Topics for dissertation thesis for the academic year 2015/2016 at the Faculty of Science UJEP.

1. Chemical modification of surfaces of variol type sof substrates, thein characterization and tests of their bioactivity.

Supervizor: Doc. Ing. Zdeňka Kolská, Ph.D., PřF UJEP Ústí nad Labem
Contact: Zdenka.Kolska@ujep.cz

Annotation: Experimental studies - surfaces of different types of substrates will be the chemically modified in order to create bioactive functions. Modified surfaces will be subsequently characterized by special techniques (goniometry, electrokinetic analysis, BET surface area, XPS, or eventually by XRD in special cases). Microbial tests will be realized on modified surfaces to test their bioactivity (the algal inhibition, antibacterial activity etc.).

2. The study of biological effects of new types of carbosilane dendrimers

Supervizor: RNDr. Jan Malý, PhD, PřF UJEP Ústí nad Labem
Contact: malyjalga@seznam.cz
Consultant: RNDr. Marek Malý, PhD

Annotation: The aim of this project is to study the effect of type, generation and and surface modification of carbosilane denrimeric nanoparticles on interaction with model biological membranes (liposomes, sBLM, cell membranes) and the selected cell cultures biomacromolecules (peptides, nucleic acids). Materials will be prepared with regard to their potential biomedical uses, i.e. in targeted drug delivery and diagnostics and characterized by biophysical methods (e.g. fluorimetry spectroscopy, atomic force microscopy, fluorescence microscopy, dynamic light scattering, the determination of the electro-kinetic potential, electrophoresis) and by cytotoxicity, transfection studies, flow cytometry, etc

3. New Luminescent Macropolyhedral Boron Hydrides

Supervizor: Dr. Michael Londesborough ÚACH AV ČR Řež u Prahy
Contact: Michaell@iic.cas.cz
Annotation: This project will generate a portfolio of new luminescent borane molecules, polymers and films synthetically designed (on the basis of experimental observations and computational analyses) to increase the laser efficiency of borane materials, thus making them a novel and competitive alternative to the present conjugated carbon-based laser dyes as the active medium for widely tunable laser sources.

4. Development of new types of nanofiber materials for covering superficial wounds

Supervizor: Prof. RNDr. Pavla Čapková, DrSc PřF UJEP
Contact: Pavla.Capkova@ujep.cz
Consultant: RNDr. Jan Malý, PhD, PřF UJEP

Annotation: The goal of research is the development of new types of nanofiber materials intended primarily for medical applications - especially for covering superficial wounds with controlled release of drugs with microbicidal and analgesic effects and tissue culture. Nanofiber textiles will be prepared by electrospinning technique in Nanovia Ltd. preferably from biodegradable materials and subsequently modified by various dendrimeric species in order to achieve a stable, biocompatible material suitable for biomedical applications. These nanomaterials will be studied as suitable carriers for anchoring molecules (dendrimers, peptides) for the controlled release of drugs, and promote adhesion of cells and tissues. Preparation of the nanofiber textiles will take place in Nanovia Litvinov, modification of nanofiber textiles and their subsequent characterization and testing of their properties will be provided mainly at the Faculty of Sciences UJEP (SEM, FTIR, Zeta-potential, XRD analysis) and selected biological techniques (techniques of cultivation of animal cells, study potential cytotoxicity and antimicrobial effects of nanofibrous materials, etc.). The work will be supported by Nanovia s.r.o. and UJEP in joint project activities.

5. Study of crystalline materials containing nano-particles using RBS-channeling

Supervisor:Doc. RNDr. Anna Macková, PhD. (ÚJF AV ČR)
Contact: tel: 266172102, fax: 220940141, e-mail: mackova@ujf.cas.cz

Annotation: Nano-structure deposition using ion implantation technique is very promising technology nowadays. Rare earth ion implantation into crystalline materials serves as a progressive way to develop new materials with the extraordinary optical and luminescent properties. RBS channeling analytical method is based on the charged particle channeling in the periodic potential of crystalline atom rows. The penetrating ion beam is focused in the forward direction and the back-scattering probability decreases significantly, thus the yield of the back-scattered ions in the spectra is descending function of the incoming beam angle. Following the back-scattered ion yield in dependence to the incoming angle of ions gives us information about the impurity atoms positions, disordered atoms in the interstitials positions etc. The main goal of the proposed work will be the preparation of the nano-structures by means of the ion implantation, characterization of the prepared nano-structures by RBS and RBS channeling and the simulation of ion yields according to the different crystallographic orientations.

6. Axial ion channeling simulation in crystalline materials comparing to experimental data obtained from RBS channeling and PIXE channeling

Supervisor:Doc. RNDr. Anna Macková, PhD. (ÚJF AV ČR)

Contact: tel: 266172102, fax: 220940141, e-mail: mackova@ujf.cas.cz

Annotation: RBS channeling analytical method is based on the charged particle channeling in the periodic potential of crystalline atom rows. The penetrating ion beam is focused to the forward direction and the back-scattering probability decreases significantly, thus the yield of the back-scattered ions in the spectra is a descending function of the incoming ion beam angle. Following the back-scattered ion yield in dependence to the incoming angle of ions gives us information about the impurity atoms positions, disordered atoms in the interstitials positions etc. Precise information about the investigated structural changes can't be provided without the MC simulation, where the binary collisions approximation with the close encounter probability calculation is used. FLUX is a batch of routines, which enables to simulate ion flux, ion momentum and energy for the various crystallographic orientations, enables to generate the spectrum of back-scattered ions in dependence of the incoming ion beam angle (angular scans). Using above mentioned features the positioning of dopants in the crystalline materials can be done. The simulations will be realized for the real data obtained from our previous research.

7. Functional nanomaterials for optics, photonics and spintronics prepared by ion implantation

Supervisor: Doc. RNDr. Anna Macková, PhD. (ÚJF AV ČR)
Contact: tel: 266172102, fax: 220940141, e-mail: mackova@ujf.cas.cz

Annotation: The main goal of this work will be the study of new, progressive materials for optical applications based on carbon structures. The structural changes, new doping technologies will be used to modify the carbon based structure to get the new optical and electrical properties. The important task will be the preparation of the thin polymeric or carbon based optical active structures. In the prepared structures will be studied the structural changes, compositional changes and dopant profiles using nuclear analytical methods (RBS, ERDA and PIXE) and the consequences of above mentioned to the electrical and optical properties.

8. Ion microprobe application on characterization and modification of materials

Supervisor: Doc. RNDr. Anna Macková, PhD. (ÚJF AV ČR)
Contact: tel: 266172102, fax: 220940141, e-mail: mackova@ujf.cas.cz

Annotation: Nuclear analytical methods have very broad field of applications as the characterization of thin layers, aerosols, archaeological artefacts, biological and geological science application. Ion microprobe is a beam of energetic ions which is focused using special ion optics to the 1 micrometer dimension. Ion microprobe enables us to provide a lateral scanning and to realize a qualitative and quantitative analysis by RBS (Rutherford Backscattering Spectroscopy), PIXE (Particle Induced X-ray Emission), PIGE (Particle Induced Gamma-ray Emission) and STIM (Scanning Transmission Ion Microscopy) with lateral resolution better than 1 micron. The main goal of this work will be the development and implementation of nuclear analytical methods under the condition of the simultaneous analysis using either broad or focused ion beam. Further will be work focused on the modification of materials using focused heavy ion beam (Ion Beam Writing) and software development for this task.

9. Creation of nanostructures using ion and electron beam

Supervisor: RNDr. Jan Lorinčík, PhD. (Centrum výzkumu Řež, s.r.o.)
Consultant: Doc. Ing. M. Kormunda, PhD.
Contact: e-mail: jan.lorincik@cvrez.cz

Annotation: During the PhD study the student will learn about modern nanotechnological methods of the direct writing and growing of nanostructures on the surfaces of semiconductor and photonic materials by using the techniques of ion and electron beam induced deposition (IBID/EBID) and ion and electron beam induced etching (IBIE/EBIE). A part of the PhD work will be a computer modelling of ion- or electron-solid interaction. The goal of the work is (1) the finding of new precodures that will improve the quality of the created nanostructures, (2) the search for new aplications of the techniques. The following instrumentation is available for the study: a FIB-SEM (scanning electron microscope with a Ga ion beam) equipped with EDX (Energy Dispersive X-ray), WDX (Wave Dispersive X-ray), EBSD (Electron Backscattered Difraction), GIS (Gas Injection System) and a nanomanipulator.

10. Analysis of nanostructures using FIB SIMS method

Supervisor: RNDr. Jan Lorinčík, PhD. (ÚFE AV ČR, v.v.i.)
Contact: e-mail: lorincik@ufe.cz

Annotation: During the PhD study the student will learn modern about an innovative combination of Scanning Electron (SEM) and Ion Microscopy (FIB SIMS) and its application to the analysis of nanostructured materials. A part of the PhD work will be a computer modelling of ion and electron trajectories in the microscope. The goal of the work is (1) the finding of new procedures that will lead to the improvement of analytical capabilities of the FIB SIMS technique, (2) the search for new aplications of the technique. The following instrumentation is available for the study: a FIB-SEM (scanning electron microscope with a Ga ion beam) equipped with GIS (Gas Injection System), a Time-of-flight (TOF) mass spectrometer and a nanomanipulator.

11. Structure and properties of nanofiber textile prepared by electrospinning

Supervizor: Prof. RNDr. Pavla Čapková, DrSc PřF UJEP
Contact: Pavla.Capkova@ujep.cz

Annotation: Research will focus on the relationship of technology-structure-properties of polymeric nanofiber textiles prepared by electrospinning - NANOSPIDER technology with an emphasis on structure analysis using the combination of X-ray diffraction, SEM and TEM microscopy and IR spectroscopy depending on the parameters of the electrospinning. Correlation of technological parameters and structures will be investigated with respect to

the possibility of further chemical and physical modification of nanofiber textiles for the preparation of antibacterial and pharmacologically active materials for biomedical use and for a filter media of a new generation.