The project presents research program aiming at design and synthesis of a new type of photocatalysts, i.e., substances which can accelerate chemical reactions when exposed to irradiation with light. Since the discovery, in early seventies, of the possibility of water splitting into hydrogen and oxygen in the presence of irradiated titanium dioxide, $TiO_2$ remains the most investigated photocatalytic material. This is due to its chemical and photocatalytic stability, electronic structure suitable for the occurrence of photocatalysis, relative ease of manufacturing, low price, and biological inertness, which makes it safe for the ecosystem. The only drawback in the context of practical applications is that $TiO_2$, in order to initiate a photocatalytic effect, has to absorb photons of high energy, such a those associated with ultraviolet radiation, which accounts for only few % of the solar spectrum. 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 proposed research consists in the integration of two synthetic procedures, both requiring organic medium: one related to the synthesis of organic derivatives of smectites, kind of layered minerals, and their delamination, the other enabling formation of oxide particles within nanodroplets of water dispersed in an organic liquid, in the so-called inverse microemulsion. The process will result in a new type of $TiO_2$/smectite composites, made of oxide nanoparticles trapped between the smectite layers, with tunable properties, including, among others, control of oxide nanoparticles size. Moreover, inverse microemulsion method enables synthesis of multicomponent oxides, which opens way for chemical modification of $TiO_2$ 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 made of oxide nanoparticles with tunable properties.