PROJECTS

2018

INTERNATIONAL

1. **Republic of Lithuania Ministry of Education and Science, Republic of China (Taiwan) National Research Council and Republic of Latvia Ministry of Education and Science collaboration project „2D nanostructures of noble metal nanoparticles for biosensors application “, project leader dr. Sigitas Tamulevičius (2018-2020).**

In this project capillary force assisted particle assembly will be produced and studied for applications including Surface Enhanced Raman Spectroscopy (SERS), elastic scattering and photoluminescence for biosensing. The project will aim at the developing of effective nanostructured templates, production of regular noble metal nanoparticle arrays, design and synthesis of proper peptide biomarker based on the proteomic profile of tear, as well as construction of SERS, luminescence, absorption and elastic scattering based biosensor for diagnosis of ocular surface and systemic diseases. The metal nanoparticle array templates as biosensors for detection and quantification of the biomarkers, such as infective microbes, protein or non-protein biomarkers, as well as the cancerous cells will be employed.
The formed structures are expected to be sensitive enough to analyze the biomarkers from human tears. This would open up new approach for noninvasive monitoring of diseases from simple teardrop.

2. **Project of the European Commission Research Executive Agency H2020MCRA RISE 2017 „Physical principles of the creation of novel SPINronic materials on the base of MULTI layered metal-oxide FILMs for magnetic sensors and MRAM“, project leader dr. Sigitas Tamulevičius (2018-2021).**

The main goal of the project is the elaboration of research and development principles and technology, as well as creation of novel nanoheterostructures for application in spintronic devices, first of all, in magnetic field sensors and magnetoresistive random access memories. The key research and technological aspects are focused on the formation of layers and/or nanosized grains of a ferromagnetic material with an ultimate degree of conduction electron spin polarization, separated by dielectric interlayers.
The project aims as well at the creation of a stimulating and interdisciplinary training partnership, with actors from the academia and private sector, promoting the exchange of ideas, methods, techniques as well as enabling an accelerated technology transfer from science to industry through a continuous collaboration between the stakeholders. Training of the high-level personnel possessing complementary interdisciplinary skills is thus a key issue.

3. **“Evaluation of functional properties of coatings used in CERN accelerators”, funded by Lithuanian Academy of Sciences, in relation to program for cooperation with CERN, project leader dr. Sigitas Tamulevičius (2018)**.

This work aims to optimize the functional properties of coatings used in CERN accelerators. In order to optimize the technology for the production of superconducting Nb and amorphous carbon coatings, different density coatings will be investigated using X-ray reflectometry. In order to optimize the secondary electron emission in accelerators amorphous carbon coatings suppressing the emission will be studied, the hypothesis that the low secondary electron emission factor of these coatings is related to the formation of additional energy states at the edge of the band tail will be tested.

The studies will quantify the values of coefficient of secondary electron emission for the amorphous carbon of the various technologies, the recommendations for technologies of amorphous carbon coatings and niobium coatings will be formulated.

4. **This research project „Multifunctional coatings based on ZnO nanowires for selective sensing and efficient solar harvesting“ (MultiFun) 01.2.2-LMT-K-718-02-0011 is funded by the European Regional Development Fund according to the 2014–2020 Operational Programme for the European Union Funds' Investments, under measure's No. 01.2.2-LMT-K-718 activity "Attracting Foreign Researchers for Research Implementation"; project leader dr. Simas Račkauskas (2018- 2022).**
   Together with the Faculty of Mathematics and Natural Sciences.

Large scale assembly of nanowires (NWs) into functional materials remains a problem, since NW synthesis is mostly limited by the surface of growth, hindering their wide application. Moreover, many applications require properties, which are contradictive and therefore could not be effectively realized in a single material. This project will develop multifunctional coatings based on ZnO nanowires. Novel method for the high yield production of ZnO NWs will be developed and implemented. The application of such coatings will be targeted for 2 state-of-the-art performance devices: a) a multifunctional anti-reflecting coating on solar cell, which not only lowers the reflectance and increases solar cell efficiency, but also repels water, degrades the organic pollutants, down-shifts the UV to better fit the solar spectra, simultaneously protecting from UV; b) multifunctional gas sensor array, sensitive and selective to gases, activated by light, therefore uses low power and can be used wirelessly. Both devices can be printed on any surface and used for stretchable electronics. Novel methodologies will be used: NW functionalization will be investigated by the in situ environmental transmission electron microscopy (ETEM), experimental data will be analyzed with the Design of Experiment (DoE) method in order to find interactions among functionalized ZnO NW properties.
Novel synthesis equipment for the high yield synthesis of ZnO NWs will be developed and adapted in KTU. Since ZnO NWs show promise in other fields (i.e. electronics, drug delivery, etc.) this equipment and gained experience will be used in the future projects and will enable development of related products after completion of the project. Developed ZnO NW coatings for solar cells and sensors through KTU partnering companies and other contacts, will be presented to stakeholders, seeking for commercial application. KTU will be responsible for the protection of the intellectual property gained during the project and will take care of the patent servicing and licensing.

NATIONAL

1. **Project of the Lithuanian Research Council program Improvement of researchers' qualification by implementing world-class R&D projects "Development of advanced self-healing composites for new generation touch-sensitive screens", project leader dr. Algirdas Lazauskas (2018-2021).**

This project is aimed to improve touch-sensitive screen technology via development of flexible, optically transparent, electrically conductive and self-healing multilayered composite, which would replace ITO coated glass. The first layer would consist of electrically conductive polymer with conjugated double bonds while the second layer - an optically transparent polymer with self-healing function. The surface of the second layer (outer layer) would be coated with a thin film exhibiting

superhydrophobic and superoleophobic properties. The use of suggested composite would ensure the mobile device flexibility, regeneration of the screen and significantly enhance the impact resistance. Additionally, it would allow to eliminate complex and expensive ITO coating formation processes.

2. **Project of the Lithuanian Research Council program Improvement of researchers' qualification by implementing world-class R&D projects "Heterostructures and Superlattices of the Graphene and Related Carbon 2D Nanomaterials for Photovoltaics", project leader dr. Šarūnas Meškinis (2018-2021).**

The proposed project is related to the development of the new nanomaterial synthesis technologies. That is a direct synthesis of the doped graphene and graphene superlattices on the semiconductor substrates by vacuum and plasma methods. Structure, chemical composition, optical, electrical and photovoltaic properties will be studied. Possibility to apply newly developed nanomaterials for fabrication of the higher efficiency solar cells will be considered.

3. **This project „Creation and Development of innovative optical security devices and next generation micro/nano devices and structures for optical applications" (01.2.2-CPVA-K-703-02-0014) is funded by the European Regional Development Fund according to the 2014–2020 Operational Programme for the European Union Funds' programme priority "Strengthening Research and Development and Innovation" activity "Strengthening of Activities of Competence Centres' and Innovation and Technology Transfer centers' " under measure No. 01.2.2-CPVA-K-703; project leader dr. Sigitas Tamulevičius (2018-2021).**

It is planned to carry out systematic research ensuring the verification of commercially-available concepts, the development of micro-technologies and the development and implementation of innovative products. During the project the following activities will be carried out: originals of special security means by integration of digital holograms using method of continuous wave and pulsed laser radiation; nano texts and direct hologram image formation on the surface of materials; the application of local ultra-short laser pulse effects for the formation of micro-images by local manipulation of the optical properties of capillary deposited precisely arranged nano / microparticles; investigation of diffraction optical elements and microfluidic devices for optical applications; the application of laser interference and electron beam lithography for the development and implementation of new security means.

4. **European Social Fund under the measure No 09.3.3- LMT-K-712 „Development of Competences of Scientists, researchers, other Researchers and Students through Practical Research Activities" funded project „Overview of Applications for the Kelvin Probe Force Microscopy Method", Nr. 09.3.3-LMT-K-712-09-0079, supervisor – assoc.prof. dr. Asta Guobienė (2018).**
   Together with the Faculty of Mathematics and Natural Sciences

Project aims to improve scientific qualification of students and scientists through practical scientific activity. The students implement scientific activities during summer practices in order to obtain abilities and improve scientific capacity.
Student will learn scanning probe microscopy methods for surface analysis, concentrating on Atomic Force Microscopy and Kelvin Probe Microscopy methods. Development of practical skills in scanning probe systems, development of analysis and generalization of the results obtained are expected.

5. **European Social Fund under the measure No 09.3.3- LMT-K-712 „Development of Competences of Scientists, researchers, other Researchers and Students through Practical Research Activities“ funded project „Annealing of the hydrogenizated amorphous carbon nanocomposites with embedded Cu nanoclusters: study and application for direct synthesis of the graphene“, No. 09.3.3-LMT-K-712-09-0045, supervisor – Senior Researcher, dr. Šarūnas Meškinis (2018).**
   Together with the Faculty of Mathematics and Natural Sciences

Project aims to improve scientific qualification of students and scientists through practical scientific activity. The students implement scientific activities during summer practices in order to obtain abilities and improve scientific capacity.
Student will investigate the influence of thermal heating on the structure of amorphous carbon nanocomposites with copper nanoparticles and possibilities to use these films for direct graphene synthesis and formation of silicon based diodes.

6. **European Social Fund under the measure No 09.3.3- LMT-K-712 „Development of Competences of Scientists, researchers, other Researchers and Students through Practical Research Activities“ funded project “Investigation of different geometry silver nanoparticles for SERS sensors”, No. 09.3.3-LMT-K-712-09-0058; supervisor – Assoc. Prof. dr. Asta Tamulevičienė (2018).**

Together with the Faculty of Mathematics and Natural Sciences

Project aims to improve scientific qualification of students and scientists through practical scientific activity. The students implement scientific activities during summer practices in order to obtain abilities and improve scientific capacity.
Student will investigate the different geometry silver nanoparticles as a platform for Surface Enhanced Raman Scattering (SERS) sensors, he will get acquainted with the Raman scattering spectroscopy measurement technique and analysis of the results.

7. **European Social Fund under the measure No 09.3.3- LMT-K-712 „Development of Competences of Scientists, researchers, other Researchers and Students through Practical Research Activities“ funded project “Modeling of microstructures for optical applications“, No. 09.3.3-LMT-K-712-09-0053, supervisor – Prof. dr. Tomas Tamulevičius (2018).**
   Together with the Faculty of Mathematics and Natural Sciences

Project aims to improve scientific qualification of students and scientists through practical scientific activity. The students implement scientific activities during summer practices in order to obtain abilities and improve scientific capacity.
Student will expand his knowledge in modelling of periodic structures devoted for increasing the efficiency of light sensors in near infrared wavelength region.

8. **European Social Fund under the measure No 09.3.3- LMT-K-712 „Development of Competences of Scientists, researchers, other Researchers and Students through Practical Research Activities“ funded project “Investigation of materials and structures used for capillary assisted deposition of nanoparticles”, No. 09.3.3-LMT-K-712-09-0054, supervisor – Prof. habil. dr. Sigitas Tamulevičius (2018).**
   Together with the Faculty of Mathematics and Natural Sciences

Project aims to improve scientific qualification of students and scientists through practical scientific activity. The students implement scientific activities during summer practices in order to obtain abilities and improve scientific capacity.
Student will investigate different surfactants and colloids used for the formation of micro and nano sized objects, he will evaluate the influence of microrelief and its shape on the values of contact angle and capillary deposition processes.

9. **European Social Fund under the measure No 09.3.3- LMT-K-712 „Development of Competences of Scientists, researchers, other Researchers and Students through Practical Research Activities“ funded project “ Formation of anodic aluminia membrane structures and investigation of properties by X-ray diffraction”, No. 09.3.3-LMT-K-712-09-0077, supervisor – Assoc. Prof., dr. Brigita Abakevičienė (2018).**
   Together with the Faculty of Mathematics and Natural Sciences

Project aims to improve scientific qualification of students and scientists through practical scientific activity. The students implement scientific activities during summer practices in order to obtain abilities and improve scientific capacity.
Student will expand his knowledge in formation of porous anodic aluminum oxide and will investigate the structure of the formed samples using X-ray diffraction.

10. **Project „Synthesis and characterization of silver nanoparticles devoted for the enhancement of Raman scattering signal“ (nanoSERS) 09.3.3-LMT-K-712-10-0219 is funded by EU Structural Funds according to the 2014–2020 Operational Programme for the European Union Funds' Investments priority "Development of scientific competence of researchers, other researchers, students through practical scientific activities" under Measure No. 09.3.3-LMT-K-712; project leader dr. Asta Tamulevičienė (2018- 2019).**
    Together with the Faculty of Mathematics and Natural Sciences.

Project task – to synthesize silver nanoparticles employing polyol synthesis route and investigate Raman scattering signal enhancement.
Chemical polyol synthesis of silver nanoparticles will be assimilated, synthesized nanoparticles will be analyzed employing optical and microscopical methods. Optimal synthesis parameters (temperature, synthesis duration, etc.) will be chosen to ensure the monodispersity of nanoparticles. Results will be presented in scientific conference.

11. **Project „Development of technologies for optical lithography masks origination employing direct laser writing and ablation with femtosecond laser“ (LaserMask) 09.3.3-LMT-K-712-10-0214 is funded by EU Structural Funds according to the 2014–2020 Operational Programme for the European Union Funds' Investments priority "Development of scientific competence of researchers, other researchers, students through practical scientific activities" under Measure No. 09.3.3-LMT-K-712; project leader dr. Tomas Tamulevičius (2018- 2019 m.)**
    Together with the Faculty of Mathematics and Natural Sciences.

In many cases where microlithography is employed the patterned microstructures are in the range of tens of micrometres and it is in the range of UV masks lithography resolution. It is a high throughput parallel exposure technique but the main bottle neck of the particular method is unavoidable need of masks. The later ones are usually produced employing higher resolution lithography technologies that as a rule of thumb are time consuming and expensive. Each new pattern in UV lithography requires

new set of masks. Direct laser writing or focused laser beam ablation are perfect candidates for originating of the mask with a resolution at least of few micrometres.
The aim of this practice is to propose alternative UV lithography mask origination methods employing direct laser writing and femtosecond laser ablation technologies. Student will get acquainted with the methods and will describe the technological recipes for originating of the masks. The student will evaluate the quality of the patterned mask and microstructures patterned with UV mask lithography.
After carrying out the practice, student will prepare a manual for the UV lithography mask origination employing direct laser writing and femtosecond laser ablation. The scientific results gained during the practice will be presented in national or international conference.

12. **Project „Femtosecond laser ablation of diamond like carbon nanocomposites with silver nanoparticles“ (fsDLC) 09.3.3-LMT-K-712-10-0217 is funded by EU Structural Funds according to the 2014–2020 Operational Programme for the European Union Funds' Investments priority "Development of scientific competence of researchers, other researchers, students through practical scientific activities" under Measure No. 09.3.3-LMT-K-712; project leader habil. dr. Sigitas Tamulevičius (2018- 2019 m.)**
    Together with the Faculty of Mathematics and Natural Sciences.

Project task – to get acquainted with clean room technologies and formation of DLC:Ag nanocomposites, modify nanocomposites employing ultrashort laser pulses and analyze the particle size distribution.
During practice, student will get acquainted with clean room technologies and formation of DLC:Ag nanocomposite films. Ag nanoparticle size distribution before and after applying ultrafast laser pulses will be determined using microscopical methods (SEM, AFM). Results will be presented in scientific conference.

13. **Project „Annealing of the amorphous carbon and nickel nanocomposites: study and application for direct synthesis of the graphene“ 09.3.3-LMT-K-712-10-0225 is funded by EU Structural Funds according to the 2014–2020 Operational Programme for the European Union Funds' Investments priority "Development of scientific competence of researchers, other researchers, students through practical scientific activities" under Measure No. 09.3.3-LMT-K-712; project leader dr. Šarūnas Meškinis (2018- 2019 m.)**
    Together with the Faculty of Mathematics and Natural Sciences.

The graphene is one of the most prominent 2D nanomaterials. It exhibits very interesting properties. Particularly, phenomenal electron and hole mobilities, charge multiplication, flexibility, transparency, chemical inertness can be mentioned. Graphene is an excellent Schottky contact material: graphene and silicon Schottky contact (heterojunction) infrared (IR) radiation photodetectors (photodiodes) exhibits large sensitivity (an order of magnitude larger than any other metal/Si Schottky contact photodiode to date). Graphene Schottky contacts are formed on silicon by transfer method. Graphene is grown on Cu and Ni foil or is exfoliated. The next step is long graphene transfer process on semiconductor or insulator surface. It is complicated technology which inhibits control of graphene/silicon contact properties. In the present work experiments on amorphous carbon transition to graphene will be conducted by heating amorphous carbon and nickel nanocomposites (instead of heating amorphous carbon and nickel bilayer).
The aim of this research is to investigate influence of heating on amorphous carbon and nickel nanocomposite structure and application of such method for direct synthesis of graphene as well as formation of the graphene (carbon) and silicon diodes.

Carbon and nickel nanocomposites of the different structure and composition will be formed by using magnetron sputtering technique.
To achieve direct graphene synthesis on semiconductor substrates, Raman scattering spectroscopy will be used to investigate annealing effects on carbon phase structure.
Selected samples will be used to form graphene and silicon (carbon) diodes (heterojunctions). Diode electric and photoelectric properties will be investigated.

14. **Project „Surface modification of the titanium alloy dental implants formed by an additive manufacturing technique“ 09.3.3-LMT-K-712-10-0132 is funded by EU Structural Funds according to the 2014–2020 Operational Programme for the European Union Funds' Investments priority "Development of scientific competence of researchers, other researchers, students through practical scientific activities" under Measure No. 09.3.3-LMT-K-712; project leader Assoc. Prof. Dr. Brigita Abakevičienė (2018- 2019 m.)**
    Together with the Faculty of Mathematics and Natural Sciences.

Osteointegration is referred to as the direct interaction between the bone and implant, which does not involve other tissues. Bone integration is called when there is no reciprocating rotating or moving motion between the implant and the bone. In this practice work, the titanium alloy surface structure formed during additive manufacturing production will be modified using two surface treatment technologies: sandblasted and acid etched.
During the practice, the student will acquire practical abilities to use by oneself of sand and chemical acid etching, and will also work independently with a contact surface roughness profile and an irrigation angle measuring bench.

Self-supporting projects

1. **Interreg BSR program project „Transnational Research Access in Macro-Region – Baltic TRAM" (project No.: R002) "Development of Advanced Optical Security Device", Contract No.: 18-01/1, project leader dr. Viktoras Grigaliūnas (2018).**

This project presents an advanced optical security device created by combining the dot-matrix and electron beam lithography techniques in a single master image. Patterning of holopixels arranged with different grating orientations and pitches was done using a dot-matrix master shooting machine equipped with a laser diode PMMF 608-G operating at a wavelength of 405 nm. For the patterning of nanotext and diffraction gratings in the specified areas of the same sample we have used Raith eLiNEplus high resolution electron beam lithography and ultra high resolution imaging & analysis system. The ratio of areas patterned by dot-matrix technique and e-beam lithography is about 16:1, thus relatively more expensive and slower e-beam writing time was not very large to form a combined image. The layout of combined image was investigated by optical, scanning electron and atomic force microscope. It was shown, that e-beam patterned gratings have smooth and steady edges, while the slopes and the ridge surface of the dot-matrix patterned gratings are inclined and uneven. Measurements showed differences in spatial frequency and shape of the grooves as well as profile depth between the e-beam and dot-matrix patterned gratings. This differences can be easily recognized at the expert level, thus providing a very high security degree and preventing counterfeiters.

2. **„Testing of microhardness and impact-resistance of LCD screens" (Kaunas Science and Technology Park), Contract No. 18-10/3-SV9-1995 2500 Eur. Project leader dr. Viktoras Grigaliūnas (2018).**

The scratch- and impact-resistance of various model LCD screens coming from different manufacturers have been compared in this study using the progressive load scratch test and falling weight micro-impact testing. It was revealed, that the scratch width and depth somewhat varies for various models of LCD screens. Under minimum load of 1.2 N, scratches are almost invisible to the naked eye in the iPhone 6S Plus (A), S8 (A) and S7 Edge (A) models, whereas scratches become clearly visible in the all types of investigated specimens, when the load increases to 7.1 N. It was established that iPhone 6S Plus (A) and S6 Edge (O) models are more impact-resistant than S8 (A), S7 Edge (A), J710 (O) and J530 (O) glasses. Force vs. time diagram for iPhone 6S Plus (A) glass. showed similar elastic properties to that seen for the S8 (A) glass, as similar amount of energy was absorbed through non elastic mode. Force vs. time diagrams of LCD glasses impacted with different kinetic energies showed that the J710 (O) and J530 (O) glasses have a higher elasticity than other models, while the impact-resistance of these two models is the worst from the all tested screens.