2008

International projects

- **"Plasmonic Components and Devices"** (2008‑2012), COST MP0803

The project was carried out together with research institutions from Poland, Germany, United Kingdom, Turkey, Netherlands, Switzerland.

The purpose of the COST Action was to foster, coordinate and strengthen scientific and technological collaboration in plasmonics in Europe. Over the past decades, plasmonics - the optics of metallic nanostructures - has emerged as a very promising technology. Two key applications of plasmonics are the processing of optical information at the nanoscale and label free biosensing. The Action covered both fields of application, since similar fundamental and technological issues are at stake. Emphasis was put on the integration of plasmonic components into CMOS and organic devices. The Action helped bridge the gap between fundamental research and European industry; it also developed and implemented a strategy for education on plasmonics in Europe.

National projects

- **"Peculiarities of Nanostructures Formation in Cement Building Materials: Investigation and Technological Development" (nano-CSM)** (2008‑2010), project of high technologies development programme

The project was carried out together with Institute of Thermoisolation of Vilnius Gediminas Technical University, Lithuanian Institute of Energetics, Centre of building materials and constructions of Kaunas university of technology, Institute for Hi-Tech Development, JSC STATIZOLA, JSC Betoneta.

The project was based on the creation of new cement building materials (binding materials, grout, maintenance compositions, concrete), which properties depend on the nanostructured derivatives formed in the bulk of it. The aim of research was to investigate mechanism of nanoderivatives formation in multicomponent composition, to find out relation between material structure and final properties of composition and possibilities to modify them in the required manner. The influence of various nanomodifiers such as zeolite, colloid solution of natrium silicate, micro fibre, obtained in the plasma chemical reactor on the mechanism of the nanoderivatives formation and its properties were investigated and the recommendations for multi-component materials producers were presented.

- **"Development and Application of Advanced Holographic Security Means" (HOLOKID)** (2008‑2010), project of high technologies development programme

The project was carried out together with Kaunas University of Technology, Institute of Physics, JSC Lodvila.

The aim of this project was to develop new holographic technologies and to perform a search for new materials and structures potentially applicable for security means.

During the first year of the project, influence of initial layer on mechanical properties of electrolyticaly on Si surface microrelief deposited Ni layer and parameters of microrelief replication during printed master matrix production was investigated. Technology for holographic image formation by microdiffractive elements from two dimensional images were created and optimised. Processes of

kinegram and microdiffractive elements hologram production were coupled. Methodology for evaluation of hologram diffraction efficiency using radiation of various wavelengths was created. With the aim of high diffraction efficiency, process of original hologram writing, used for the production of 3D rainbow hologram, was optimised. Experiments of the computer based hologram design were carried out by a fully vectorised 3D Beam Propagation Method. Parameters of the electron beam lithography were optimised for realisation of the holograms synthesized. In the frame of search for new materials for electronic ID tags, synthesis and investigation of low molecular mass p type organic semiconductors with a high mobility of charge carriers was performed as well as experiments on production and investigation of organic field effect transistors were carried out.

During the second year of the project, the influence of replication process on quality of microrelief replicated on high area was investigated and quantitatively described; the principles of new technology combining optical replication and dot matrix holography were developed; the 3D hologram recording process was optimised taking into account thermal deformation of holographic plate; computer simulations of 2D images constructed of point sources and plane objects were performed employing fast Fourier transformations and fully vectorised 3D Beam Propagation Method; new electro active low molecular masses hole and electron transporting semiconductor layers were produced and characterised; new hole and electron transporting conjugated polymers and oligomers were synthesized and characterised; charge transfer phenomena at the interface of electrode and organic semiconductor were analysed to produce organic semiconductor based Shottky diode.

During the third year of the project, dependence of optical properties of diffractive optical elements on technological regimes of recombining was defined, quality of thermal replica of microstructure was improved by high frequency vibrations, 2D/3D hologram production technologies on the basis of laser interference lithography and coupling of 2D/3D holograms with micro diffractive elements were created and adopted for the mass production of optically variable devices, measurement of diffraction efficiency and image signal to noise ratio was proposed as mean of qualitative evaluation of 2D/3D holograms, new, faster and more accurate fully vectorised 3D BPM RK4 algorithm based on the 4th order Runge-Kuta method was used for the design of synthetic computer holograms, holograms of 2 and 256 greyscale levels were realized in the thick PMMA layer by e-beam lithography, three new, thermally stable, amorphous organic materials, potentially suitable for active layers of organic FETs and light-emitting diodes, were synthesised, current-voltage characteristics for various configurations of organic FETs were investigated.

- **"Photonic Crystal Micro-Resonators"** (2008), funded by the Lithuanian State Science and Studies Foundation.

The project was carried out together with Polytechnic University of Catalonia and Vilnius University.

The final goal of the project was to fabricate and to explore theoretically and experimentally such photonic crystal resonators, as well as to estimate their application for all-optical information processing. The subject of the project was sub-millimetre and micrometre length resonators filled by photonic crystals. Photonic crystals, due to their celebrated dispersion and diffraction properties, and due to their promising applications, have been intensively studied. In the applied project we have investigated a kind of hybrid system, the system combining the properties of the resonators (with the mode structures) and the properties of photonic crystals (complicated dispersion relation). The investigations of such system have been initiated in 2007, in collaboration between the Laser Research Centre of Vilnius University, the Institute of Physical Electronics of Kaunas University of Technology, and the Polytechnic University of Catalonia (research team leader Prof K. Staliunas). The project extended the initial studies to perform experiments with smaller spatial scale (micron scale) photonic structures, also with two-dimensional photonic structures.