and optoelectronics of twodimensional transition metal dichalcogenides. *Nature Nanotech* **7,** 699–712 (2012)
[2] Juan Xia, Jiaxu Yan, Ze Xiang Shen, Transition metal dichalcogenides: structural, optical and electronicproperty tuning via thickness and stacking. *FlatChem **4**,* (2017)
[3] M. E. Rodríguez, A. Mandelis, G. Pan, J. A. García, V. Gorodokin, and Y. Raskin. Minority carrier lifetime and iron concentration measurements on p-Si wafers by infrared photothermal radiometry and microwave photoconductance decay. *Journal of Applied Physics **87**,* 8113 (2000)

P21: Development of Rare-Earth-Doped Hybrid Materials Towards Luminescence Enhancement

Leonardo FRANCISCO, [a] Maria FELINTO, [a] Hermi BRITO [b]

[a] *Nuclear and Energy Research Institute (IPEN-CNEN), University of São Paulo (USP);*
[b] *Institute of Chemistry (IQ), University of São Paulo (USP);*
leo.francisco@usp.br

The rapid growth on the development of rare-earth-doped luminescent materials has been drawing attention due to complex energy converting systems that can be structurally engineered to tune absorption and emission wavelengths, outlining new materials and applications for photonics. [1, 2] In this scenario, this work presents the development of rare-earth-doped strontium aluminate phosphors prepared by the Pechini method and modified with 3-aminopropyltrimethoxysilane *via* microwaveassisted synthesis, integrating a silica network with rare-earth β-diketonate complexes in order to enhance the absorption section and promote energy-transfer processes within the system. The prepared materials were analyzed by X-ray powder diffraction, where a characteristic monoclinic $SrAl_2O_4$: Eu^{2+}, Dy^{3+} phase with crystallite size around 30 nm was observed. Several structural changes attributed to surface modification were also noted. Scanning Electron Microscopy images and Energy-Dispersive X-ray Spectroscopy results revealed the expected surface alteration effects, as well as the element mapping throughout the samples. Standard UV-Vis and Vacuum-UV Luminescence Spectroscopies were also performed. The optical behavior of the synthesized materials was characterized by green Eu^{2+} emission assigned to the $4f^65d^1 \rightarrow 4f^7(^8S_{7/2})$ interconfigurational transition under near-ultraviolet excitation alongside narrow 4f-4f transitions of non-reduced Eu^{3+}. Furthermore, in functionalized samples, $S_0 \rightarrow S_n$ transitions attributed to β-diketonate ligands were also observed, unveiling an increasing absorption section under ultraviolet light. Finally, it was noted a significant increase in the persistence decay time under near Band-Gap excitation in modified materials, suggesting interactions between the inorganic host-matrix, the silica network, and the β-diketonate complexes.

References:

[1] Y. Li, et. al.; Long persistent phosphors-from fundamentals to applications. *Chem Soc Rev.*, **2016**, 2090-2136.

P22: Room temperature p-orbital magnetism in carbon chains

[a)]C. H. WONG*, [a)]A. F. ZATSEPIN, [a)]E. A. BUNTOV, [c)]J. LYU, [c)]R. LORTZ, [a)]D. A. ZATSEPIN and [b)]M. B. GUSEVA

[a)]Institiue of Physics and Technology, Ural Federal University, Russia.
[b)]Faculty of Physics, Moscow State University, Russia.
[c)]Department of Physics, The Hong Kong University of Science and Technology, China
ch.kh.vong@urfu.ru

The study of magnetism without the involvement of transition metals or rare earth ions is regarded as the key to the fabrication of next generation spintronic devices. We provide experimental evidences in which the kink-structuring monoatomic carbon chains, the socalled linear-chained carbon, generate intrinsic ferromagnetism above room temperature. According to our DFT calculations, this unconventional magnetism is originated from the p-shells. In contrast, the linear monoatomic carbon chains are nonmagnetic. The average magnetic moment of the kink-structuring monoatomic carbon chains is 0.3μB.

References:

[1] Nanoscale, 2018,10, 11186-11195
[2] Carbon, 1992, 30 , 213 —221
[3] F. CataldoCRC press, USA, 2005, 219–252

P23: IR-transparent $MgO-Y_2O_3$ composite ceramics by Hot pressing and Spark plasma sintering

Dmitry PERMIN[a,b], **Alexander BELYAEV**[a], **Stanislav BALABANOV**[a], **Maksim BOLDIN**[b]
[a] *G.G. Devyatykh Institute of Chemistry of High-Purity Substances of the RAS;*
[b] *Lobachevsky State University of Nizhny Novgorod;*
permin@ihps-nnov.ru

Recently, $MgO-Y_2O_3$ nanocomposite ceramics have become renowned as new promising infrared (IR) transparent materials with high thermal and mechanical stability. This work presents a comparison of consolidation conditions and properties of $MgO-Y_2O_3$ ceramics produced by spark plasma sintering (SPS) and hot pressing (HP) techniques.

Initial $MgO-Y_2O_3$ nanopowders were synthesized by the method of self-propagating high-temperature synthesis (SHS) using metal nitrates as an oxidizer and glycine as a fuel. The powders showed a composite nature and correspond to the target materials in the crystal structure. The morphology of the powders is characterized by the presence of loose agglomerates with a porous structure, which is a consequence of intense gas formation during SHS.

According to electron microscopy, the average grain size of the SPS-derived $MgO-Y_2O_3$ ceramics is about 150 nm up to temperatures of 1200°C, after which it increases rapidly. The minimum porosity is observed for samples sintered at a temperature of 1150-1200 °C. The transmission of the ceramics after SPS does not exceed 60% due to significant contamination with carbon-contained impurities. Additional annealing in air at a temperature of 1100°C leads to an increase in IR transmission to 80.9% at a wavelength of 5 μm for samples obtained at a temperature of 1150°C.

The optimal temperature for hot pressing of $MgO-Y_2O_3$ ceramics is 1400°C, which is higher compared to SPS. At that, HP leading to the production of samples with the transmission of 83.6% at a wavelength of 5 μm.

Thus, the chosen methods allow the sintering of ceramics with a density of more than 99% while maintaining an average grain size of 100-150 nm. The best results at this stage are achieved by the method of hot pressing with indirect heating. The transmission of these samples in the infrared range corresponds to the best published results.

ACKNOWLEDGMENT
The study was funded by the Russian Science Foundation (research project No. 19-7310127).

P24: Catalytic/Photocatalytic Activity of Phase Tuned In_2S_3 Nanocrystals

Yogendra Nath CHOURYAL,[a)] Rahul Kumar SHARMA,[a,b)] and Pushpal GHOSH[a)]*

[a)]School of Chemical Sciences and Technology, *Department of Chemistry, Dr. Harisingh Gour University (A Central University) Sagar, 470003, M.P., India.* [b)]*Department of Chemistry, Government Shyam Sundar Agrawal PG College, Sihora-483225, Jabalpur, India*
yogendrachouryal5@gmail.com & pushpalghosh27@gmail.com

Herein, we have discussed the tuning of crystal phase and catalytic/photocatlytic activity of highly energy efficient and environmentally benign In_2S_3 semiconducting nanocrystals (NCs). These NCs are synthesized using task-specific ionic liquids (ILs) as a structure directing agent. In this work, effect of reactivity of sulphur precursor (thioactamide/thiourea), alkyl chain length of the cations of the ILs, H- bonding ability of the ILs, reaction temperature on the crystal phase, crystallite size, morphology and photocatalytic activity of In_2S_3 NCs are illustrated. On increasing the alkyl chain length of 1alkyl-3-methylimidazolium bromide [$C_n$mim]Br (n=2,4,) cubic phase was obtained. However, on further increasing the pendant length of [$C_n$mim]Br (n=6,8 and 10) and in the presence of tetramethylammonium bromide (TMAB) tetragonal crystal phase is obtained. In addition, below 150 ^oC, pure cubic phase is obtained with and without IL while at 150 ^oC, cubic and tetragonal phases are obtained with and without IL respectively. And marigoldlike microsphere is observed which consist of nanoribbon/nanoflakes.[1] Furthermore, wide range of band gap of In_2S_3 NCs is also tuned by varying the alkyl chain length of ILs and concentration of sulphur precursor. Thereafter, as-prepared In_2S_3 NCs are employed to study the adsorption driven degradation of crystal violet (CV) dye in dark as well as light. A maximaum catalytic efficeiency ~ 94.8 % is observed for In_2S_3 nanocrystals using (TMAB) ionic liquid.[1] Our study also shows that structure and nature of dye molecule are also important for adsorption based degradation by nanocatalyst. For example, crystal violet (CV), methylene blue (MB), rhodamine B (B) and methyl orange (MO) showed 91%, 77%, 44.7% and 15.29% catalytic/photocatalytic efficiency when they are exposed by asprepared In_2S_3 nanocatalyst.[2]

References

[1] Sharma, R. K.; Chouryal, Y. N.; Chaudhari, S.; Saravanakumar, J.; Dey, S. R.; Ghosh, P.* Adsorption-Driven Catalytic and Photocatalytic Activity of Phase Tuned In_2S_3 Nanocrystals Synthesized via Ionic Liquids. *ACS Appl. Mater. Interfaces.* 9, **2017,**11651−11661.
[2] Sharma, R. K.; Chouryal, Y. N.; Nigam, S.; Saravanakumar, J.; Barik, S.; Ghosh, P.* Tuning the Crystal Phase and Morphology of the Photoluminescent Indium Sulphide Nanocrystals and Their Adsorption-Based Catalytic and Photocatalytic Applications. *ChemsitrySelect.* 3, **2018**, 8171-8182.

P25: Cu_2ZnSnS_4 nanoparticles for inkjet printing technology

Tetiana KIRISH[a1] Mariana LUTSIV[a] Adam ŻABA,Katarzyna MATRAS-POSTOLEK [a2]

[a] Cracow University of Technology, Faculty of Chemical Engineering and Technology, Department of Biotechnology and Physical Chemistry, Warszawska str, 24, Cracow, 31-155;
tanyakirish@gmail.com [a1], k.matras@pk.edu.pl [a2]

Inks with metal or semiconductor nanoparticles have attracted broad interest in the printed electronics industry due to their unique properties related with the reduced size and increased surface area. The printing technology has a large influence on the cost of the fabrication of electronic systems. In the field of printed electronics, a large amount of work is put into the inkjet printing of this inks consist of semiconductor nanocrystals (NCs) and conjugated polymeric materials [1, 2].

For the ink formulation, CZTS nanoparticles were obtained by using a continuousflow synthesis based on microwave-assisted heating of a mixture of sodium sulfide, tin chloride, copper(I)chloride and zinc chloride dissolved in a mixture of water and ethylenediamine. For the further formulation of a stable nanoparticle ink with rheological and wetting properties suitable for inkjet printing, a mixture of different solvent was used for ink formulation. CZTS ink was prepared. A viscosity and surface tension were measured to tune the fluid properties to the desired values.

For characterization of obtained CZTS NCs and prepared ink, different analysis techniques were used, such as TEM, XRD, PL-NIR and SEM. To confirm the ability of the ink to be printed, the printing test was performed using PixDro LP 50 inkjet printing system with the Spectra SE-128 AA printhead.

ACKNOWLEDGMENT
This work was financially supported by National Centre for Research and Development under Lider Program, contract no. LIDER/009/185/L-5/13/NCBR/2014. We would like to thank you dr Grzegorz Tomaszewski and dr Jan Kulawik from Research Network Łukasiewicz, Institute of Electron Technology, Kraków Division, ul. Zabłocie 39, 30-701, Kraków, Poland for helping to test printing inks.

References:
[1] Tekin, E.; Smith, P.; Schubert, U. Soft Matter 4, 2008, 703.
[2] Rae, A.; Hammer-Fritzinger, D. Sol. St. Tech. 49.4, 2006, 53.

P26: Synthesis and optical properties of $Y_3Al_5O_{12}$ grown by microwave driven hydrothermal technique

<u>Nikola Cichocka</u>, [a)] Serhiy Kobyakov, [a)] Jarosław Kaszewski,[b)] Roman Minikayev[b)], Agata Kamińska[a,b)]

[a)] Cardinal Stefan Wyszynski University, Faculty of Mathematics and Natural Sciences. School of Exact Sciences, Dewajtis 5, 01-815 Warsaw, Poland [b)] Institute of Physics, Polish Academy of Sciences, Aleja Lotnikow 32/46, 02-668 Warsaw, Poland; ncichocka92@gmail.com

Rare earth (RE) doped perovskites, garnets and monoclinic forms have been drawing large attention due to its photovoltaic properties. Rare earth doped ceramic powders are used nowadays and can find new applications in industry and medicine [1]. The most popular ceramic material is cubic yttrium-aluminium garnet ($Y_3Al_5O_{12}$, YAG), because it can be easily doped with rare earth ions owing to its crystalline structure. Such materials have a wide spectrum of applications in optoelectronics [2].

Nanopowder of $Y_3Al_5O_{12}$ doped with Eu^{3+} has been synthesised using microwave driven hydrothermal technique. All of the syntheses were performed at 60 bar and high temperature (150-300^oC). KOH aqueous solution was used to adjust pH value of solution and precipitate hydroxides residue. For structure and optical properties the X-ray diffraction (XRD) and the luminescence spectra of Eu^{3+} were measured.

References:

[1] Iskandar F. Nanoparticle processing for optical applications – A review. *Advanced Powder Technology*, Vol. 20, **2009,** 283-292.

[2] Ikesue A., Furusato I., Kamata K. Fabrication of Polycrystal line, Transparent YAG Ceramics by a Solid-State Reaction Method. *Journal of the American Ceramic Society*, Vol. 78, **1995,** 225-228.

P27: Exploiting the bandgap engineering to finely control dual-mode $Lu_2(Ge,Si)O_5:Pr^{3+}$ luminescence thermometers

Małgorzata SÓJKA, [a] Carlos D. S. BRITES, [b] Luis D. CARLOS, [b] Dagmara KULESZA, [a] Eugeniusz ZYCH, [a]

[a] Faculty of Chemistry, University of Wrocław, 14 F. Joliot-Curie, 50-383 Wrocław, Poland;
[b] Physics Department and CICECO, Universidade de Aveiro, 3810–193 Aveiro, Portugal;
malgorzata.sojka@chem.uni.wroc.pl

In this study we examined a series of a new type of temperature sensors which work in a broad range of temperatures (17 – 650 K) – Lu_2SiO_5:0.05%Pr and its chemically modified version by a bandgap engineering approach (replacing Si by Ge) [1]. Addition of Ge to replace Si was expected to decrease the host bandgap – energetic separation of its valence and conduction bands. Consequently, we expected that the 5d□4f luminescence would be more susceptible for temperature quenching. Indeed, while in Lu_2SiO_5:Pr it lasted up to 475 K in Lu_2GeO_5:Pr it was not observed at all. In the mixed compositions the 5d→4f luminescence was quenched at temperatures dependent on the Si:Ge ratio, see Figure 1. This, in turn, allowed to control the range of temperatures within which the 5d→4f/4f→4f emission intensity ratio could be utilized for thermometry. Furthermore, the kinetics of the 5d→4f luminescence was also found controllable by bandgap engineering and could be utilized for luminescence thermometry. Thus, the $Lu_2(Ge_x,Si_{1-x})O_5$:Pr phosphors were designed as dual-mode luminescence thermometers exploiting either the inter- and intra-configurational luminescence intensity ratio or the 5d→4f emission decay time. During the presentation we will discuss performance of the thermometer and how to fine-control its properties.

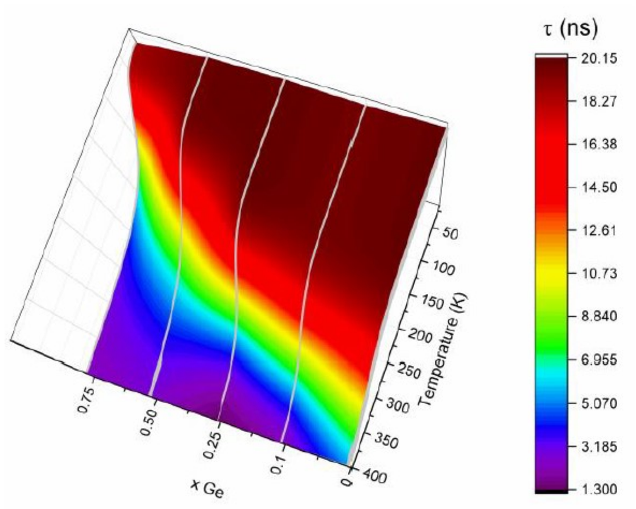


Figure 1. Decays of the $Lu_2Ge_x,Si_{1-x}O_5$:0.05%Pr 5d→4f luminescence depicted as a 3D graph.

References:

[1] Sójka, M.; Brites, C. D. S.; Carlos, L. D.; Zych, E., Exploiting bandgap engineering to finely control dual-mode $Lu_2(Ge,Si)O_5:Pr^{3+}$ luminescence thermometers. *Journal of Materials Chemistry C,* 8, **2020,** 10086-10097.

Supported by National Science Centre, Poland under grant #UMO-2017/25/B/ST5/00824.

P28: Multifunctional versatile 2D layered materials and changes in their physicochemical properties upon modifications

Katarzyna WAL [a,b], Wojciech STAWIŃSKI [a], Piotr RUTKOWSKI [b]

[a] Łukasiewicz Research Network – PORT Polish Center for Technology Development Stabłowicka 147, 54-066 Wroclaw, Poland; [b] Wrocław University of Science and Technology, Department of Process Engineering and Technology of Polymer and Carbon Materials, Faculty of Chemistry, Gdańska 7/9, Wrocław 50-344, Poland
katarzyna.wal@port.lukasiewicz.gov.pl

Clay minerals known as natural layered materials are successfully used in the field of adsorption, catalysis, electrochemistry, photochemistry, and cosmetics [1]. They are composed of two types of phyllosilicate sheets: tetrahedral and octahedral, which form 1:1 or 2:1 structure. One of the representatives of this group of compounds is vermiculite classified as 2:1 trioctahedral mica-type mineral [2]. This type of material is among others promising natural two-dimensional nanomaterial, adsorbent and component of polymer composites [3].

The aim of presented work was modification of vermiculite in order to increase its porosity and specific surface area, that can tune the material's functional properties by increasing the contact surface and generating more active sites in its structure. Different acid treatments with variety of concentrations over the clay mineral was applied. Waste produced during acid treatment procedure was used to obtain hydrotalcite-like layered double hydroxide (LDH) materials. Furthermore, acid activated vermiculite was combined with received layered double hydroxide to form novel hybrid material in one-pot synthesis. Measurement of the BET specific surface area analysis, thermogravimetry (TG) and attenuated total reflectance-Fourier transform infrared (ATR-FTIR) spectroscopy was selected to perform physicochemical characteristics of obtained materials. The analysis of the results showed that applied modifications significantly increased of the porosity of vermiculite.

References:

[1] Miyamoto, N., & Yamamoto, S., Functional Layered Compounds for Nanoarchitectonics. In Supra-materials Nanoarchitectonics. Elsevier Inc., 2017, 173-192

[2] Modak, A., & Jana, S., Advances in Porous Adsorbents for CO2 Capture and Storage. Carbon Dioxide Chemistry, Capture and Oil Recovery, 2018, 165-184

[3] Wang, W., & Wang, A., Vermiculite Nanomaterials: Structure, Properties, and Potential Applications. In Nanomaterials from Clay Minerals. Elsevier Inc., 2019, 415-484

P29: Secondary Nucleation Controlled Luminescence Behavior of RE^{3+} Doped BaF_2 Nanocrystals

Rahul Kumar SHARMA[a),b)], **Pushpal GHOSH**[a)*]

[a)] *Department of Chemistry, Dr. Harisingh Gour University (A Central University), Sagar-470003, India;* [b)] *Department of Chemistry, Government Shyam Sundar Agrawal PG College, Sihora-483225, Jabalpur, India; rksharma7987@gmail.com & pushpalghosh27@gmail.com*

Recently, rare-earth (RE^{3+}) doped fluoride-based nanomaterials have drawn a considerable attention for various applications such as optoelectronic, magnetic, solar cell, bioimaging etc. The photophysical processes of RE^{3+}-doped nanomaterials are independent of quantum confinement effect and fluoride-based host matrix are extensively used as they have low phonon energy, high refractive index and large band gap. Therefore, RE^{3+} (Eu^{3+}, Ce^{3+})-doped BaF_2 nanoparticles are synthesized using the ionic liquids (ILs)-assisted solvothermal methods.[1,2] In these methods, 1-ethylmethyl imidazolium bromide ([C_2mim]Br as a solvent, capping agent) and1-butylmethyl imidazolium tetrafluoroborate ([C_4mim]BF_4 as a solvent, reaction partner and capping/templating agent *i.e* 'all three in one') ILs are employed.[1,2] Herein, it is noticed that on calcination, RE^{3+}-doped BaF_2 nanoparticles at high temperatures like 200, 400, 600 and 800 °C, crystal phase remain same throughout the calcining temperature. However, lattice strain, morphology and optical behavior are drastically tuned with calcination temperature.[1] Interestingly, lattice strain is tuned from tensile to compressive strain and morphology is changed from cubic (BaF_2:Eu^{3+})/flakes (BaF_2:Ce^{3+}) to stair-like layered structures. This happens due to '*secondary nucleation*'. In addition, due to secondary nucleation, photoluminescence of Eu^{3+} and Ce^{3+} ions are quenched at high temperature. As a model, BaF_2:Ce^{3+} nanoparticles are studied to show the light on quenching mechanism. State of the art, Thermally Stimulated Luminescence (TSL) and Thermally Stimulated Exo-electron Emission (TSEE) techniques are employed to unravel the interplay of lattice defect in quenching mechanism.[2]

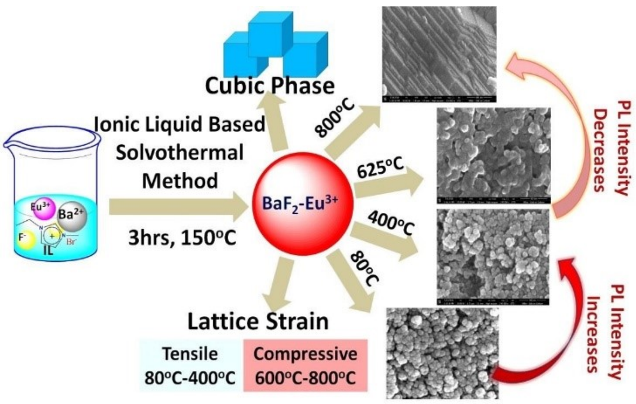


Figure 1: Schematic diagram showing effect of calcinations on lattice strain, morphology and luminescence.[1]

References:

[1]. Sharma, R. K.; Nigam, S.; Chouryal, Y. N.; Nema, S.; Bera, S. P.; Bhargav, Y.; **Ghosh, P.*,** Eu-Doped BaF_2 Nanoparticles for Bioimaging Applications, *ACS Appl. Nano Mater*, 2, **2019**, 927-936. [2]. Sharma, R. K.; Chouryal, Y. N.; Slesarev, A. I.; Ivanovskikh, K. V.; Leonidov, I. I.; Nigam, S.; **Ghosh, P.*,** A Closer Look at Defects and Luminescence of Nanocrystalline Fluorides Synthesized via Ionic Liquids: The Case of Ce^{3+}-Doped BaF_2, *New Journal of Chemistry,* 44, **2020,** 200-209.

P30: The key role of intrinsic lifetime dynamics from upconverting nanosystems in Multiemission Particle Velocimetry

Gabriella TESSITORE, [a] **Steven L. MAURIZIO**, [a] **Tarek SABRI**, [a] **Cameron D. SKINNER**, [a] **and John A. CAPOBIANCO.** [a]

[a] *Department of Chemistry and Biochemistry & Centre for Nanoscience Research, Concordia University, 7141 Sherbrooke W., Montreal, H4B 1R6 Canada; g.tessitore87@gmail.com*

Measuring the particle velocity at the nano- and microscale can be challenging with the velocimetry techniques based on luminescence probes. The major drawback of their use resides in the requirement for calibration of the emission profiles, which limits their use to the specific experimental conditions using for the calibration. The proposed multiemission particle velocimetry method guarantees accurate velocity measurements, independent of the particle concentration or experimental setup, and without need for calibration. The used nanoprobes are core–shell upconverting nanoparticles co-doped with Yb^{3+}, Tm^{3+} and Tb^{3+}. Upon excitation with a focused near-infrared pulsed laser, these nanoparticles emit photons at different wavelengths. The time interval between these successive emissions is independent of the local environment or particle velocity. The velocity of the particles is calculated by measuring the distance between the maxima of two different emissions and dividing it by this known difference in luminescence lifetimes. This method was proved accurate by using simple digital imaging of nanoparticles flowing in 75–150 µm diameter capillaries with a phone camera and an inexpensive experimental setup. The relative standard deviation of the experimental velocities with respect to the theoretical ones was 5% or lower without any calibration.[1]

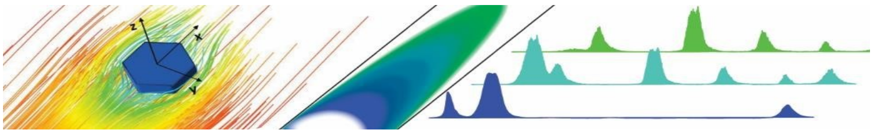


Figure 1: Schematics of a particle surrounded by flow lines within a microcapillary. The emissions from the particle can be correlated with the time through timeresolved spectra, yielding the particle velocity.

References:

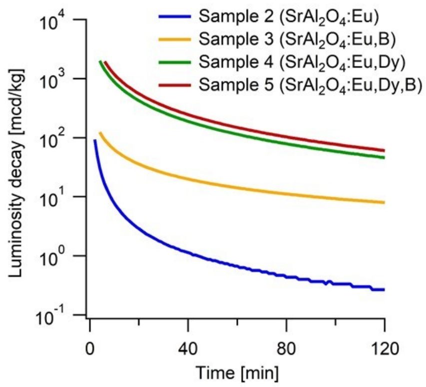
[1] Tessitore, G.; Maurizio, S.L.; Sabri, T..; Skinner, C.D.; Capobianco, J.A., The Key Role of Intrinsic Lifetime Dynamics from Upconverting Nanosystems in Multiemission Particle Velocimetry. *Adv.Mater.,* **2020,** 2002266.

P31: Analysis of traps, extinction coefficient and role of Dy^{3+} and B^{3+} in the persistent phosphor $SrAl_2O_4:Eu^{2+}, Dy^{3+}, B^{3+}$

Teresa DELGADO, [a] **Hans HAGEMANN**, [b] **Jafar AFSHANI** [b]

[a] *Chimie ParisTech-CNRS, IRCP (PSL), 11 rue P. et M. Curie, 75005 Paris, France*
[b] *Université de Genève, Quai Ernest-Ansermet 30, Geneva, Switzerland*
teresa.delgado@chimieparistech.psl.eu

The investigation of crystals of $SrAl_2O_4:Eu^{2+},Dy^{3+}$ that, unlike the powder, do not contain surface defects, allows a better insight into the mechanism that governs the longlasting phosphorescence of this material. The spectroscopic properties of a crystal of $SrAl_2O_4:Eu^{2+},Dy^{3+}$ were studied in detail including a novel estimation of its extinction coefficient [1]. Moreover, in order to get more insights about the mechanism by which Dy^{3+} and B^{3+} enhance the afterglow, the Eu^{2+} free samples $SrAl_2O_4:Dy^{3+}$ and $SrAl_2O_4:Dy^{3+},B^{3+}$ were deeply investigated [2]. Unique features were observed in their excitation and emission spectra that show the lattice defects induced by the replacement of Sr^{2+} by Dy^{3+}, the existence of different crystallography sites for the Dy^{3+} ions and the local distortion of the energy levels of Dy^{3+} ions in the presence of B^{3+}. Finally, the chemical contribution of Dy^{3+} and B^{3+} to the afterglow was addressed by a series of systematic thermoluminescence experiments in samples of increasing complexity. These experiments allowed associating the different traps with the chemical composition of the sample.



Influence of composition in the afterglow.

References:

[1] Delgado, T.; Afshani, J.; Hagemann, H., Spectroscopic Study of a Single Crystal of $SrAl_2O_4:Eu^{2+}:Dy^{3+}$. *J. Phys. Chem. C*, 123, **2019**, 14, 8607-8613.
[2] Delgado, T.; Ajoubipour, S.; Afshani, J.; Yoon, S.; Walfort, B.; Hagemann, H., Spectroscopic Properties of Dy^{3+}- and Dy^{3+}, B^{3+}- Doped $SrAl_2O_4$. *Opt. Mater.,* 89, **2019**, 268-275.
[3] Bierwagen, J.; Delgado, T.; Jiranek, G.; Yoon, S.; Gartmann, N.; Walfort, B.; Pollnau M.; and Hagemann. H.; *J. Lumin.*, 222, **2020**, 117113.

P32: Glasses and glass-ceramics based on TeO_2 for potential applications in photovoltaic

Łukasz MAREK, Marcin SOBCZYK

Faculty of Chemistry, University of Wrocław; lukasz.marek@chem.uni.wroc.pl

A major problem limiting the conversion efficiency of PV cells is spectral mismatch of solar radiation with the bandgap energy of solar cells [1]. There are two strategies presented to enhance conversion sunlight into electrical energy, based on quantum cutting process and cooperative energy transfer mechanism $Te^{4+} \rightarrow Yb^{3+}$.
The quantum cutting process and rarely reported emission from the $^1G_4$ level in oxide materials have been demonstrated in Pr^{3+}-doped glasses [2]. The quantum process efficiency for glasses and glass-ceramics has been determined based on normalized absorption and excitation spectra. The luminescence and excitation spectra of glasses revealed the presence of bands arising from electronic transitions of Te^{4+} in UV-VIS spectral range. The efficient energy transfer $Te^{4+} \rightarrow Yb^{3+}$ observed in tellurite glasses makes it possible to use it as a solar energy converter in silicon cells.

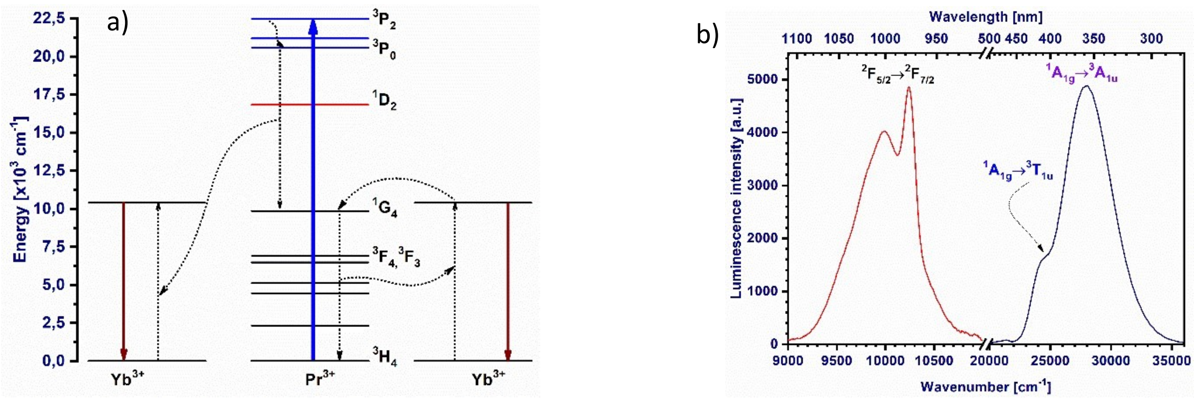


Fig. 1. a) Energy transfer mechanism between Pr^{3+} and Yb^{3+} ions co-doped tellurite glasses and glass-ceramics. b) The luminescence (λ_{exc}= 360 nm) and excitation spectra (λ_{em}= 977 nm) of Yb^{3+}- doped TZNY glass.

References:

[1] Huang, X.; Han, S.; Huang, W.; Liu, X., Enhancing solar cell efficiency: the search for luminescent materials as spectral converters. *Chem. Soc. Rev.,* Vol. 422., **2013,** 173-201.
[2] Marek, Ł.; Sobczyk, M., Spectroscopic investigations of Pr^{3+} ions in Na_2O-La_2O3-$ZnOTeO_2$ glasses. *Journal of Non-Crystalline Solids,* Vol. 487, **2018,** 96-103.

P33: Pectin as a biopolymer used in different functional materials synthesis

Marta Fiedot-Toboła, Anna Dmochowska, Wojciech Stawiński

Łukasiewicz Research Network – PORT Polish Center for Technology Development
Stabłowicka 147, 54-066 Wrocław, Poland marta.fiedot-tobola@port.lukasiewicz.gov.pl

Pectin is a carbohydrate polymer present in cell wall of plants. Generally it is built from α-(1–4)-linked D-galacturonic acid particles. Thanks having active carboxyl groups in the structure it has great tendency to create ionic or hydrogen bonds [1]. Due to this phenomenon pectin is widely used as gelling agent in everyday life for jam production. This feature of this polysaccharide is an object of interest to many scientists. Crosslinking of pectin, using various additives and reaction conditions, results in formation of different structures like foils [2] or functional hydrogels [3].

In the case of presented studies we demonstrated that pectin is very universal polysaccharide which could be used to many functional materials synthesis. We obtained three types of structures where this polymer plays crucial role. That were hydrogels (Fig. 1a), foils (Fig. 1b) and organofilized zinc oxide nanoparticles (Fig. 1c). Details about that what role pectin played in used synthesis methods and the possible application of obtained materials will be presented.

Fig. 1. Images of obtained pectin based: a) hydrogels, b) foils, c) ZnO nanoparticles

References:

[1] Flutto, L., *PECTIN | Properties and Determination*. Danisco, New Century, KS, USA, **2003**, 4440-4449

[2] Espitia, P. J. P., Du, W. X., de Jesu s Avena-Bustillos, R., Soares, N. D. F. F., & McHugh, T. H. Edible films from pectin: Physical-mechanical and antimicrobial properties-A review. *Food hydrocolloids*, 35, **2014**, 287-296.

[3] Hasanah, U., Setyowati, M., Efendi, R., Muslem, M., Md Sani, N. D., Safitri, E., ... & Idroes, R.. Preparation and characterization of a pectin membrane-based optical pH sensor for fish freshness monitoring. *Biosensors*, 9(2), **2019**, 60.

P34: Lanthanide-doped pressure sensors based on inorganic materials

Przemysław WOŹNY, [a] **Marcin RUNOWSKI**, [a] **Stefan LIS**, [a]

[a] *Department of Rare Earths, Adam Mickiewicz University, Uniwersytetu Poznańskiego 8, 61-649 Poznań, Poland przemyslaw.wozny@amu.edu.pl*

Pressure is one of the basic physical properties in describing nature. Determining the precise pressure value is still a demanding process for small or separated systems. Here, we focused on the high-pressure determination by contactless, optical sensors.
Under high-pressure conditions, the internal structure of materials (plastic and elastic deformation) changes as a result of decreasing ionic distances, and changes in parameters in the unit cell. Lanthanide ions (Ln^{3+}) are insensitive to the surrounding, but exhibit excellent luminescence properties e.g. narrow emission bands, long luminescence life-time, visible luminescence after excitation by radiation over a broad range (UV-NIR) due to *f-f* transitions. Inorganic materials (e.g. YVO_4[1], SrB_2O_4[2], $GdBO_3$[3]) doped with Ln^{3+} ions exhibit characteristic changes in luminescence properties in the compression process i.e. blue/red-shift of the emission band, broadening of the band, decrease of emission intensity, changes in the band ratio, etc. Novel high-pressure sensors can be obtained by hydrothermal, sol-gel or solid-state methods. Using an appropriate method, the size and morphology of the material can be designed (nano- or micro-size) for application in different systems.

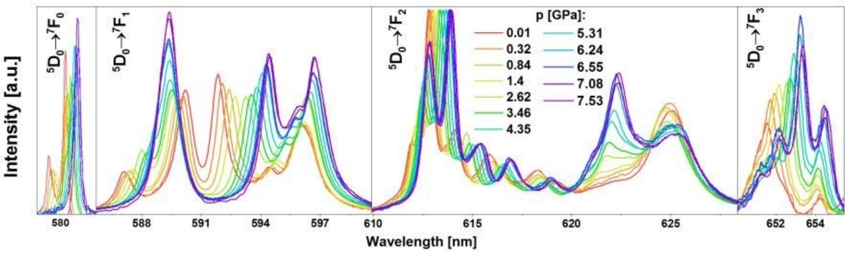


Fig. *Normalized emission spectra for β-$GdBO_3$: Eu^{3+} recorded in the compression.*

Measurements of the luminescence properties under high-pressure were possible to carry out in the Diamond Anvil Cell (DAC) due to the hardness and transparency of the diamonds. The pressure value was determined by ruby (Al_2O_3: Cr^{3+}), but its disadvantages (R_1 and R_2 band overlapping in non-hydrostatic conditions and temperature sensitivity) encourage further research on innovative pressure sensors.

References:

[1] Woźny, P.; Runowski, M.; Lis S., Emission color tuning and phase transition determination based on high-pressure up-conversion luminescence in YVO_4: Yb^{3+}, Er^{3+} nanoparticles, *J. Lumin.*, 209, **2019**, 321–327.

[2] Runowski, M.; Woźny, P.; Lavín, V.; Lis S., Optical pressure nano-sensor based on lanthanide doped SrB_2O_4:Sm^{2+} luminescence – Novel high-pressure nanomanometer, *Sensors Actuators B Chem.*, 273, **2018**, 585–591.

[3] Woźny, P.; Runowski, M.; Sobczak, S.; Szczeszak, A.; Katrusiak, A.; Lis S., Highpressure luminescence of monoclinic and triclinic $GdBO_3$: Eu^{3+}, *Ceram. Int.*, **2020**, 1–9.

P35: UV-induced fabrication of diffraction grating in hybrid organic-inorganic SiO_2-TiO_2 thin films

Łukasz DUDA [a,b], **Maciej CZAJKOWSKI** [a], **Małgorzata GUZIK**[a,b], **Alicja Bachmatiuk** [a]

[a] Łukasiewicz Research Network – PORT Polish Center for Technology Development, Stabłowicka 147, 54-066 Wrocław, Poland; [b] Faculty of Chemistry, University of Wrocław, F. Joliot-Curie 14, 50-383 Wrocław, Poland lukasz.duda96@gmail.com

Diffraction grating is an optical element with a periodic structure with periodically changing refractive index. It may split and diffract incident light into several beams in many different directions depending on period of grating, wavelength and angle of the incident light. Diffraction grating are often used in monochromators, lasers or in planar photonics as waveguide couplers.

In TiO_2/SiO_2 thin films, grating may be fabricated by means of lithographic techniques which involve deposition, patterning, development of photoresist followed by etching of TiO_2/SiO_2 and removal of deposited photoresist [1]. Another approach is to use a hybrid material consisting of photoinitiator and ORMOSIL (*Organic Modified Siloxane*) containing polimerizable organic unit, which undergoes polimerization under the UV radiation, which can lead to changes in thickness and/or value of refractive index in UV irradiated areas of the film [2]. Same or similar effect may be achieved without photoinitiator in TiO_2-ORMOSIL films in which organic component, in presence of photocatalytic titanium oxide and UV light, undergoes degradation which leads to densification of the film at irradiated areas [3].

We present preliminary studies on an organic-inorganic hybrid material consisting of 3-glycidoxypropyltrimethoxysilane and TiO_2. Grating was achieved by illuminating the hybrid film surface with a sinusoidal light pattern created by two interfering UV laser beams. The presence of grating was monitored by reference laser beam. The period was determined using optical microscopy.

References:

[1] Łukowiak, A.; Dylewicz, R.; Patela, S.; Stręk, W.; Maruszewski K., Optical properties of SiO_2-TiO_2 thin films waveguides obtained by the sol–gel method and their applications for sensing purposes. *Optical Materials,* Vol. 25., **2005,** 1501-1505.

[2] Brusatin, G.; Giustina D.G.; Guglielmi, M.; Innocenzi, P., Photocurable glycidoxypropyltrimethoxysilane based sol-gel hybrid materials. *Progress in Solid State Chemistry,* Vol. 34., **2006,** 223-229.

[3] Gardin S.; Giustina D.G.; Brusatin G.; Signorini, R., UV-Curable SiO2-TiO2 Films for the Realization of Diffractive Optical Elements, *Journal of Nanoscience and Nanotechnology,* Vol. 11., **2011**, 195-199.

Acknowledgements:

The research was carried out within the TEAM-NET programme of the Foundation for Polish Science "Hybrid sensor platforms of integrated photonic systems based on ceramic and polymer materials." The research was conducted under agreement with Łukasiewicz Research Network – PORT Polish Center for Technology Development, Wrocław.

P36: Design and simulation of the grating coupler dedicated to low refractive index contrast integrated photonic circuits

__Piotr Pala__ [a)], Tadeusz MARTYNKIEN[a)], Jacek OLSZEWSKI [a)]

[a)] *Faculty of Fundamental Problems of Technology, Wroclaw University of Science and Technology, Wybrzeze Wyspianskiego 27, 50-370 Wroclaw, Poland; piotr.pala@pwr.edu.pl*

We present simulation and design of the grating coupler dedicated to a new material platform based on silicon dioxide with titanium dioxide. For our simulations, we used analytical and numerical methods. To calculate the initial parameters of the coupler, like λ - operating wavelength, Λ - grating period, θ - angle of the fiber alignment, ff - filing factor, h_t - height of the grating teeth or e_d – etched depth , we used the Bragg condition combined with an effective index method [1]. To optimize the parameters, we used the finite element method to solve wave equation in frequency domain. Exemplary results and an out-of-plane component of electric field distribution for grating coupler designed for λ = 1550 nm are shown in Fig.1

a) *b)*

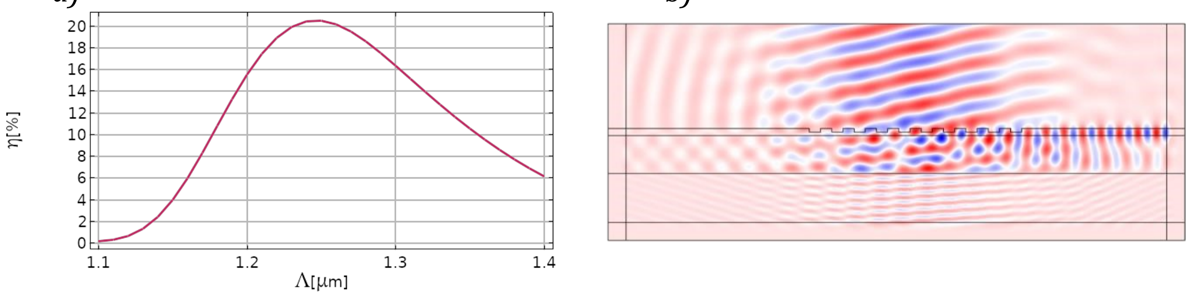


Figure 1. a) The grating period length Λ optimization results concerning the coupling efficiency; maximum coupling efficiency achieved at Λ = 1.24 μm (θ = 10°; ff = 0,5; h_t = 400 nm; e_d = 200 nm) (b) Out-of-plane component of electric field distribution demonstrating the operating principle of the grating.

Acknowledgements:
The „Hybrid sensor platforms of integrated photonic systems based on ceramic and polymer materials" project carried out within the TEAM-NET programme of the Foundation for Polish Science financed by the European Union under the European Regional Development Fund, POIR.04.04.00-00-14D6/18-01.

References:
[1] Wang, Yun, et al. "Universal grating coupler design." *Photonics North 2013*. Vol. 8915. International Society for Optics and Photonics, 2013.

P37: Trivalent Lanthanide based Silicon arrays for Molecular Logic and Computing through Physical Inputs

Miguel A. HERNÁNDEZ-RODRÍGUEZ, [a] **Carlos D.S. BRITES**, [a] **Rafael PIÑOL**, [b] **Angel MILLÁN**, [b] **Luís D. CARLOS** [a]

[a] Phantom-g CICECO – Aveiro Institute of Materials Department of Physics Universidade de Aveiro, Aveiro, 3810-193, Portugal; [b] Departamento de Física de la Materia Condensada, and Instituto de Ciencia de Materiales de Aragón CSIC-Universidad de Zaragoza, Zaragoza; 50009, Spain

Presenting author email: miguelandreshr@ua.pt

The advances in molecular logic reported in the last decade show the potential of luminescent molecules for logical operations, a paradigm-changing concerning siliconbased electronics. Trivalent lanthanide (Ln^{3+}) ions, with their characteristic narrow line emissions, long-lived excited states, and photostability under illumination, could improve the state-of-the-art molecular logical devices. Here, the use of monolithic silicon-based structures incorporating Ln^{3+} complexes for performing logical functions is reported. Logic gates (AND, INH, and DEMUX), sequential logic (KEYPAD LOCK), and arithmetic operations (HALF ADDER and HALF SUBTRACTOR) exhibiting a switching ratio >60% are demonstrated for the first time using nonwet conditions. This is the first work showing sequential and arithmetic operations combining molecular Ln^{3+} complexes and physical inputs. As an advantage compared to chemical inputs, the use physical inputs may allow the concatenation of logical functions and reuse of the logical devices permitting homogeneity regarding inputs and outputs and thereupon, the integration of current molecular logic devices.

P38: SiO_2-based glasses obtained by the sol-gel method, doped with organic dyes from the chalcone group

Maria ZDOŃCZYK, [a), b)] **Bartłomiej POTANIEC,** [b)] **Alicja BACHMATIUK,** [b)] **Joanna CYBIŃSKA** [a), b)]

[a)] *University of Wroclaw, Faculty of Chemistry, 14 F. Joliot-Curie Street, 50-383 Wroclaw, Poland;* [b)] *Łukasiewicz Research Network - PORT Polish Center for Technology Development, 147 Stabłowicka Street, 54-066 Wrocław, Poland; bartlomiej.potaniec@port.lukasiewicz.gov.pl*

Chalcones belong to a large group of bioflavonoids found in plants. They are precursors in the biosynthesis of all classes of flavonoid compounds. Their structure of α,β-unsaturated bicyclic natural ketones have a broad spectrum of activity depending on the type of substituents attached to the aromatic rings [1]. These compounds have been extensively used for various optical applications including lasers, photorefractive polymers or photo-alignment layer of liquid crystal displays [2].

Using the procedure described by P. Karasiński [3], glasses based on SiO_2 were synthesized by the sol-gel method. The material was then doped with dyes from the chalcone group. The material obtained in this way was aged and then annealed in a furnace. After annealing, phosphorescence was observed, occurring in some cases after excitation with a UV lamp with a wavelength of 364 nm. We present the glass synthesis method and spectroscopic data for synthesized dyes and glasses.

References:

[1] Potaniec, B.; Zarowska, B.; Kozłowska, J.; Anioł, M., Synthesis and antimicrobiological properties of chalcones oximes, *New Biotechnology*, Vol.33, **2016**.
[2] Gaber, M.; El-Daly, S.A.; Fayed, T.A.; El-Sayed, Y.S., Photophysical properties, laser activity and photoreactivity of a heteroaryl chalcone: A model of solvatochromic fluorophore, *Optics & Laser Technology*, Vol.40, **2008**, 528-537.
[3] Karasiński, P., Sol-gel derived optical waveguide films for planar sensors with phase modulation, *Optica Applicata,* Vol. XXXIV, **2004**, 467-475.

Acknowledgements:

The *Hybrid sensor platforms of integrated photonic systems based on ceramic and polymer materials* project is carried out within the TEAM-NET programme of the Foundation for Polish Science financed by the European Union under the European Regional Development Fund.

P39: The characterization of nickel complexes of α5 domain from mycobacterial SmtB/BigR4 transcription regulators, a histidine mutations study

Paulina POTOK, [a] Anna ROLA, [a] Sławomir POTOCKI, [a]

[a] *Faculty of Chemistry, University of Wroclaw, F. Joliot-Curie 14, 50-383 Wroclaw, Poland; 290646@uwr.edu.pl*

Mycobacterium tuberculosis (Mtb) is the infectious agent of tuberculosis (TB), a disease which continues to overwhelm health systems, despite the existence of a combination chemotherapy and the widespread use of an anti-TB vaccine[1]. Considering the rapidly growing number of multi-drug resistant TB, new method of TB treatment is needed. One of the most promising targets for novel antimicrobial therapies against mycobacterium strains are metal-sensing transcriptional regulators (e.g. ArsR-like) [2]. Mycobacterial SmtB, ArsR-family protein, allows bacteria to survive in challenging environments by dissociating from DNA during toxic concentrations of zinc ions [3].

The aim of this work is to study influence of nickel ion to zinc-binding domain from SmtB (*M. tuberculosis*). The ligands chosen to be studied are α5 zinc ion binding domains of SmtB/BigR4 proteins and two mutants of BigR4. The study is aimed to recognise and characterise the coordination site of the metal-ligands interaction and to determine the effect of mutations of studied systems. In this project, we used potentiometric titrations, which allowed to determine thermodynamic stability constants of peptides and complexes they form with metal ions. Stoichiometry of complexes was checked by using MS, UV-Vis absorption and CD spectroscopy. The structure of all tested peptides was determined by the NMR approach.

The results show that all the peptides form equimolar complexes with nickel ion. The BigR4 protein domain is more stable than the SmtB. Moreover, the His mutations affect the stability of complexes and coordination modes of the metal ions.

References:

[1] Keshavjee, S.; Farmer, P., Tuberculosis, Drug Resistance, and the History of Modern Medicine. *New England Journal of Medicine,* Vol. 367(10) , **2012,** 931-936.

[2] Osman, D.,; Cavet, J., Bacterial metal-sensing proteins exemplified by ArsR–SmtB family repressors. *Natural Product Reports*, Vol. 27(5), **2010**, 668-680.

[3] Busenlehner, L.; Pennella, M.; Giedroc, D., The SmtB/ArsR family of metalloregulatory transcriptional repressors: structural insights into prokaryotic metal resistance. *FEMS Microbiology Reviews,* Vol. 27(2-3), **2003**, 131-143

P40: 2D Intracellular temperature mapping of cancer cells using Eu^{3+}/Sm^{3+}-based polymeric micelles

Justyna Zeler [a),b)], Carlos D. S. Brites [a)], Rafael Piñol [c)], Yuanyu Gu [c),d)], Pedro Téllez [e)], Albano N. Carneiro Neto [a)], Thiago E. da Silva [a),f)], Raquel Moreno-Loshuertos [g)], Patrício Fernandez-Silva [g)],Ana Gallego [g)], Luis Martinez-Lostao [g)], Abelardo Martínez [h)], Luís D. Carlos [a)], Angel Millán [c)]

a) Phantom-g, CICECO-Aveiro Institute of Materials, Department of Physics, University of Aveiro, Aveiro, Portugal
b) Faculty of Chemistry, University of Wroclaw, Wroclaw, Poland
c) ICMA, Institute of Materials Science of Aragon, CSIC-University of Zaragoza, 50008 Zaragoza, Spain
d) School of Materials Science and Engineering. Nanjing Tech University, 210009, Nanjing PR China
e) Servicio de Apoyo a la Investigación. University of Zaragoza, C/ Pedro Cerbuna 10, 50006 Zaragoza, Spain
f) Department of Fundamental Chemistry, Federal University of Pernambuco, 50670-901, Recife, PE, Brazil.
g) Departamento de Bioquímica, Biología Molecular y Celular, Universidad de Zaragoza, Zaragoza, Spain
h) Departamento de Electrónica de Potencia, I3A, Universidad de Zaragoza 50018 Zaragoza, Spain presenting author e-mail: Justynazeler@ua.pt

Measurement of thermogenesis in living cells is a peculiar challenge due to the complexity of the biochemical environment and to the rapid and yet not well-understood heat transfer mechanisms throughout the cell.

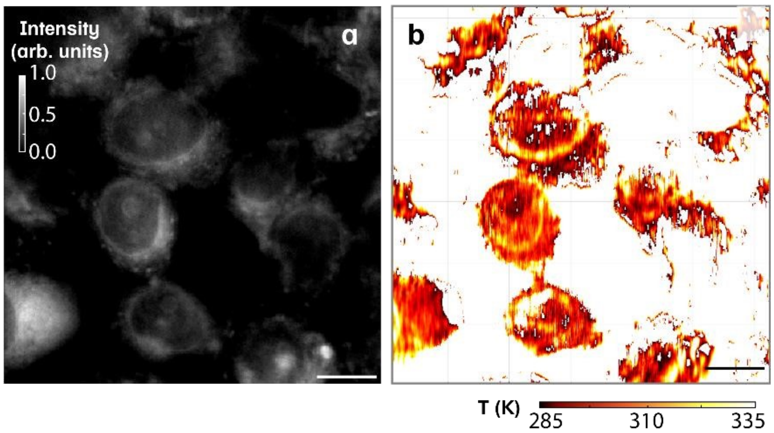


***Figure 1.** The emission in Eu^{3+} channel recorded with the CMOS camera and illuminating the cultures with a 365 nm LED (the scale bar corresponds to 10 um) (a), together with obtained temperature map at room temperature (b).*

We will present a system for intracellular temperature mapping in a fluorescence microscope using rationally designed luminescent Eu^{3+}/Sm^{3+}-bearing polymeric micellar probes incubated in breast cancer MDA-MB468 cells [1]. 2D thermal images recorded increasing the temperature of the cells culture medium between 296 and 304 K show non-homogeneous intracellular temperature distribution up to ~20 degrees and subcellular gradients of ~5 degrees between the specific organelles and the rest of the cell (see Figure 1). Obtained results present the thermogenic activity of the different components of cell, highlighting the potential of this tool to study intracellular processes.

References:

[1] Piñol at al., Real-time intracellular temperature imaging using lanthanide-bearing polymeric micelles. *Nanoletters,* 20, **2020,** 6466- 6472.

Acknowledgement: This project has received funding from the European Union's Horizon 2020 FET Open programme under Grant Agreement No. 801305.

P41: Hybrid sol-gel layers on elastic substrate with potential use in photonics

Kamila STARTEK, [a] **Alicja BACHMATIUK**, [a] **Anna LUKOWIAK**, [b]

[a] Łukasiewicz Research Network – PORT Polish Center for Technology Development; Wrocław
[b] Institute of Low Temperature and Structure Research, Polish Academy of Sciences, Wrocław;
Kamila.Startek@port.lukasiewicz.gov.pl

Elastic sol–gel-derived layers are currently in the focus for application in an increasing number of technical fields, *e.g.* electronic and optical devices or packaging. In this research work, functional coatings, based on hybrid organic/inorganic materials, are being developed to combine the polymer flexibility and ease of processing with the rigidity, thermal stability, and good optical properties of inorganic materials. The focus is to obtain low-temperature sol–gel layer on flexible substrate.
The most desirable feature of the sol–gel-derived layers with potential use in photonics are: high transparency [1], anti-reflectance [2], and low thermal expansion coefficient [3]. What is more, there is an increasing interest in flexible photonics matrices with low roughness parameters.

Here, functional sol–gel-based materials were synthesized at room temperature by the hydrolysis and polycondensation of precursors, such as silicon alkoxides and organically modified metal alkoxide, under controlled conditions. The silica-based layers were deposited by a spin-coating method on flexible polymeric support. Surface morphology (OM, SEM), surface topography (AFM), structural properties (FT-IR with ATR mode) and thermomechanical properties (TMA) were examined and compared for all samples. It was shown that the layers' properties strongly depend on the type of precursor used for samples preparation.

References:

[1] Kumar, M., Kim, H.-S., Park, D. Y., Jeong, M. S. & Kim, J. A non-volatile "programmable" transparent multilevel ultra-violet perovskite photodetector. *Nanoscale* 10, **2018**, 11392–11396.
[2] Nishioka, K.; Moe, S.P.; Ota, Y. Long-Term Reliability Evaluation of Silica-Based Coating with Antireflection Effect for Photovoltaic Modules. *Coatings* **2019**, *9*, 49.
[3] Li, C.; Yang, W.; Wang, M.; Yu, X.; Fan, J.; Xiong, Y.; Yang, Y.; Li, L. A Review of Coating Materials Used to Improve the Performance of Optical Fiber Sensors. *Sensors* **2020**, *20*, 4215.

P42: Experimental setup for measurement of SU-8 waveguides excitation quality

Karolina GEMZA [a,b], **Daria HLUSHCHENKO** [c], **Tadeusz MARTYNKIEN** [a], **Jacek OLSZEWSKI** [a]

[a] *Faculty of Fundamental Problems of Technology, Wroclaw University of Science and Technology, Wybrzeze Wyspianskiego 27, 50-370 Wroclaw, Poland;*
[b] *SPIE PWr Student Chapter;*
[c] *Łukasiewicz Research Network – Port Polish Center For Technology Development, Stabłowicka 147, 54-066 Wrocław karolina.gemza@student.pwr.edu.pl*

We present the experimental results obtained from a measurement setup designed for the quantitative inspection of waveguides excitation. The light beam is launched into the individual waveguides by a lensed optical fiber, which has a spot size smaller than standard SMF [2]. Precise XYZ positioners and an overhead camera enable the waveguide selection. The results are registered using a CCD camera and a spectrometer. The schematic of the setup and examples of results for rib waveguides fabricated in negative photoresist SU-8 [1] on silica are shown in Fig. 1.

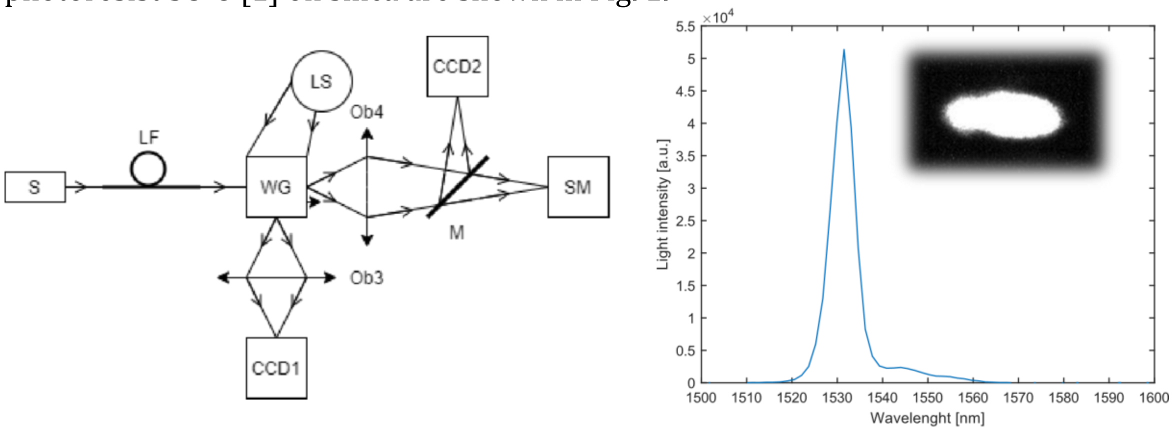


Fig. 1. Schematic of the experimental setup (a), where: S – source, LF – lensed fiber, WG – waveguide sample, LS – overhead white light source, Ob – objective, CCD – CCD camera, M – mirror, SM – spectrometer; spectra and a photo of the gleaming end of a 10 µm wide waveguide (b).

References:

[1] Shaw, J. M., Gelorme, J. D., LaBianca, N. C., Conley, W. E., & Holmes, S. J. , Negative photoresists for optical lithography. *IBM Journal of Research and Development*, 41(1.2), **1997**, 81–94.
[2] Rajarajan, M., Rahman, B. M. A., & Grattan, K. T. V., Numerical study of spot-size expanders for an efficient OEIC to SMF coupling. *IEEE Photonics Technology Letters, 10(8),* ***1998****, 1082–1084.*

Acknowledgement:
The „Hybrid sensor platforms of integrated photonic systems based on ceramic and polymer materials" project carried out within the TEAM-NET programme of the Foundation for Polish Science financed by the European Union under the European Regional Development Fund, POIR.04.04.00-00-14D6/18-01.

P43: The Influence of the *Odd-Even Effect* of Aliphatic Dicarboxylate Ligands on the Photoluminescent Properties of Europium Complexes

<u>Israel ASSUNÇÃO</u>, [a] Albano NETO, [b,c] Renaldo MOURA Jr.,[d], Cássio PEDROSO [a], Ivan SILVA [a], Maria Cláudia FELINTO [e], Ercules TEOTÔNIO [f], Oscar MALTA [b], Hermi BRITO [a]

a) Institute of Chemistry, University of São Paulo, Brazil;
b) Department of Fundamental Chemistry, Federal University of Pernambuco, Brazil;
c) CICECO, University of Aveiro, Portugal;
d) Department of Physics and Chemistry, Federal University of Paraíba, Campus II, Brazil;
e) Nuclear and Energy Research Institute-IPEN/CNEN, Brazil;
f) Department of Chemistry, Federal University of Paraíba, Brazil
ipassunc@iq.usp.br; hefbrito@iq.usp.br; oscar.malta@ufpe.br

Eleven $[Eu_2(L)_3(H_2O)_x]\cdot y(H_2O)$ complexes with aliphatic dicarboxylate ligands (L: OXA, MAL, SUC, GLU, ADP, PIM, SUB, AZL, SEB, UND, and DOD, where x=2–6 and y=0–4) were synthesized and characterized by elemental and thermal analysis, FTIR spectroscopy and powder X-ray diffraction. The obtained data confirms the ligand to metal ratio, the hydration degree, the coordination mode and that the complexes are crystalline. The *oddeven effect* was observed for the final dehydration temperature of the Eu^{3+} complexes (Fig. 1). Moreover, the effect was also observed in the experimental and theoretical photoluminescent properties such as the intensity parameters, Ω_2 and Ω_4 (Fig. 2) and the emission intrinsic quantum yield, Q_{Ln}^{Ln}(Fig. 3) of the Eu^{3+} complexes. The *odd-even effect* on the Ω_2 and Ω_4 values could be explained by using an extension of the dynamic coupling mechanism, herein named the ghost-atom (GA) model, in which the long-range polarizabilities (α^*) were determined by simulating the presence of a ghost atom in the middle of each ligand carbon chain and the localized molecular orbital approach. The GA approach is an extension of the Bond Overlap Model (BOM) [1].

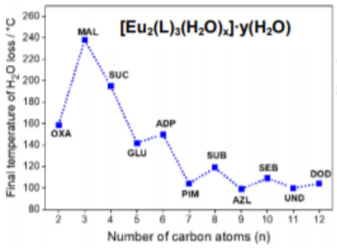


Fig. 1: Zigzag pattern obtained from final temperature (°C) of released H_2O molecules as a function of the number of carbon atoms ($2 \le n \le 12$).

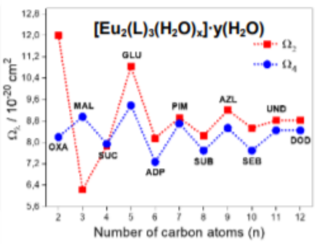


Fig. 2: Odd–even effect on the experimental intensity parameters Ω_2 (red squares) and Ω_4 (blue circles) as a function of the number of carbon atoms ($2 \le n \le 12$).

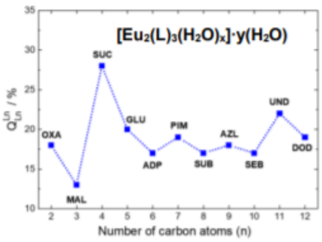


Fig. 3. The relationship between the emission intrinsic quantum yield (Q_{Ln}^{Ln}) as a function of the number of carbon atoms ($2 \le n \le 12$).

References:

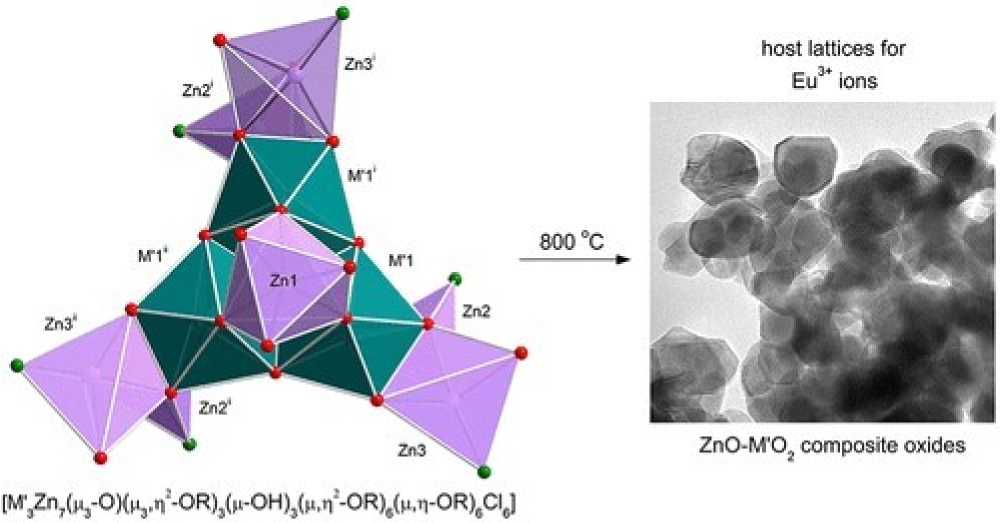
[1] Moura Jr., R. T., Carneiro Neto, A. N., Longo, R. L., Malta, O. L., On the calculation and interpretation of covalency in the intensity parameters of 4f–4f transitions in Eu^{3+} complexes based on the chemical bond overlap polarizability. *J. Lumin*. 2016, 170, 420–430.

P44: Convenient Route to Heterometallic Group 4–Zinc Precursors for Binary Oxide Nanomaterials

Rafał PETRUS,[a] Katarzyna CHOMIAK,[b] Józef UTKO,[c] Magdalena WILK-KOZUBEK,[b] Tadeusz LIS,[c] Joanna CYBIŃSKA,[b,c] Piotr SOBOTA [b]

[a] Faculty of Chemistry, Wrocław University of Science and Technology, 23 Smoluchowskiego, 50-370 Wrocław, Poland; [b] Łukasiewicz Research Network – PORT Polish Center for Technology Development, 147 Stabłowicka, 54-066 Wrocław, Poland; [c] Faculty of Chemistry, University of Wrocław, 14 F. Joliot-Curie, 50-383 Wrocław, Poland; presenting author e-mail: magdalena.wilk-kozubek@port.lukasiewicz.gov.pl

In this study, simple and efficient synthetic routes to a family of uncommon group 4– zinc heterometallic alkoxides were developed. Single-source molecular precursors with thes tructures $[Cp_2TiZn(\mu,\eta\text{-}OR)(THF)Cl_2]_n$(**1**),$[Zr_3Zn_7(\mu_3\text{-}O)(\mu_3,\eta^2\text{-}OR)_3(\mu\text{-}OH)_3(\mu,\eta^2OR)_6(\mu,\eta\text{-}OR)_6Cl_6]$ (**2**) and $[Hf_3Zn_7(\mu_3\text{-}O)(\mu_3,\eta^2\text{-}OR)_3(\mu\text{-}OH)_3(\mu,\eta^2\text{-}OR)_6(\mu,\eta\text{-}OR)_6Cl_6]$ (**3**) were prepared, and used to obtain group 4–zinc oxides. Compounds **1**–**3** were characterized by EA, NMR, FTIR and XRD. Compound **1** decomposed at 800–900°C to give a mixture of binary metal oxides ($Zn_2Ti_3O_8$, $ZnTiO_3$, or Zn_2TiO_4) and common polymorphs of TiO_2 and ZnO. After calcination at 1000°C, only TiO_2 and the high-temperature-stable phase Zn_2TiO_4 were observed. Thermolysis of compounds **2** and **3** gave mixtures of ZnO and ZrO_2 or HfO_2, respectively. The ZnO–ZrO_2 and ZnO–HfO_2 mixed oxides have constant phase compositions across a broad temperature range and therefore are attractive host lattices for Eu^{3+} ions for applications as yellow/red double-light-emitting phosphors.



$[M'_3Zn_7(\mu_3\text{-}O)(\mu_3,\eta^2\text{-}OR)_3(\mu\text{-}OH)_3(\mu,\eta^2\text{-}OR)_6(\mu,\eta\text{-}OR)_6Cl_6]$
M' = Zr, Hf

P45: The influence of the synthesis route on the physicochemical properties of core-shell $NaYF_4:Yb^{3+},Er^{3+}/NaYF_4$ nanoparticles and their water colloids

Natalia JURGA, [a] **Dominika PRZYBYLSKA**, [a] **Piotr KAMIŃSKI**, [a] **Artur TYMIŃSKI**, [a] **Tomasz GRZYB** [a]

[a] *Department of Rare Earths, Faculty of Chemistry, Adam Mickiewicz University in Poznań, Uniwersytetu Poznańskiego 8, 61-614 Poznań, Poland natalia.jurga@amu.edu.pl*

Recently, much attention has been paid to up-converting nanoparticles (UCNPs) doped with lanthanide ions (Ln^{3+}). Such materials can emit light at a shorter wavelength than excitation wavelength [1]. It is worth to mention, that the right choice of the synthesis route of the UCNPs is crucial in obtaining well-defined products which can find potential application e.g. in bioimaging, biosensing and luminescent thermometry [2].

The main goal of the study was to investigate how the use of various rare earth (RE) ions precursors and surface modification affect UCNPs' properties. The RE chlorides, acetates and oleates were used as precursors. Up-converting core/shell type $NaYF_4:Yb^{3+},Er^{3+}/NaYF_4$ nanostructures have been obtained using precipitation in high-boiling solvents. Furthermore, NPs were transferred from organic to water solution by ligand-free modification method which allows them to form stable aqueous colloids (confirmed by zeta potential measurements) [3]. Their size was determined by transmission electron microscopy as well as dynamic light scattering. Both, oleate-capped and ligand-free NPs, exhibit UC emission under 975 nm excitation. Additionally, the effective energy transfer between sensitizer (Yb^{3+}) and activator (Er^{3+}) ions was confirmed. Moreover, the temperature sensing behavior of nanomaterials doped with Ln^{3+} ions was examined.

References:

[1] Heer, S.; Lehmann, O.; Haase, M.; Güdel, H.U., Blue, Green, and Red Upconversion Emission from Lanthanide-Doped $LuPO_4$ and $YbPO_4$ Nanocrystals in a Transparent Colloidal Solution. *Angew. Chem. Int. Ed.,* 42, **2003,** 3179-3182.

[2] Sedlmeier, A.; Gorris, H.H., Surface modification and characterization of photonupconverting nanoparticles for bioanalytical applications. *Chem. Soc. Rev.*, 44, **2015**, 1526-1560.

[3] Bogdan, N.; Vetrone, F.; Ozin, G.A.; Capobianco, J.A., Synthesis of Ligand-Free Colloidally Stable Water Dispersible Brightly Luminescent Lanthanide-Doped Upconverting Nanoparticles. *Nano Lett.*, 11, **2011**, 835-840.

Acknowledgments:

The work was supported by grant no. POWR.03.02.00-00-I020/17 co-financed by the European Union through the European Social Fund under the Operational Program Knowledge Education Development and National Science Centre Poland under grant No. UMO-2016/22/E/ST5/00016.

P46: The effect of dose on thermoluminescence of $ScPO_4:Eu^{3+}$ ceramic

Joanna JEDOŃ, [a)] Justyna ZELER, [a),b)] Eugeniusz ZYCH, [a)]

[a)] *Faculty of Chemistry, University of Wroclaw 14. F. Joliot-Curie Street, 50-383 Wroclaw, Poland;*

[b)] *Physics Department, CICECO-Aveiro Institute of Materials University of Aveiro 3810-193 Aveiro, Portugal; joanna.jedon@chem.uni.wroc.pl*

Detailed studies on thermoluminescent (TL) properties of a new orange-red persistent luminescence $ScPO_4$:0.1%Eu ceramic phosphor were performed and the data were analyzed. It was found that the TL of $ScPO_4$:0.1%Eu strongly depends on the X-rays dose. Thus, upon higher doses not only the TL intensity was increased with dose but new TL peaks at higher temperatures were observed. A series of TL experiments were carried out to learn more about the stability of storing the trapped carriers in traps. Clearly, $ScPO_4$:Eu ceramics may act as a dual-function thermoluminescent material as it shows both persistent luminescence and permanent energy storage in deep traps upon higher doses of ionizing radiation [1][2]. $ScPO_4$:Eu might be considered an interesting detector of high-doses of ionizing radiation.

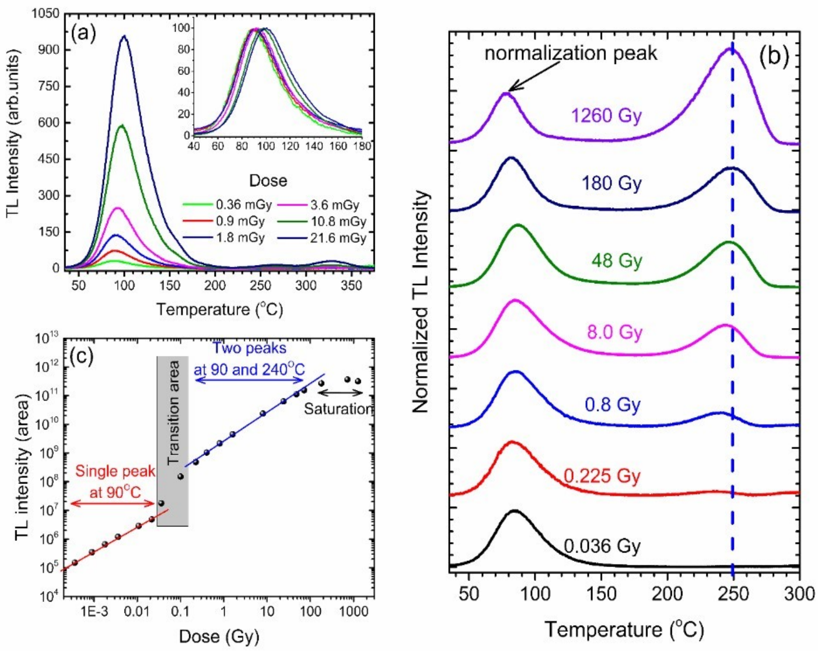


Fig. 1. *Dependence of the TL glow curves of $ScPO_4$:0.1%Eu on low (0.36-21.6 mGy) (a) and higher doses (36 – 1260 Gy) of beta radiation (b). The dose–response dependence of total TL intensity of $ScPO_4$:0.1%Eu ceramic (c).*

References:

[1] Jedon , J.; Zeler, J.; Zych, E., The effect of dose on thermoluminescence of $ScPO_4:Eu^{3+}$ ceramic. *Opt. Mater*, 107, **2020**, 110090

[2] Jedon , J.; Zeler, J.; Zych, E., On the orange-red persistent luminescence of $ScPO_4:Eu^{3+}$. *J. Alloys Compd*, 816, **2019**, 152603

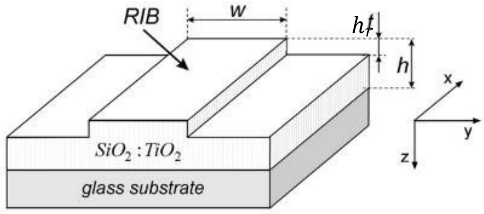
P47: Numerical study of bent shallow rib waveguides based on the SiO_2:TiO_2 material platform

a) Edyta ŚRODA a,b), Jacek OLSZEWSKI a)

a) *Faculty of Fundamental Problems of Technology, Wroclaw University of Science and Technology, Wybrzeze Wyspianskiego 27, 50-370 Wroclaw, Poland;* b) *SPIE PWr Student Chapter;*

edyta.sroda@pwr.edu.pl

We present the results of a numerical study we performed for bent shallow rib waveguides assuming the SiO_2:TiO_2 material platform [1]. The simulations were carried out using the frequency-domain finite element method. We employed the conformal mapping technique to replace a circularly bent waveguide with an equivalent straight waveguide. We demonstrate that for SiO_2:TiO_2 material platform, waveguide bend radius can be reduced by increasing the rib's height. It makes the waveguide multimode, however, the higher-order mode's bending loss are much greater than the fundamental mode loss. As shown in Fig. 1, with the increase of rib height, the fundamental mode's bending loss decreases significantly. In contrast, the first higher-order mode's bending loss is large and exceed the 30 dB/cm threshold value for the bend radius small enough, which makes the waveguide effectively single-mode.



$$n_{SiO_2:TiO_2} = 1.793\ @632\ nm$$
$$n_{substrate} = 1.515\ @632\ nm$$

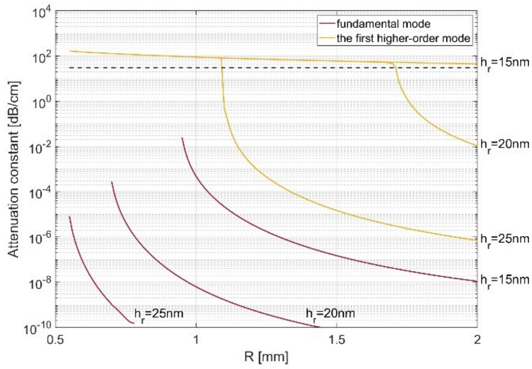


Fig. 1. Schematic structure of a rib waveguide and the attenuation constant vs. the bent radius, h = 200 nm, w = 2 μm. The dotted line indicates the threshold value of 30 dB/cm.

References:

[1] Karasinski, P.; Tyszkiewicz, C.; Rogozin ski, R., Rib waveguides based on the sol-gel derived SiO2:TiO2 films, Photonics Lett. Pol., Vol. 2, **2010,** 40-42

Acknowledgements:

The „Hybrid sensor platforms of integrated photonic systems based on ceramic and polymer materials" project carried out within the TEAM-NET programme of the Foundation for Polish Science financed by the European Union under the European Regional Development Fund, POIR.04.04.00-00-14D6/18-01.

P48: Luminescent nanocolloids based on Sr_2ScF_7 doped with Ln^{3+} ($Ln= Er^{3+}, Tm^{3+}, Yb^{3+}$)

Dominika PRZYBYLSKA, Dominika PIEKARZEWICZ, Tomasz GRZYB

Department of Rare Earths, Faculty of Chemistry, Adam Mickiewicz University in Poznań, Uniwersytetu Poznańskiego 8, 61-614 Poznan, Poland dominika.przybylska@amu.edu.pl

Development of new material in nanoscale for application in biology and medicine as well as in new sources of light have been investigated very intensively in recent years [1-3]. Especially these, which exhibit upconversion phenomenon (UC, anti-Stokes emission), due to the conversion of the energy from the near-infrared radiation range to visible and ultraviolet light. [4] The very promising materials are halides and oxides, e.g. YF_3, Y_2O_3 or $NaYF_4$, with lanthanide ion (Ln^{3+}) as dopants (Yb^{3+}/Er^{3+}, Yb^{3+}/Tm^{3+}, Yb^{3+}/Ho^{3+})[1,2]. Concerning the application of described nanoparticles in biology or medicine, it is necessary to introduce them into the aqua environment or phosphatebuffered saline (PBS, a buffer solution commonly used in biological research) due to the necessity to deliver them to cells, tissues or living organisms.

For this purpose, the properties of nanomaterials based on Sr_2ScF_7 host compounds will be presented and discussed. The synthesis route of these two groups of nanomaterials was optimized and the surface of forming NPs was modified by cross-linking polymers (e.g. xanthan gum). The formed nanocolloids were studied within a long time to check their stability. This study includes changes in morphology and spectroscopic properties.

References:

[1] Yan, C., Zhao, H., Perepichka, D. F. & Rosei, F. Lanthanide Ion Doped Upconverting Nanoparticles: Synthesis, Structure and Properties. *Small,* Vol.12, **2016,** 3888–3907

[2] Zheng, K. et al. Recent advances in upconversion nanocrystals: Expanding the kaleidoscopic toolbox for emerging applications. *Nano Today*, Vol.29, **2019**, 100797

[3] Wang, Y. *et al.* Remote manipulation of upconversion luminescence. *Chem. Soc. Rev.* Vol. 47, **2018,** 6473–6485

[4] Auzel, F. Upconversion and Anti-Stokes Processes with f and d Ions in Solids. *Chem. Rev.* Vol.104, **2004**, 139–173

Acknowledgements:

The work was supported by National Science Centre Poland under grant Preludium, No. UMO2017/27/N/ST5/02149.

P49: Optimizing measurement parameters for HRTEM studies of 2D transition metal dichalcogenides

Anna Siudzińska, [a] Sandeep Gorantla,[a] Detlef Hommel,[a] Alicja Bachmatiuk, [a]

[a] *Łukasiewicz Research Network – PORT Polish Center for Technology Development, Stabłowicka 147, 54-066 Wrocław, Poland; anna.siudzinska@port.lukasiewicz.gov.pl alicja.bachmatiuk@port.lukasiewicz.gov.pl*

Two dimensional transition metal dichalcogenides (TMDCs) for years have attracted great interest in research due to their unique properties such as direct band gap comparing to their bulk samples. Semiconducting TMDCs based on molybdenum and tungsten with band gaps raging from the visible to the near infra-red possess great application possibilities in flexible electronics, optoelectronics or as nanoscale semiconductors [1, 2]. Structural studies using high-resolution electron microscopy techniques are essential in determining the quality and properties of 2D materials. Unfortunately, atomically thin, sandwich-like structure with two layers of dichalcogen surrounding transition metal, makes TMDCs extremely prone to beam influence during electron microscope investigation.

Here we present detailed optimization of measurement parameters for HRTEM studies of selected 2D transition metal dichalcogenides (molybdenum diselenide, molybdenum disulfide, molybdenum ditelluride, tungsten diselenide, tungsten disulfide), starting from preparation of 2D material from bulk sample, through transfer of selected flakes to TEM grid, up to adjustment of electron beam conditions during the observations. We examined in details the effect of acceleration voltage, current dose, exposure time and use of beam monochromator on HRTEM investigation quality. Considering knock-on damage energy threshold for presented materials the acceleration voltage of 60 kV was explored [3, 4], in addition with monochromated mode.

References:

[1] Jariwala, D.; Sangwan, V. K.; Lauhon, L. J.; Marks, C. H.; Hersam M. C., Emerging Device Applications for Semiconducting Two-Dimentional Transition Metal Dicalcogenides. *ACS Nano,* Vol. 8, 2, **2014,** 1102-1120.

[2] Wang, Q. H.; Kalantar-Zadeh, K.; Kis, A.; Coleman, J. N.; Strano, M. S., Electronics and Optoelectronics of Two-Dimentional Transition Metal Dicalcogenides. *Nature Nanotechnology,* Vol. 7, **2012,** 699-712.

[3] Lehnert, T.; Lehtinen, O.; Algara-Siller, G.; Kaiser, U., Electron Radiation Damage Mechanisms in 2D $MoSe_2$. *Applied Physics Letters,* Vol. 110, **2017,** 033106.

P50: Early stage studies of oblique helicoidal cholesteric phase for tunable liquid crystal lasers

Stefan CZARNOCKI,[a)] Maciej CZAJKOWSKI,[a)] Bartłomiej POTANIEC,[a)] Joanna CYBIŃSKA[a),b)]

[a)]*Łukasiewicz Research Network – PORT Polish Center for Technology Development, Wrocław, Poland;* [b)] *Faculty of Chemistry, University of Wrocław, Wrocław, Poland e-mail: maciej.czajkowski@port.lukasiewicz.gov.pl*

The molecules of liquid crystal dimers composed of two mesogens linked by a flexible aliphatic chain may align in a bent shape and consequently, even non-chiral compounds by their mutual interaction may arrange in helicoidal manner, forming twistbend nematic (N_{TB}) phase, with helicoid periodicity in order of 10 nm [1]. Liquid crystal dimers may be also utilized in liquid crystal mixtures with chiral dopants forming oblique helicoidal cholesteric (CLC_{OH}) phase, with position of the reflection band able to control by the electric field in wide range - from NIR to UV range [2,3]. The periodic structure of the cholesteric phase brings the reflectivity, thus may serve as resonator of the laser and the materials exhibiting CLC_{OH} phase may be utilized in tunable lasers [3].
We synthesized dimeric cyanobiphenyl liquid crystal derivatives, including one new compound exhibiting wide range of the nematic phase. The mixture based on cyanobiphenyl liquid crystals including *E7* mixture was prepared and enclosed in the cell. The sample was investigated under the polarized optical microscope with controlled temperature. The CLC_{OH} alignment was induced and controlled by *AC* electric field as manifested by the change of the color of the reflection band from red to blue (Fig. 1). It was found that CLC_{OH} alignment in the cell is sensitive also to the temperature.

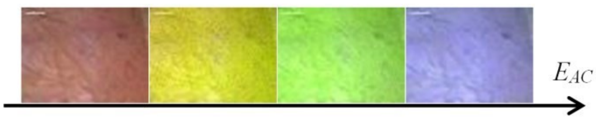


Fig.1. Change of the color of light reflection upon AC voltage , observed under the microscope

It will be presented short introduction related to the CLC_{OH} phase, experimental results and structures of synthesized organic dyes studied for their solubility in the liquid crystal host. Usage of the studied materials in liquid crystal lasers is considered.

References:

[1] Chen D.; Porada J. H.; Hooper J. B.; Klittnick A.; Shen Y.; Tuchband M. R.; Korblova E.; Bedrov D.; Walba D. M.; Glaser M. A.; Maclennan J. E.; Clark N. A., Chiral heliconical ground state of nanoscale pitch in a nematic liquid crystal of achiral molecular dimers. *Proceedings of the National Academy of Sciences* 110 (40), **2013**, 15931-15936.
[2] Xiang, J.; Li, Y.; Li, Q.; Paterson, D.A.; Storey, J.M.D.; Imrie, C.T.; Lavrentovich, O.D., Electrically Tunable Selective Reflection of Light from Ultraviolet to Visible and Infrared by Heliconical Cholesterics. *Adv. Mater*., 27, **2015**: 3014-3018.
[3] Xiang J.; Varanytsia A.; Minkowski F.; Paterson D. A.; Storey J. M. D.; Imrie C. T.; Lavrentovich O.D.; Palffy-Muhoray P., Electrically tunable laser based on oblique heliconical cholesteric liquid crystal. *Proceedings of the National Academy of Sciences*, 113 (46) **2016**, 12925-12928.

Acknowledgements:
The research was conducted within the framework of research project no 2018/31/B/ST8/02832, cofinanced by National Science Centre, Poland.

P51: **Synthesis and spectroscopic studies of pyrophosphate $K_2SrP_2O_7$ doped with Eu^{3+} and Eu^{2+} ions**

Adrian PATEJ, Adam WATRAS, Rafał J. WIGLUSZ

Institute of Low Temperature and Structure Research, PAS, 2 Okólna St., 50-422 Wroclaw, Poland
a.patej@intibs.pl

Phosphates are abundant group of chemical compounds used as dielectric materials, fertilizers or fireworks components. It is possible due to their chemical and temperature stability, and durability as well as easy and cheap manufacture [1]. They are also applied as matrices doped with optically active ions to create phosphors and fluorescent dyes [2, 3].

The aim of the research was to obtain Eu^{3+}- and Eu^{2+}-doped pyrophosphate $K_2SrP_2O_7$ by combustion method with urea as a fuel. Then, the synthesis parameters were optimized to check the effect of annealing parameters (i.e. temperature, time and atmosphere) on structural and spectroscopic properties. Obtained materials were measured using x-ray diffraction (XRD), scanning electron microscopy (SEM), excitation and emission luminescence spectra, decay times and luminescence temperature quenching.

To the best of our knowledge, only two papers describing spectroscopic properties of Eu^{3+}-doped $K_2SrP_2O_7$ appeared yet [4, 5], however the materials were obtained by conventional solid-state method. There is no article described Eu^{2+}-doped materials yet.

References:

[1] Averbuch-Pouchot, M.-T.; Durif, A., *Topics in phosphate chemistry*, World Scientific Publishing Company, Singapore, **2010.**

[2] Sole, J. G.; Bausa, L. E.; Jacque, D., *An Introduction to the Optical Spectroscopy of Inorganic Solids*, John Wiley and Sons Ltd, The Atrium, West Sussex, **2005**.

[3] Mondejar, S.P.; Kovtun, A.; Epple, M., *Lanthanide-doped calcium phosphate nanoparticles with high internal crystallinity and with a shell of DNA as fluorescent probes in cell experiments*, J. Mater. Chem, 17, **2007**, 721-727.

[4] Dhoble, K. S.; Wani, J. A.; Dhoble, S. J., *Combustion Synthesis and Luminescence Characterization of $K_2SrP_2O_7$: Eu Phosphor*, Int. J. Res. Biosciences, Agric. Technol., 2, **2015**, 378–381.

[5] Dhoble, K. S.; Wani, J. A.; Dhoble, S. J. , *NUV excited $K_2SrP_2O_7$: RE^{3+} (RE = Sm,Tb, Eu, Dy) phosphors for white light generation*, Adv. Mater. Lett., 7, **2016**, 765-769.

P52: Lanthanide Complexes with N-Phosphorylated Carboxamide as UV Converters with Excellent Emission Quantum Yield and Single-Ion Magnet Behavior

Yen H. PHAM,[ab] **Viktor A. TRUSH**,[c] **Albano N. CARNEIRO**,[d] **Maria KORABIK**,[a] **Jerzy SOKOLNICKI**,[a] **Oscar L. MALTA**,[e] **V. M. AMIRKHANOV**[c] **and Paula GAWRYSZEWSKA***[a]

[a]Faculty of Chemistry, University of Wroclaw, 14 F. Joliot-Curie Str., 50-383 Wroclaw, Poland.
[b]Faculty of Natural Sciences, Saigon University, 273 An Duong Vuong Str., District 5, Ho Chi Minh City, Vietnam.
[c]Department of Chemistry, Kyiv National Taras Shevchenko University, Volodymyrska str. 64, Kyiv 01601, Ukraine.
[d]Physics Department and CICECO-Aveiro Institute of Materials, University of Aveiro, Campus Universitário de Santiago, 3810-193 Aveiro, Portugal.
[e]Departamento de Química Fundamental, Universidade Federal de Pernambuco, Cidade Universitária, 50740-560 Recife, Brazil. E-mail: yen.pham@chem.uni.wroc.pl.

Multidentate ligands efficiently sensitizing emission of different lanthanide ions are rare and complexes often suffer from bleaching. Presented here are photostable lanthanide coordination compounds (**Na_2LnL_4**, where HL is *N*-(diphenylphosphoryl)pyrazine-2-carboxamide, Ln^{3+} = Nd^{3+}, Sm^{3+}, Eu^{3+}, Tb^{3+}, Dy^{3+}, Yb^{3+}) with single-magnet behavior as the first example in which, using the same sensitizer and the same excitation wavelength, extremely high overall emission quantum yields are achieved for various lanthanide ions. Based on the Na_2LnL_4 complexes, multicolor PMMA polymer layers (PMMA - poly(methyl methacrylate) with tunable emission were obtained.

References:

[1] Pham, Y.H.; Trush, V.A.; Carneiro, A.N.; Korabik, M.; Sokolnicki, J.; Weselski, M.; Malta, O.L.; Amirkhanov, V. M.; Gawryszewska, P., Lanthanide complexes with N phosphorylated carboxamide as UV converters with excellent emission quantum yield and single-ion magnet behavior. *J. Mater. Chem. C,* Vol. 8, **2020**, 9993-10009.
[2] Pham, Y.H.; Trush, V.A.; Korabik, M.; Amirkhanov, V. M.; Gawryszewska, P., *Dyes and Pigments,* **2020**, under review.

P53: Structural and spectroscopic properties investigation of Nd^{3+}-doped YPO_4 nano and micro-powders obtained by various methods of synthesis

[I] Jakub PAWŁÓW, [I] Kacper PROKOP, [I] Małgorzata GUZIK, [II] Yannick GYUOT, Georges BOULON, [I] Joanna CYBIŃSKA

[I] *Faculty of Chemistry, University of Wrocław, ul. F. Joliot-Curie 14, 50-838 Wrocław, Poland*
[II] *Institute Lumière Matière (ILM), UMR5306 CNRS-Université Claude Bernard Lyon 1, Université de Lyon, 69622 Villeurbanne, France*
jakub.pawlow1@gmail.com

At the turn of the last few decades, due to rapid technological development, scientists have particularly focused on compounds showing luminescent properties. The topic of many publications that relate to the use of this type of materials are nanocrystalline inorganic phosphors as matrices, such as vanadates or phosphates [1] doped with various lanthanides are often used. Rare earth doped orthophosphates - REPO4 are often used as luminescent materials in fluorescent lamps [2].

This work concludes both structural and spectroscopic investigation of micro- and nano-powders of zircon-type, Nd^{3+}-doped YPO_4 micro/nano powders, obtained by various methods of synthesis – co-precipitation and solid-state. Morphology of material and its phase purity were analyzed using X-ray diffraction (XRD) and scanning and transmission electron microscopy (SEM and TEM). The spectroscopic properties were analyzed by using low-temperature high-resolution techniques like absorption spectroscopy at 4.2K and tuneable laser site selective spectroscopy at 77K. It was observed that $^4F_{3/2}$ excited level decay times recorded at 77K have shown an abnormal temporal behavior of Nd^{3+} photoluminescence. This phenomenon is observed both for nano and micro-powdered samples. Detailed structural and spectroscopic studies of Nd^{3+}-doped YPO_4 micro- and nano-powders were performed, taking account the role of Nd^{3+} dopant ion as a structural probe. The authors would like to acknowledge the financial support by HARMONIA 9 UMO-2017/26/M/ST5/00563.

References:

[1] J. Cybińska, M. Woźniak, A. V. Mudring, E. Zych, J. Lumi. Vol. 169, **2016**, p. 868-873
[2] J. M. Nedelec, C. Mansuy, R. Mahiou, Sol–gel derived YPO4 and LuPO4 phosphors, a spectroscopic study, J. Mol. Struct., Vol. 651–653, **2003**, p. 165–170.

P54: The capability of graphene on improving the electrical conductivity and anti-corrosion properties of copper wires

Krzysztof LIS, [a), b)], **Grażyna Gryglewicz**,[b)], **Alicja Bachmatiuk**,[a)]

[a)] *Łukasiewicz Research Network – PORT Polish Center Fop Technology Development;*
[b)] *Department of Polymer and Carbonaceous Materials, Faculty of Chemistry, Wrocław, University of Science and Technology*
klis@port.lukasiewicz.gov.pl, abachmatiuk@port.lukasiewicz.gov.pl

Graphene is considered to be an ideal candidate as corrosion protection coating in applications as: microelectronic, interconnects or implantable devices. Graphene coatings are found to be highly impermeable to all gases, liquids and aggressive chemicals [1,2]. CVD graphene and graphene oxide coatings with high purity and commercially available copper wires were examined. CVD processes for graphene synthesis were carried out using methane as a carbon source at temperatures of ~1000°C and atmospheric pressure. Graphene oxide produced by modified Hummers method [3] was applied to the surface of the copper wires by dip coating method.

A series of tests were performed including: assessment of the coatings quality, surface coverage, current carrying capacity and salt spray corrosion measurements for aging tests.

References:

[1] Su, Y., Kravets, V., Wong, S. et al. Impermeable barrier films and protective coatings based on reduced graphene oxide. *Nat Commun 5, 4843,* ***2014***

[2] J. Liu, L. Hua, S. Li, M. Yu, Graphene dip coatings: An effective anticorrosion barrier on aluminum, *Applied Surface Science*, Volume 327, **2015**

[3] Sun, X., Liu, Z., Welsher, K. et al. Nano-graphene oxide for cellular imaging and drug delivery. *Nano Res*. 1, 203–212, **2008**

P55: Sol-gel glass photonic microlasers doped with Rhodamine 6G

a), b) Daria Hlushchenko, c),d) Katarzyna Komorowska

a) Lukasiewicz Research Network – PORT Polish Center for Technology Development,
b) Wroclaw University of Science and Technology
c) Lukasiewicz Research Network – PORT Polish Center for Technology Development,
d) Wroclaw University of Science and Technology daria.hlushchenko@pwr.edu.pl

Microlaser is a structure in which the light travels in a closed loop — along a circle, reflecting from the sides creating whispering gallery modes (WGM), that can be interpreted as electromagnetic waves that circulate and are strongly dependent from microlasers dimensions, geometry and dielectric properties (refractive index). Photoluminescence spectrum is determined by the geometry of the resonator and the nature of the active medium [1].

Previously fabricated sol-gel microlasers was impregnated by Rhodamine 6G. For all microlasers was measured emission spectra where photoluminescence observed at 550 nm (fig.1a). An efficient laser emission is observed when the samples pumped at 532 nm. For received microlasers WGM measurement tests was carried out (fig.1b).

Although regular circular microlasers are able to obtain low threshold lasing, the disadvantage of these highly symmetric designs is their not directional emission. Directionality proposed by introducing a deformation to the regular circular geometry. Later several groups showed directional behaviour in microcavity lasers by using different cavity designs like elliptical cavities, stadium shaped cavities and spiral cavities.

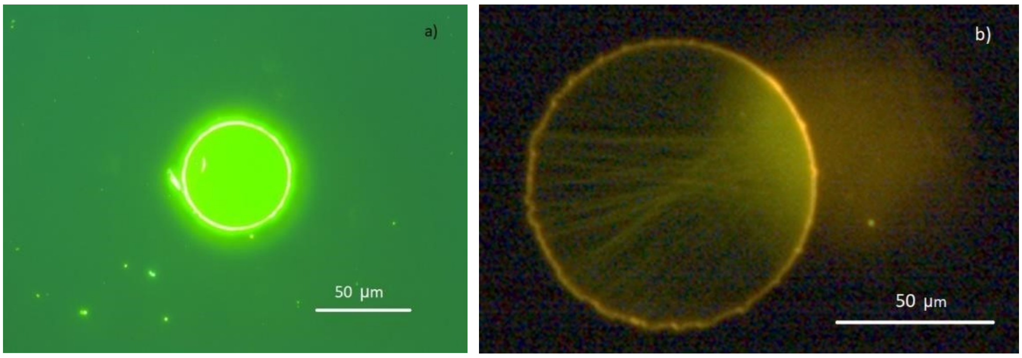


Fig. 1. Images of microlasers from photoluminescence microscope

Microresonator circuits was chosen as possible application for such microlasers. One of the most difficult challenges in the design and fabrication of integrated microlaseer-based photonic devices and systems is the efficient coupling of light into and out of a microlaser without compromising its narrow resonance linewidth. In our resonator circuit were used planar waveguides for couple microlaser device [1-4].

References:

[1] Gozhyk I. Polarization and gain phenomena in dye-doped polymer micro-lasers. Optics. École normale supérieure de Cachan - ENS Cachan, 2012. English. NNT : 2012DENS0052.

[2] S. Lozenko S.; N. Djellali N.; Gozhyk I.; Delezoide C.; Lautru J.; Ulysse C.; Zyss J, and Lebental M. Enhancing performance of polymer-based microlasers by a pedestal geometry. J. Appl. Phys. 111, 103116 (2012); https://doi.org/10.1063/1.4720474.

[3] Xiao-lei Zhu, Dennis Lo. Sol–gel glass distributed feedback waveguide laser. Appl. Phys. Lett. 80, 917 (2002); https://doi.org/10.1063/1.1448386.

[4] Lebental M.; Lauret J.S.; Hierle R, and Zyss J. Highly directional stadium-shaped polymer microlasers. Appl. Phys. Lett. 88, 031108 (2006); https://doi.org/10.1063/1.2159099.