2014

International projects

- **"Modelling and Development of Sensors Based on Nanocomposite Thin Film Diffraction Gratings"** (2014‑2015), funded by Research Council of Lithuania, implemented under the 2011‑2015 programme in the field of scientific and technical cooperation of Ministry of Education and Science of the Republic of Lithuania and State Agency of Science, Innovation and Informatisation of Ukraine

The aim of this scientific and technical cooperation was to create novel optical sensors based on nanocomposite thin film diffraction gratings. During the project, diamond-like carbon and silver nanocomposite periodical thin films were modelled, fabricated using magnetron sputtering and investigated. Before fabrication of testing sample, the optimisation of structure parameters was performed. Scientists from Ukraine carried out the modelling and investigation of optical properties of diamond-like carbon nanocomposite materials dependence on dialectical matrix materials, nanoparticles size, shape and concentration. Optical properties of nanoparticles were investigated employing Mie theory. Effective dielectric permittivity of nanocomposite materials was modelled using Maxwell-Garnett theory. If silver nanoparticles concentration was from several tenths to several atomic concentration units, the permittivity was modelled using Bruggeman and Sheng theory. Lithuanian scientists created synthesis technology of thin films with appropriate properties. For optimization of magnetron sputtering technology, sputtering parameters and technological route were chosen. SEM, EDX, ESCA, XRD, FTIR and Raman scattering methods were used. Optical properties of thin films fabricated by reactive magnetron sputtering were compared with modelling results. Periodical structures in diamond-like carbon and silver nanocomposite thin films were created using electron and holographic lithographies. Modelling of holographic lithography interference patterns were carried out and periodical microstructures were fabricated using Lloyd interferometer. Numerical simulations of electromagnetic radiation interaction with periodical structures in fabricated nanocomposite films were carried out. Maxwell's equations with exact mathematical model of diffraction for different diffraction gratings were used for calculations. Ukrainian scientists employed rigorous coupled wave analysis method (RCWA), and Lithuanian scientist used finite-difference time-domain method (FDTD).

Publications:

• Yaremchuk, Iryna; Meškinis, Šarūnas; Fitio, Volodymyr; Bobitski, Yaroslav; Šlapikas, Kęstutis; Čiegis, Arvydas; Balevičius, Zigmas; Selskis, Algirdas; Tamulevičius, Sigitas. Spectroellipsometric characterization and modeling of plasmonic diamond-like carbon nanocomposite films with embedded Ag nanoparticles// Nanoscale Research Letters (2015) 10:157. DOI 10.1186/s11671-015-0854-y

• Meškinis, Šarūnas; Čiegis, Arvydas; Vasiliauskas, Andrius; Šlapikas, Kęstutis; Gudaitis, Rimantas; Yaremchuk, Iryna; Fitio, Volodymyr; Obitski, Yaroslav; Tamulevičius, Sigitas. Annealing effects on structure and optical properties of diamond like carbon films containing silver // Nanoscale Research Letters"(accepted 12.2015)

- **"Power Electronics for Green Energy" (Green Power Electronics)** (2014-2015), EU Strategy for the Baltic Sea Region „Seed Money Facility"

Partners: University of Southern Denmark; Acreo Swedish ICT AB, Sweden; University of Tartu, Estonia; Kaunas University of Technology, Lithuania; University of Latvia; WTSH – Business Development and Technology Transfer Corporation of Schleswig Holstein, Germany.

The purpose of the project: to bring together key stakeholders from various technology disciplines within power electronics, wind and solar energy in the Baltic Sea Region; to involve relevant partners from the innovation ecology along the supply chain from R&D institutions, SMEs, innovation policy and business development.

The tasks of the project: to build a consortium with particular and relevant regional partner organisations for the main project; to identify the relevant regional stakeholders to be involved in the main project; to develop a comprehensive project including specific aims, work plan, budget meeting the specific needs.

National projects

- **"Application of Nanocomposite Layers for Innovative Antimicrobial Layers and Optical Biosensors" (NANOBIOSENSOR)** (2014), funded by Kaunas University of Technology and Lithuanian University of Health Sciences

Real time monitoring of optical constants, physical, chemical and biological processes and reaction kinetics was developed. Antimicrobial properties of diamond like carbon/Ag nanocomposite layers with controllable plasmonic properties were investigated. Sub-micrometre period ordered structures were also formed on these layers for in-situ measurement of complex refractive index kinetics. A prototype (biosensor) for complex refractive index kinetics measurements was assembled and calibrated for investigation of biological medium and processes in real time. Also, plasma deposition method was employed to deposit and investigate DLC: Ag nanocomposite layers with antimicrobial properties. After performing microbiology tests, the antimicrobial efficiency of DLC: Ag nanocomposite layers for natural bacteria and their effect for in-situ measurements was evaluated.

Self-supporting projects

- **"Improvement of Biocompatible Dental Prosthesis Manufacturing Technology"** (2014‑2015), JSC Amicus Dentis

In pursuance of Amicus Dentis company order funded by MITA innovative check, investigations of samples produced under different conditions using different surface preparation and different zirconium oxide ceramics covered with selected decorative ceramics were carried out. Using the shear and the three-point bending tests, the mechanical properties were analysed and compared. The surfaces of fractures were examined using methods such as a scanning electron microscopy and Raman analysis. The research results were applied in the production techniques of such prosthesis.

- **"Creation of Holographic Security Labels"** (2014), JSC Holograma

The purpose of the project was the optimisation of holographic image formation technology using microdiffractive elements; the consolidation of two different methods (hologram optical doubling and microdiffractive elements formation) of hologram formation; the creation of prototype.

- **"Production of Kinematic Security Labels with a Logo"** (2014), LR State Security Department

The purpose of the project: the creation of technology of nanographics (LR State Security Department logo) integration into the optical security element.

- **“The Selection of the Ultrashort Pulse Laser Beam Dividers Geometry and Technological Processes for the Control of the First and Higher Harmonic Radiation Diffraction Spectrum”** (2014), JSC Altechna R&D

For JSC Altecha R&D research, methodology of ultra-short pulses laser beam splitter geometry was created and its implementation in lithographic technologies was developed. For investigation of ultra-fast radiation diffraction efficiency, a specific methodology was created. The fabricated splitters are capable to split the laser beam into two beams of equal intensities.