- 2018/31/B/ST5/03292 [2019-2022] Nowe kompozyty smektytów z nanocząstkami TiO2 otrzymanymi metodą odwróconej mikroemulsji do zastosowań fotokatalitycznych - prof. E. Serwicka-Bahranowska

The scientific aims of the project are: a) to obtain TiO_2/clay composites according to a novel design based on the synthetic procedure employing exfoliated organoclays and inverse microemulsion of Ti-based nanoparticles, and (b) to test the newly engineered materials as photocatalysts for purification of water from organic pollutants. Since the discovery in 1972 of the photocatalytic decomposition of water on TiO_2 photoelectrode, titania is the most investigated photocatalytic material, due to suitable positions of valence and conduction bands, its chemical and photocatalytic stability, relative ease of manufacturing, low price, and biological inertness, which makes it safe for the ecosystem. However, owing to the large band gap, TiO_2 may utilize only a small fraction of the solar radiation. Strategies for improving photocatalytic efficiency of TiO_2 involve either structural or compositional modification, and the project addresses both these routes. The novelty of the idea consists in combining the synthetic chemistry involved in the preparation of organoclays, with the inverse micellar route of producing oxide nanoparticles in an organic medium, to yield new type of TiO_2/clay composites, made of oxide nanoparticles trapped between the smectite layers. The proposed procedure offers a number of possibilities for control of composite properties via a) changing the type of clay, b) changing the organocation, c) modification of oxide nanoparticles size by appropriate choice of the microemulsion synthesis parameters. Moreover, inverse microemulsion method enables synthesis of multicomponent oxides, which opens way for chemical modification of TiO_2 nanoparticles. All these options will be investigated during the project implementation. Thus, natural dioctahedral clay mineral, montmorillonite, and synthetic trioctahedral clay, Laponite, will constitute the chief clay components to be investigated. The use of alkylammonium and alkylphosphonium organocations is foreseen. Optimization of inverse microemulsion method will include control of oil-to-water and water-to-surfactant ratio, nature of surfactant and cosurfactant, reagent concentrations, etc. Chemical modification of titania will involve doping within the TiO_2 structure and/or coupling with other semiconducting nanoparticles. The new TiO_2/clay composites will be tested for application as photocatalysts in reactions aiming at degradation of organic pollutants in water. Water soluble dyes and acidic organics will be the chief target, as both groups of compounds are easily discharged into rivers and sewers, leading to the contamination of the environment. The novel photocatalysts, although targeting specific reactions, may prove active in a number of other photocatalytic processes. Moreover, the expected development of new methodologies for photocatalysts syntheses is of importance for all areas of materials engineering and applied mineralogy which require manufacturing of composites containing oxide nanoparticles with tunable properties.