Dr Tomasz Baran - Description for the general public

The progressive lack of fossil fuels and environmental pollution boosts the search for a more efficient employment of renewable energy sources. In this respect, solar energy has been demonstrated to be storable in the form of energy vectors, such as H_2, produced through photoelectrochemical water splitting – splitting of water into hydrogen and oxygen upon solar light irradiation. Photocatalysis and photoelectrocatalysis are a reactions which use light to activate a substance which modifies the rate of a chemical reaction without being involved itself. General mechanism of photocatalytic reaction is shown in figure 1.

The goal of the project is to obtain core/shell nanomaterials with high activity towards photoelectrocatalytic hydrogen evolution. The project will introduce a novel architectural core/shell design for the photoelectrocatalytic hydrogen evolution reaction through the development of low-cost photoelectrodes that will functionally integrate absorbing semiconductors and cocatalysts. Project will aim to investigate the correlation between morphological features, electronic properties and efficiency of primary photocatalytic processes (see fig 1) such as charge separation, trapping, recombination and interfacial transfer processes. By this project we would like to highlight: there is no other way to obtain stable and efficient photo(electro)catalyst than correct understanding and deep investigation on such primary photocatalytic processes.

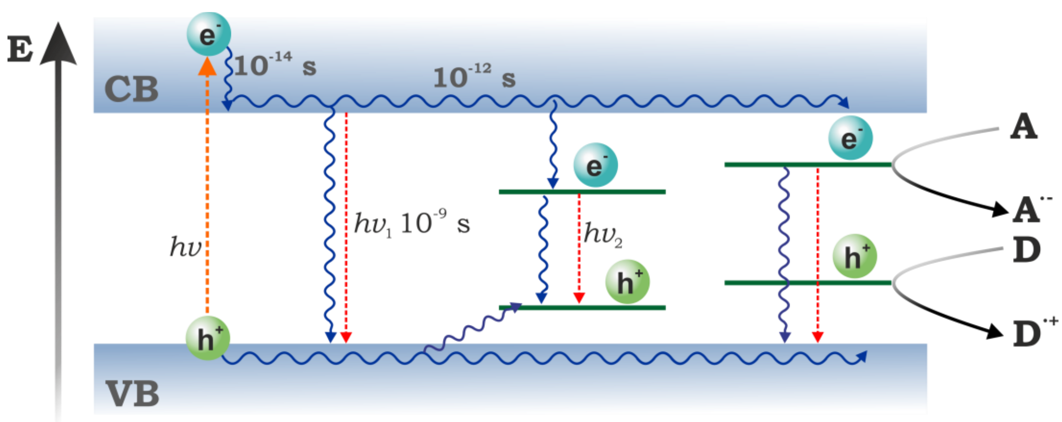

Figure 1. Primary photocatalytic processes: charge separation, recombination, trapping and interfacial transfer

It is more and more discerned that alongside novel photo(electro)catalysts developments, improved knowledge of the charge transfer, trapping and recombination dynamic is crucial for their technological development. In this context, present project will focused on understanding the optical, electronic and catalytic features of core/shell photomaterials, investigating the nature of electronic transitions and the factors that influence the interaction between the photocathode surface and liquid. The combination of low-cost core/shell materials with high efficiency in sunlight harvesting, for generating electrons/holes pairs to be used to drive the desired redox reactions, is the key point for bringing artificial photosynthesis from the research labs to the everyday life. The present project approach to this problem is to obtain very efficient core/shell nanocomposites based on copper. The proposed project will have an important impact both from a scientific point of view and possibly being the starting point for future industrial involvement. In particular, the precise control and understanding of charge transport properties is a crucial requirement for artificial photosynthetic systems. This will obtained by detailed analysis of charge trapping, recombination and charge transfer processes. The project and its results will strongly impact in the basic physics and chemistry of semiconductors as well as enhance the understanding of their integration to design efficient photoelectrodes.