

# Laboratory of Materials Technologies\*\*



Members of our laboratory, Dean of the Faculty of Chemistry, members of the Department of Functional Materials at Ł-ITME together with representatives of the Ministry of Science and Higher Education of Poland, Łukasiewicz Research Network, Nature Photonics and partners of the Teaming for Excellence ENSEMBLE3 project.

## HEAD:

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## GROUP MEMBERS:

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## RESEARCH PROFILE:

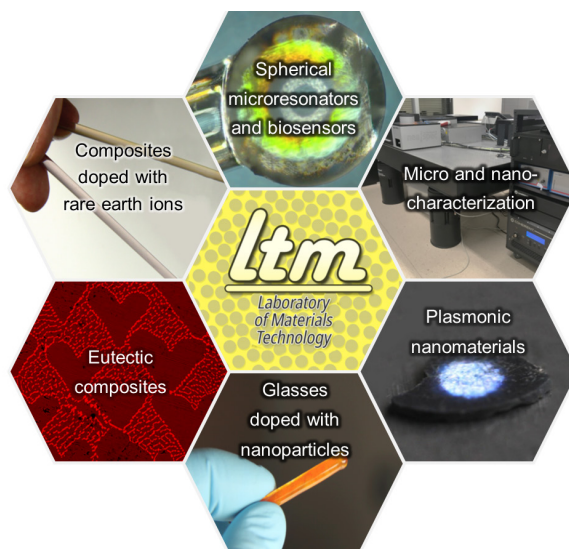
Developing new methods for manufacturing photonic materials utilizing crystal growth methods. Our research focuses on metamaterials, plasmonic and materials with special optical/electromagnetic properties using top-notch characterization techniques from the macro to the nanoscale.

## CURRENT RESEARCH ACTIVITIES:

We develop volumetric and micron-scale photonic materials based on: (i) self-organization mechanism in eutectic composites; (ii) directional solidification of nanocomposites made of glasses doped with optically active elements such as plasmonic nanoparticles, quantum dots and rare earth ions; (iii) solidification of microbeads to act as whispering gallery mode microresonators for microbiosensing systems or microlasers. The glass-based novel photonic materials are manufactured by the NanoParticle-Direct Doping method (NPDD) developed in our laboratory. Utilizing eutectic directional solidification, we demonstrate various optical phenomena such as photoluminescence enhancement and up-conversion, tunable narrow-band transmission switched on and off with polarization; selective plasmonic enhancement of SERS/surface enhanced Raman scattering and others.

Besides manufacturing, we characterize the optical properties of materials especially on the micron and nanoscale with techniques such as Raman, UV-VIS and infrared spectroscopy (including nano-FTIR), time-resolved luminescence and optical near-field microscopy (s-SNOM).

Our goals are to combine our knowledge and expertise to develop low-cost photonic devices with enhanced functionalities.



## SELECTED PUBLICATIONS:

1. P. Osewski, A. Belardini, M. Centini, C. Valagiannopoulos, G. Leahu, R. Li Voti, M. Tomczyk, A. Alù, D.A. Pawlak, C. Sibilìa, New self-organization route to tunable narrowband optical filters and polarizers demonstrated with ZnO–ZnWO<sub>4</sub> eutectic composite, *Adv. Opt. Mater.* 8 (2020) 1901617.
2. R. Nowaczyński, M. Gajc, H.B. Surma, P. Osewski, A. Strzęp, W. Ryba-Romanowski, D.A. Pawlak, Manufacturing of volumetric glass-based composites with single- and double-QD doping, *Part. Part. Syst. Charact.* 36 (2019) 1800124.
3. M. Gajc, H.B. Surma, D.A. Pawlak, Optically-active metastable defects in volumetric nanoplasmonic composites, *Sci. Rep.* 8 (2018) 13425.
4. K. Wysmułek, J. Sar, P. Osewski, K. Orliński, K. Kołodziejak, A. Trenczek-Zajęc, M. Radecka, D.A. Pawlak, A SrTiO<sub>3</sub>-TiO<sub>2</sub> eutectic composite as a photoanode material for photoelectrochemical hydrogen production, *Appl. Catalysis B: Environmental.* 206 (2017) 538.
5. K. Kołodziejak, J. Sar, K. Wysmułek, P. Osewski, M. Warczak, A. Sadkowski, M. Radecka, D.A. Pawlak, When eutectic composites meet photoelectrochemistry – Highly stable and efficient UV–visible hybrid photoanodes, *J. Catalysis.* 352 (2017) 93.
6. P. Osewski, A. Belardini, E. Petronijevic, M. Centini, G. Leahu, R. Diduszko, D.A. Pawlak, C. Sibilìa, Self-phase-matched second-harmonic and white-light generation in a biaxial zinc tungstate single crystal, *Sci. Rep.* 7 (2017) 45247.
7. K. Sadecka, M. Gajc, K. Orliński, H.B. Surma, A. Kłos, I. Józwił-Biała, K. Sobczak, P. Dłużewski, J. Toudert, D.A. Pawlak, When Eutectics Meet Plasmonics: Nanoplasmonic, Volumetric, Self-Organized, Silver-Based Eutectic, *Adv. Opt. Mat.* 3 (2015) 381.
8. K. Sadecka, J. Toudert, B. Surma, D.A. Pawlak, Temperature and atmosphere tunability of the nanoplasmonic resonance of a volumetric eutectic-based Bi<sub>2</sub>O<sub>3</sub>-Ag metamaterial, *Opt. Express.* 23 (2015) 19098.
9. M. Gajc, H.B. Surma, A. Kłos, K. Sadecka, K. Orliński, A.E. Nikolaenko, K. Zdunek, D.A. Pawlak, NanoParticle Direct Doping: Novel method for manufacturing three-dimensional bulk plasmonic nanocomposites, *Adv. Funct. Mater.* 23 (2013) 3443.
10. D.A. Pawlak, S. Turczyński, M. Gajc, K. Kołodziejak, R. Diduszko, K. Roźniatowski, J. Smalc, I. Vendik, How far are we from making metamaterials by self-organization? The microstructure of highly anisotropic particles with an SRR-like geometry, *Adv. Funct. Mater.* 20 (2010) 1116–1124.

\*\* The Laboratory of Materials Technology was founded based on the Framework Agreement on Cooperation between the UW and the Institute of Electronic Materials Technology, now being part of the Łukasiewicz Research Network. It acts effectively as one entity (yet within two institutions) with complementary infrastructure and scientific apparatus and including key expertise in the crystal growth research area.