**Dissertation abstract**

mgr inż. Paweł Mazierski

„Modified $TiO_2$ nanotubes: preparation, characterization and application”

Supervisor: prof. dr hab. inż. Adriana Zaleska Medynska

One of the most important challenges in the field of heterogeneous photocatalysis is the development of a new type of modification of vertically oriented $TiO_2$ nanotubes, photoactive (durable and stable) under the influence of lower energy irradiation (desirable from the visible range). Literature data indicate that the $TiO_2$ nanotubes obtained by anodic oxidation were subjected to various modifications. Nevertheless, there is a need to search for a new and also to develop existing modification methods leading to effective/stable modification of $TiO_2$ nanotubes and the quality of these methods, modifications and modifier morphology may have a key impact on the photoactivity of the obtained materials.

The goal of the dissertation was: *(i)* to develop effective methods for modification of $TiO_2$ nanotubes, exhibiting enhanced photocatalytic properties, especially under the influence of visible irradiation, *(ii)* to explain both the mechanism of their excitation, as well as the mechanism of photocatalytic reactions under the influence of visible irradiation and *(iii)* to correlate the preparation conditions with photoactivity and surface and structural properties. Five series of nanotube layers were obtained: *(i)* $TiO_2$ nanotubes obtained using ionic liquids (EMIM-$BF_4$, BMIM-$BF_4$ and OMIM-$BF_4$) as a structure-forming agent and a precursor of nitrogen and boron, *(ii)* $TiO_2$ nanotubes modified with selected rare earth metals (Er, Yb, Ho, Tb, Gd and Pr) using cathodic deposition, *(iii)* $TiO_2$/$Ag_2O$/Ag nanotube heterojunction obtained by anodic oxidation of Ti-Ag alloys, *(iv)* $TiO_2$ nanotubes internally decorated with co-catalyst in the form of PdO, obtained by anodic oxidation of Ti-Pd alloy and *(v)* $TiO_2$ nanotubes modified with $Bi_2S_3$ quantum dots and Pt nanoparticles using SILAR and photodeposition methods, respectively. The most important factors affecting the photoactivity of the obtained materials under the influence of visible irradiation are: geometric dimensions of nanotubes and their morphology, chain length in imidazole cation of ionic liquid, presence of nitrogen, boron and $Ti^{3+}$, rare earth metal type (preferably Ho), $Ti^{3+}$ content, content of Ag and $Ag_2O$

nanoparticles in the $TiO_2$/ $Ag_2O$/Ag nanotube layer, potential gradient formed on the $TiO_2$/$Ag_2O$/Ag, $TiO_2$/PdO and $TiO_2$/$Bi_2S_3$/Pt heterojunctions as well as the amount of Pt nanoparticles and $Bi_2S_3$ quantum dots. Optimal conditions have caused, among others effective absorption of irradiation and diffusion of components into the nanotube layers and inhibition of recombination processes of photogenerated charge carriers.