APPLIED HYBRID MATERIALS

Course Workload		Assessment form (examination/ graded test/ ungraded test)
ECTS	Hours	
6	216	Exam

This course is devoted to the current state of rapidly developing areas of nanotechnology, material science, biophysics and others. It discusses the modern techniques of nano- and microparticle synthesis and their stabilization via polymer coating. Moreover, the methods of nano- and microparticles characterization such as electron and optical microscopy, dynamic light scattering, laser Doppler anemometry and others will be presented. As a major part of this course, application of different discussed materials in biology, medicine, optics etc. will be reviewed. Additionally, the general introduction in a “Lab-on-a-chip” concept will be explained.

Course structure:

1. INTRODUCTION IN APPLIED HYBRID MATERIALS
    1.1. Brief history of hybrid materials.
    1.2. Definition of hybrid materials and types of hybrid materials.

2. SYNTHESIS OF ORGANIC/INORGANIC NANOPARTICLES
    2.1. Mechanism of particles formation, chemical interactions typically applied in hybrid materials.
    2.2. Different technology of synthesis: sol-gel process, ligand-assisted reprecipitation, etc.

3. POLYMER COATING OF NANOPARTICLES WITH SMART MATERIALS, APPLICATION IN OPTICS AND MEDICINE
    3.1. Mechanisms of pNIPAM, silica particles coating, such as Layer-by-layer deposition.

4. METHODS OF NANOPARTICLES CHARACTERIZATION
    4.1. Scanning, electron microscopy, X-ray diffraction, FTIR-spectroscopy, NMR-spectroscopy, X-ray photoelectron spectroscopy.
    4.2. Thermogravimetric analysis, Differential scanning calorimetry, Dynamic light scattering, Laser Doppler Anemometry, Confocal Laser Scanning Microscopy.

5. INTERACTION OF NANOPARTICLES WITH CELLS
    5.1. Cell staining techniques, Flow cytometry.

6. INTERACTION OF NANOPARTICLES WITH ANIMALS

6.1. Cell-based therapy, Regenerative medicine.

7. MICROFLUIDICS I: INTRODUCTION, METHODS OF MICROFLUIDICS, GENERAL DEFINITIONS

7.1. Brief history of microfluidics as a Science field, definition of microfluidics, main application and the origin of microfluidics.

8. MICROFLUIDICS II: THEORETICAL BASICS AND APPLICATION OF MICROFLUIDICS

8.1. Theoretical basics of microfluidics, such as Navier-Stokes equation, characteristic numbers and related definitions, basics of droplet microfluidics, and surface tension.

8.2. Capabilities of microfluidics, microfluidics at our Department.