Metal halide perovskites for heterogeneous photocatalysis

For many years, the growing concentration of pollutants in the world, both in the air and water, has been a research topic for a field of science such as environmental engineering. It has been proven that one of the most effective methods of removing harmful impurities and generation of hydrogen which is considered to be the fuel of the future, is heterogeneous photocatalysis, belonging to the group of advanced oxidation methods. The necessary condition for the photocatalytic process is the use of an appropriate photocatalyst. Currently, the most commonly used materials for this purpose, e.g. TiO_2, can be excited only by affecting the system with high-energy from UV-Vis irradiation to achieve satisfactory reaction efficiency. Due to the fact, that almost half of the solar irradiation reaching the surface of the Earth containing the visible irradiation range and only 5% is ultraviolet irradiation, the use of this type of photocatalyst under cheap, sunlight irradiation becomes impossible.

In the recent past, there have been reports in literature about halide perovskite quantum dots and double metal halide perovskites, which have had found application in the production of photosensitive materials due to the fast transfer of charges and effective energy conversion. Furthermore, their unique structural and optical properties, such as high absorption of visible irradiation as well as a narrow band gap between the conduction and valence bands, make this type of semiconductors suitable candidates for photocatalysts in reactions of photocatalytic degradation of pollutants and hydrogen generation. Until now, the application of perovskite quantum dots and double metal halide perovskites for this type of reactions is an unknown area to global science related to research into the production of highly photoactive materials in the range of visible irradiation.

The main aim of this project is **a) to obtain photocatalysts based on quantum dots perovskite structure, composites composed of perovskite quantum dots embedded in a semiconductor matrix oriented in three-dimensional space** and **double metal halide perovskites exhibited high photocatalytic activity under visible irradiation**, **b) to investigate the influence of type, crystal structure, stability as well as optical and surface properties of the obtained materials on their photocatalytic properties and c) to investigate the influence of type and morphology of semiconductor matrix on which quantum dots will be deposited on the properties and photocatalytic activity of obtained composites.** Obtained photocatalysts will be comprehensively analyzed in terms of size, crystal structure, phase composition (XRD technique), microstructure and surface morphology (SEM, TEM analysis), surface area (BET), composition and presence of surface defects (XPS) and optical properties such as the ability to absorb and emit irradiation (UV-Vis spectroscopy and photoluminescence). Photocatalytic activity tests of the obtained nanomaterials under visible and UV-Vis range will be performed in model reactions of photodecomposition of environmental pollutants such as phenol (in the water phase) and toluene (in the gas phase) and in reaction of water-splitting to hydrogen. On the basis of a detailed analysis of kinetics, photocatalytic tests with the participation of appropriate charges scavengers, as well as by determining the influence of irradiation wavelength on the quantum yield of reaction using *Action Spectra* analysis the mechanism of excitation of photocatalysts and the mechanism of photocatalytic degradation of pollutants will be examined.