DESCRIPTION FOR THE GENERAL PUBLIC

Present reason for choosing the research topic

The most formidable challenges for humanity in 21th century are limited fuel sources and pollution of the atmosphere that could be overcame by realization of hydrogen economy. The water splitting process is relatively simple and efficacious method for hydrogen production, but for application at industrial scale it requires a development of cheap and effective photoanodes. As the sun energy is main energy source for water splitting process the required photoanode should be photoactive in full sunlight spectrum. A complex composite nanostructure combined of photoactive and stable in water environment materials could satisfy this requirement. As the most abundant and relatively cheap materials the silicon and metal oxides are well suitable for this purpose.

State the objective of the project

During the water splitting process a decomposition of water into oxygen and hydrogen gases occurs at a specific photoanode under sunlight irradiation. Total efficiency of the process depends on the energy adsorbed through sunlight by the photoanode. The more energy adsorbing by the photoanode, the more intensively chemical reaction at its surface occurs. Therefore, main objective is to obtain a structure that absorbing energy from sunlight effectively and provides high charge separation rate. Such a structure should also be reasonable for economic requirements. An appropriate solution consists in utilizing of silicon, as the most abundant element, but due to fast photodegradation some fundamental problems are arising. Therefore a composite structure based on silicon and protective coverage could be used. As a protective coverage a TiO_2 layer could utilized and additional ZnO admixture will enhance its photoeletrochemical efficiency through inducing a set of intermediate energy states in the band gap.

In order to achieve specified aim of the project the following **objectives** are set:

- to develop porous silicon based nanostructures – PSiNP arrays, combining lithography methods (sphere lithography, photolithography) and MACE;
- to obtain PSiNP with TiO_2 and ZnO coverages using ALD technique;
- to study the structural, optical and electronic properties of the obtained structures depending on $TiO_2$and ZnO layers morphology;
- to investigate the photoelectrochemical efficiency of PSiNP-TiO_2, PSiNP-ZnO and PSiNP-TiO_2/ZnO photoanode for PEC application.

Describe the research to be carried out

All the mentioned objectives will be realized via thorough and comprehensive investigation using SEM, TEM, XRD, Raman, absorbance and reflectance techniques. These measurements will make possible the fine tuning of the PEC parameters in order to achieve the best efficiency results. Examination of the hydrogen production efficiency in water splitting process on PSiNP-TiO_2/ZnO photoanodes will be fulfilled at quartz PEC cell. The PEC cell is rigged with specific electrodes and artificial light energy source.

In order to find the optimal operation conditions the structural properties of PSiNP-TiO_2/ZnO will be changed via sets of routine procedures:

- changing the number of ALD cycles for TiO_2 and ZnO;
- changing the doping level of silicon substrate;
- changing the nanopillar array parameters (width, height);
- porosity control of nanopillar array through MACE conditions.