Novel materials for CO_2 photo-electro-conversion into valuable hydrocarbons

Solar irradiation is the most bountiful renewable energy source available on our planet but it is diffuse and intermittent. At the same time, carbon dioxide (CO_2) is a greenhouse gas, whose concentration in atmosphere is increasing continually from the ongoing combustion of fossil fuels. One of the available approaches, to address both of these challenges, is the usage of solar energy to convert CO_2 into stable, valuable chemicals, useful as fuels or raw materials for the chemical industry. This goal could be realized using photoelectrochemical conversion of CO_2, combining the interaction of light with electrochemical systems, however, designing of efficient photoelectrochemical system requires new photoelectrodes, possessing high efficiency and selectivity of CO_2 transformation into useful chemicals (e.g. fuels) under visible light.

In view of this, the main objective of this project is to develop a radically novel library of Cu-based mixed oxides (such as $CuAgO_2$, $CuRhO_2$) and novel composite photocathode materials (never synthesized before) to enhance efficiency of CO_2 conversion. Moreover, photoelectrode materials will be obtained in the form of thin film or in the form of porous (foam-like) structure to increase the surface area and finally to increase the yield of CO_2 transformation. Other detailed objective to be achieved throughout the project includes correlation of photocathode surface properties with their activity towards CO_2 conversion and investigation of the mechanism of photoelectrocatalytic reactions.

The project will allow to train PhD student in the field of novel semiconductor synthesis, composite material preparation, advanced characteristic of solid materials, reaction efficiency validation as well as mechanistical studies. The most significant expected outcome from the project is a radically novel library of Cu-based mixed oxides (perovskites) and novel composite electrode materials (never synthesized before).