

The project is aimed to study the possibility of selectivity control in photo(electro)catalytic processes through engineering the semiconductor/solvent or semiconductor/gas interfaces. Photo(electro)catalytic reactions are the solar-driven processes which can be used to produce solar fuels, fine chemicals or to depollute water and air. However, the overall performance of heterogeneous selective photocatalytic systems developed so far is still rather low, and the factors governing the selectivity in heterogeneous photocatalysis are still poorly understood. A good example of lack of any selectivity of such processes is photocatalytic degradation of pollutants, which encompasses generation of a strong, non-selective oxidant (hydroxyl radical). Based on our preliminary work on various light-driven selective conversions, the major thrust of this project is to develop novel and more efficient photo(electro)catalytic systems for various highly attractive conversions (*i.e.*, selective oxidations of alcohols and diphenyl sulfides, reduction of oxygen to hydrogen peroxide, reduction of carbon dioxide) and to gain fundamental mechanistic understanding of the factors governing the kinetics of charge separation, charge recombination and catalytic turnover in direct relation to product selectivity. Specifically, the project aims are: i) to investigate composites combining materials with optimum surface catalytic properties with well-passivated low-gap semiconductors as light harvesters, ii) to study the influence of various types of additional metal catalytic sites (single atoms/ions *vs.* nanoclusters *vs.* particles), iii) to develop tandem catalytic configurations of particulate photocatalysts in which the products formed selectively at one component are utilized *in-situ* by another component for further light driven selective transformation. These objectives will be addressed by a combination of synthetic (*e.g.*, atomic layer deposition approach), photoelectrochemical, spectroscopic (*e.g.*, transient absorption/fluorescence spectroscopy, spectroelectrochemistry, intensity-modulated photocurrent/photovoltage spectroscopy) and theoretical studies. The project results are expected to provide unique design rules for the development of highly active and selective photo(electro)catalytic architectures and to advance our understanding of the fundamental advantages and bottlenecks of such systems for selective catalytic transformations.