The objective of the project is to develop a new strategy in relation to functionalized structures based on shape-controlled metal oxides. Heterostructures of TiO_2@Cu_2O (or TiO_2@Fe_2O_3) will be the main subject of this study. The project aims to improve the present understanding of the impact of processing conditions on the basic relationships between the different shapes of TiO_2 nanocrystals and the composition of metal oxide structures as well as their photoelectrochemical and photocatalytic properties. For a better understanding of this issue, the photoelectrochemical/photocatalytic behavior of morphology-controlled TiO_2 crystals with specific exposed surfaces will be compared to that of functionalized TiO_2@Cu_2O (TiO_2@Fe_2O_3) structures. The scientific problem to be solved is the development of new functionalized structures based on shape-controlled metal oxides, capable of suitable performance in the photocatalytic decomposition of water and organic pollutants.

The hydrothermal method will be applied for the synthesis of TiO_2 NCs. The following techniques will be used to modify the facets of TiO_2 crystals: the ionic layer adsorption and reaction (SILAR) routine and the hydrothermal process, which will be used to create particles/the coating shell. The materials – pure and functionalized TiO_2 NCs – will be characterized using standard techniques, namely XRD, TG/DTA, BET, Raman and IR spectroscopy, electrochemical impedance spectroscopy EIS, optical spectrometry, SEM, AFM, TEM, as well as XPS. Based on the combination of electrical and optical properties, XPS and electron work function analysis, the electronic structure of TiO_2@Cu_2O (TiO_2@ Fe_2O_3) systems will be proposed. Understanding the mechanism of interaction with light will provide new insight into the performance of photoanodes/photocatalysts.

The significance of this project is its contribution to the science of materials with respect to the physico-chemical properties of composites in general, and heterostructures of TiO_2@Cu_2O (TiO_2@ Fe_2O_3) in particular. The research proposal is interdisciplinary in character and covers chemistry, materials science, physics of advanced materials, renewable energy sources and photocatalysis. New functionalized structures based on shape-controlled metal oxides are promising candidates for application in photocatalysis/ photoelectrochemistry, owing to their excellent structural, optical and electrical properties. Clean energy and environmental applications are the most recognized issues for modern economy and social development.