Project NCN no. 2015/18/E/ST4/00196

Studies of the interaction of silyl-anchor dyes with metal oxide nanoparticles

The aim of the project is to investigate the interaction between the new type of dyes with silyl anchoring groups and the metal oxide nanoparticles. Recently, excellent efficiency of dye-sensitized solar cells (DSSC) working with the newly proposed dyes with silyl anchoring groups ensuring stronger bonding with the titanium dioxide surface (Si-O-Ti) than the so far used dyes with carboxyl anchoring groups (C-O-Ti) have been reported. The investigation planned will include highly accurate measurements of the rate and yield of different charge separation processes at the dye/ nanoparticle/electrolyte interfaces that contribute to the final current generated in the solar cells. The advanced methods needed to achieve the above include among others time-resolved laser spectroscopy and electrochemical impedance spectroscopy. Our preliminary results have shown that optimisation of charge separation requires a different approach to preparation of the metal oxide nanoparticles than that hitherto used in DSSC.

The new type of dye anchoring to the semiconductor surface has been found to be resistant to the exposure to water, which is in contrast to the earlier dye structures. That is why we plan to test the new dyes as the photoactive elements of the electrodes in the system for water splitting and hydrogen production. The dye-sensitized photoelectrochemical cells will also be studied by the spectroscopic methods in the aspect of the dynamics of processes taking place in them.

The studies will border on a few modern branches of science: nanotechnology, laser spectroscopy, electrochemistry, organic chemistry and physics of semiconductors. The knowledge in the area of photovoltaics and hydrogen fuel production gained in realisation of the project should contribute to increase in the competitiveness of Polish research in the international arena. In particular, we hope that the results obtained in the project will revive the DSSC technology as an alternative to relatively expensive silicon photocells and contribute to development of the technology of hydrogen production from water.