DESCRIPTION FOR THE GENERAL PUBLIC

Development and tailoring of novel nanomaterials for photonic devices such as optical biosensors is an important challenge of modern science and cutting-edge technology due to their superior performance compared to conventional microelectronic devices. Optical biosensors become more attractive for end-users due to small dimensions, lightweight and portability. Furthermore, optical devices do not require electric contacts and demonstrate high precision in measurements. The efficiency of nanomaterials mainly originates from the high surface-to-volume ratio. Large surface area, porosity, topography, morphology and surface functionality improve the sensing properties of the material and strengthen between surface and adsorbate (analyte). Among various types of nanostructures, porous silicon (PSi) nanocomposites have been intensively applied in different fields, such as in catalysis, sensor, Li ion batteries, DNA sensing, and optics, due to their superior properties induced by quantum confinement effects. These nanocomposites are composed of the infiltrated materials (e.g. metal oxide – MOx) which enhance or introduce new desired properties and the PSi matrix. The fabrication of PSi / MOx nanocomposites, as well as the study of their physical/chemical properties will explore a development of new functional materials with high surface area and advanced properties for applications in bio-photonics, nanoelectronics or catalysis.

Our **research hypotheses** is that combination of highly porous media, like PSi, and metal oxide (e.g. ZnO) nanostructures embedded in the PSi matrix will induce new structure, electrical and optical properties at PSi-ZnO interface, such as amorphous-to-crystalline phase transitions, strain-induced effects, quantum confinement effects (blue shift of band gap, quantum confinement of electrons in ultrathin ZnO nanolayers) and room temperature photoluminescence. The thickness of ZnO nanolayers (2-20 nm) will guarantee that all fundamental properties of ZnO will be tailored by the surface effects. Thus, immobilization of biomolecules to form bioselective layer and further adsorption of target biomolecules will make significant changes in optical and electronic properties of the PSi-ZnO nanostructures. The interface and surface driven effects in PSi-ZnO structure could be a platform of novel optical biosensors, what is a recent high developing scientific and technological idea.

The **main goal** of the project will be fabrication and characterization of porous silicon (PSi) – ZnO-based nanocomposite structures for bio-photonic application. In order to obtain the fundamental knowledge about these nanocomposites, a thorough characterization of their structural, chemical and optical properties should be performed.

To achieve specified aim the following **project objectives** are set:

1) To investigate the influence of the tuned morphology by Metal-Assisted Chemical Etching (MACE) PSi structures to structural and optical properties of ZnO-based nanocomposites, deposited by Atomic Layer Deposition (ALD) technique into the PSi matrix.

2) To investigate quantum confinement and phase transition effects in ZnO-based nanocomposites depending on the thickness of ZnO nano layer, deposited into PSi structures and new effects, risen at the ZnO-PSi interface.

3) To form bioselective layer into ZnO-PSi system and investigate its influence to electric and optical properties of ZnO-Psi structure.

4) To investigate sensitive properties of the biofunctionalized ZnO-PSi structure to target biomolecules (DNA) using optical technique (reflectance and photoluminescence)

5) To analyze sensitivity and selectivity of the developed photonic nanomaterials and to propose practical recommendations for use of nanocomposites in optical biosensors.