2007

International projects

- “**Imprinted Plasmonic Active Surfaces**” (2007‑2008), Nordsforsk project No.070064

This project brings together three research groups from three universities (University of Southern Denmark (SDU), Helsinki University (HU), and Institute of Physical Electronics of Kaunas University of Technology (Lithuania) (KTUFEI)) aimed at the development of cooperation and coordinated research in the field of new materials and structures as possible elements of future plasmonic devices. The project was based on cooperative research where all three groups worked as experts in their fields supplementing to the achievement of the common goal - improving our understanding of the fundamental interplay between surface and transport processes at the nano-scale ultimately determining the next generation of solid state sensors. The simple, low cost procedures for building the structures suggest a potentially important role for these devices in high performance chemical and biological sensing. Surface plasmons produced in different configurations recently have been extensively used in a large variety of tools and techniques for bio- and chemical sensing by exploiting plasmon resonance in thin metallic films. Metallic nanoparticles have distinctly different optical characteristics than surface plasmons at planar interfaces. Within the current project, optical active surfaces based on periodically corrugated polymer surfaces filled with silver nanoparticles (plasmonic crystals) were produced and systematically investigated. This configuration allows surface plasma waves excitation and consequently enhancement of the photoemission sensitivity, to tune the surface plasmon resonance to an absorption band of a molecule to be detected. This kind of approach allows one as well to create controlled structures of nanoparticles compatible with high-throughput techniques (UV imprint).

National projects

- “**Nanostructural Components of Terahertz Photonics**” **(NanoKomponentai)** (2007‑2009), project of the national-priority scientific program of Lithuanian State and Studies Foundation

The project was carried out together with Institute of Semiconductor Physics.

The project of experimental and theoretical research is addressed to semiconductor nanotechnologies for the development of compact terahertz emitters/detectors and passive THz circuit component using metamaterials. Obtained results are of essential importance determining optimal parameters and suitable working regime for the practical realization of the devices. We have employed various spectroscopic – photoreflection and electrical reflection, surface photovoltage signal and photoluminescence, terahertz photocurrent and photoresponse as well as Fourier - techniques to study experimentally beryllium and silicon doped GaAs/AlAs quantum wells and Ga,As/A1GaAs superlattices, InAs quantum dots in GaAs/A1GaAs superlattices, GaN/A1GaN quantum wells within the 4-300 K temperature range. By applying Monte Carlo and finite-difference time-domain methods we have simulated propagation of electromagnetic waves in micro cylinder-shaped terahertz quantum-cascade lasers, and pulsed THz emission from semiconductor surface and from p-i-n structures. The study was carried out in close collaboration with colleagues from Austria, Germany and the United Kingdom.

- “**Novel Micromechanical Systems and Technologies**” **(NAMSIS)** (2007‑2009), project of high technologies development programme

The project was carried out together with Kaunas University of Technology, JSC Sebra.

The main project results are related to the development of the novel technologies for fabrication of the mechanical and micromechanical devices (components of the precise mechanics). Project included works in all three main areas of the development of the device fabrication technologies. The first direction is devoted to the novel improved technologies of the fabrication of the advanced precise mechanics devices. Investigations on vibration cutting application for fabrication of the precise mechanic's components were performed. The second direction of the investigations was devoted to the improvement of the process control by monitoring of the tool wear condition to avoid wear-related damage of the equipment or fabricated component. To solve the problem mentioned above micromechanical force sensor was developed. The third direction of the research was related to the improvement of the tools wear resistance by development of the novel technology of the deposition of protective coatings.

- "**Synthesis and Investigation of Diamond Like Nanocomposite Films" (DYLYN)** (2007), funded by the Lithuanian State Science and Studies Foundation, No. T-07134

Diamond like carbon (DLC) received considerable interest due to its outstanding mechanical, chemical, optical and electrical properties. Doping with both metallic and non-metallic elements and compounds can be used to control properties of DLC films. In the last decade, a diamond-related material similar to diamond-like carbon was developed, which consisted of the two random interpenetrating amorphous networks of hydrogenated amorphous carbon (a-C:H) and amorphous silicon oxide (a-SiO_x). These SiO_x doped DLC films deposited by plasma enhanced chemical vapour deposition or hydrocarbon ion beam deposition have some advantages over conventional hydrogenated DLC films as a dielectric (insulating) layers due to reduction of the internal stress and friction coefficient, considerably better adhesion with ferrous substrates such as iron. Increase of the fracture toughness, deposition rate, optical transmittance and higher thermal stability were reported for SiO_x containing DLC films as well. SiO_x containing DLC films are known under the name of diamond-like nanocomposite films.

The dependence of the structure, electrical and optical properties of the diamond-like nanocomposite films on conditions of the synthesis process were investigated. Novel method for control of the film deposition process - optical emission spectroscopy - was developed.

- "**Dot-Matrix Development and Application**" (2007), funded by the Lithuanian State Science and Studies Foundation, No. T-07354.

The aim of the project was development and application of new methods and technological processes for optical holography in production of optically variable devices (to achieve new degree of security in documents and articles protection against counterfeiting). During this project optical scheme for dot-matrix holograms by laser beam interference lithography was developed using 442 and 405 nm wavelength lasers. The method for placement of diffractive dots, determined orientation and spatial frequency was developed. New methodology was developed and applied for dot matrix holograms characterisation by two approaches: optical approach and direct (contact) measurements.

- "**Ag Nanostructures for Investigation of the Influence of Ionizing Radiation**" (2007), funded by the Lithuanian State Science and Studies Foundation, No. T-07312.

Supermolecular silver compound synthesis methods based on dendrimeric polymers were investigated. Silver-dendrimer compounds, when exposed to particular radiation (UV, IR and ionizing), form into silver nanoparticles – zero valence clusters with a particular number of silver atoms, which corresponds to their size and amount in liquid medium. Investigation of silver-dendrimer decay kinetics under various conditions enabled to predict the access of silver nanoparticles to biological liquid medium, evaluate their stability with respect to time. Complex investigation of silver nanoclusters (X-Ray diffraction, probe methods, optical spectroscopy, electron microscopy) enabled to summarize the main steps of silver-dendrimer compound formation, their properties and applications in ionizing radiation diagnostics, recommend the technology for applications in biological and other media.