Description for the general public

With increasing the environmental problems such as wastewater and low quality of drinking water, the research activities mainly focused on the development of novel and effective methods for water purification. Advanced Oxidation Processes (AOP) are of special interest for the treatment of water and wastewater due to their high efficiency in mineralize a great variety of pollutants through the oxidation by generated hydroxyl radicals ($OH^{\bullet}$). Among AOP, many studies have been performed to develop heterogeneous photocatalysis for the purpose of removing toxic organic and inorganic contaminants in air and water solutions. The main advantage of photocatalytic processes is that the organic pollutants are decomposed to the corresponding intermediates and finally mineralized to carbon dioxide and water. However, the photocatalytic efficiency of many photocatalytic materials is limited due to their high recombination of photogenerated electron-hole pairs. Moreover, low photoactivity of photocatalysts limited the commercial application of this process. Therefore, avoiding of recombination of photogenerated carriers is very important for photocatalytic processes. One of the most efficient strategy of enhance the photocatalytic performance is using nanocomposite catalysts instead of single photocatalytic materials. In nanocomposites, electrons and holes can migrate from one component (semiconductor) to another component (other semiconductor, noble metal, transition metal or metal oxide, metal sulphide or carbon material) what causes better separation of photogenerated carriers, reducing their recombination. Therefore, the development of highly efficient photocatalysts, especially visible-light-driven materials is still a hot topic in the field of photocatalysis.

The aim of the presented project is basic research on the synthesis of new spherical core/shell nanocomposites and studies on physicochemical and photocatalytic properties. The activity of produced nanocomposites will be examined via the reaction of photocatalytic decomposition of organic pollutants from water under ultraviolet and visible light irradiation. The nanocomposites will be composed of mesoporous core of titanium dioxide (TiO_2), graphitic carbon nitride ($g\text{-}C_3N_4$) and carbon and shell of TiO_2 or $g\text{-}C_3N_4$. The different compositions of core/shell structures such as $m@TiO_2/g\text{-}C_3N_4$, $m@g\text{-}C_3N_4/TiO_2$, $m@C/TiO_2$ and $m@C/g\text{-}C_3N_4$ and core/shell/shell structures consist of two shells ($m@C/TiO_2/g\text{-}C_3N_4$ and $m@C/g\text{-}C_3N_4/TiO_2$) will be synthesized. The combination of TiO_2, $g\text{-}C_3N_4$ and carbon into core/shell structures present a feasible route towards improving charge separation in the electron-hole transfer process. Therefore, the proposed nanocomposites will be a good catalysts for photocatalytic decomposition of organic pollutants. Moreover, the effect of doping the above mentioned core/shell materials with various transition metals (for example Fe, Ni, Co, Ag and Pd) on their physicochemical properties and photocatalytic activity will be studied in order to further increase of photocatalytic activity of the produced materials. The systematic studies will clarify the mechanisms of separation of electrons and holes between different components of nanocomposites and mechanisms of photocatalytic reactions in the presence of synthesized nanocomposites under visible and ultraviolet light irradiation. The scientific results obtained during the realization of the respective research tasks will be popularized by publishing in high quality international journals and presenting during national and international conferences. Additionally, the PhD student will perform the research tasks present PhD thesis.