PHYSICAL AND TECHNOLOGICAL SCIENCES

Semiconductor Photonics Group

Vilnius University

Keywords: *Semiconductors, wide-band-gap semiconductors, scintillators, nonequilibrium carrier dynamics, carrier recombination, carrier diffusion, time-resolved luminescence, spatially-resolved luminescence, ultrafast pump-probe spectroscopy.*

Research activities

Currently, the research activities are focused on three directions:

- carrier dynamics and light emission efficiency in III-nitride structures emitting in UV and green regions;
- fast phenomena in intrinsic and doped scintillation materials;
- light emission properties of III-nitride nanorods.

The key topics are:

- study of carrier dynamics in III-nitrides aimed at the development of high-efficiency LEDs, laser diodes and other optoelectronic devices in UV, green, and IR regions;
- fast scintillators for detectors of ionizing radiation.

We also work on:

- development of single-photon emitters based on semiconductor nanostructures;
- development of smart compound optoelectronic sensors of chemical agents with dual readout based on AlGaN high electron mobility field effect transistor (HEMT) and luminescence spectroscopy under III-nitride LED excitation;
- development of scintillation detectors with 10 ps time resolution.

Proposal

The group has experience and facilities for studying carrier dynamics in semiconductors and their nanostructures, scintillator materials and phosphors by using photoluminescence spectroscopy with picosecond time resolution and submicrometer spatial resolution in confocal and SNOM modes, in a wide range of excitation power densities spanning 12 orders of magnitude, in the temperature range from 8 to 600 K, under fixed and tuneable wavelengths excitation ranging from near IR to UV. A unique light-induced transient grating technique enabling simultaneous determination of carrier lifetime and diffusion coefficient is also exploited in picosecond and femtosecond domains.

Meet our team

Group leader Prof. Dr. Gintautas Tamulaitis, Head of Semiconductor Physics Department, is a winner of the Lithuanian National Science Awards in 2002 and 2008, author and co-author of more than 140 papers in international peer-reviewed journals, which are cited more than 1500 times (H = 21). He works with his group consisting of Dr. Ramūnas Aleksiejūnas, Dr. Jūras Mickevičius, Dr. Saulius Nargelas, Dr. Darius Dobrovolskas, Dr. Jonas Jurkevičius, PhD students Kazimieras Nomeika, Žydrūnas Podlipskas, Augustas Vaitkevičius, Oleg Kravcov, and, currently, 5 undergraduate students.

Research outcomes

Selected current publications:

- **J. Mickevičius** et al., Influence of carrier localization on high-carrier density effects in AlGaN quantum wells, Optics Express, 22, A491 (2014).
- **D. Dobrovolskas** et al., InGaN/GaN MQW Photoluminescence Enhancement by Localized Surface Plasmon Resonance on Isolated Ag Nanoparticles, Plasmonics, 9, 1183–1187 (2014).
- **J. Mickevičius** et al., Low-temperature redistribution of non-thermalized carriers and its effect on efficiency droop in AlGaN epilayers, J. Phys. D: Appl. Phys. 48, 275105 (2015).
- **T. Saxena** et al., Dynamics of nonequilibrium carrier decay in AlGaN epitaxial layers with high aluminum content, Optics Express 23, 19646-19655 (2015).
- **A. Kadys** et al., Optical and structural properties of BGaN layers grown on different substrates, J. Phys. D: Appl. Phys. 48, 465307 (2015).
- **Ž. Podlipskas** et al., Dependence of radiative and nonradiative recombination on carrier density and Al content in thick AlGaN epilayers, J. Phys. D: Appl. Phys., 49, 145110 (2016).
- **E. Auffray** et al., Luminescence rise time in self-activated PbWO4 and Ce-doped Gd3Al2Ga3O12 scintillation crystals, J. Lumin. 178, 54-60 (2016).
- **D. Dobrovolskas** et al., Influence of defects and indium distribution on emission properties of thick In-rich InGaN layers grown by the DERI technique, Semicond. Sci. Technol. 32, 025012 (2017).
- **G. Tamulaitis** et al., Subpicosecond luminescence rise time in magnesium codoped GAGG:Ce scintillator, Nuclear Inst. and Methods in Physics Research, A 870, 25–29 (2017).

Most important current research projects:

- H2020-INFRAIA-2014-2015 project no. 654168, Advanced European Infrastructures for Detectors at Accelerators (AIDA-2020);
- Project LAT-16022 „III-nitride semiconductors for radiation-hard infrared detectors“ of the National Research Programme „Towards future technologies“;
- Project MIP-079/2015 „Distinction of the influences of defects and carrier localization on emission in green InGaN LED structures“ of the Lithuanian Research Council.
- LRC High-level Research Group project 01.2.2-LMT-K-718-01-0041 “Neutron flux detection system with optical readout”, 2018-2022.
- LRC Global Grant project 09.3.3-LMT-K-712-01-0013 “Fast scintillators for radiation detectors”, 2018-2022.

Collaboration projects:

- COST Action MP1302 „Nanospectroscopy“;
- COST Action TD1401 „Fast Advanced Scintillator Timing (FAST)“.

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