## Description for the general public

Proposed project aims at comprehensive analysis of stability of new group of functional materials – eutectic composites - for photoelectrochemical water splitting, on the example of $SrTiO_3$-$TiO_2$ composite. Photoelectrochemical water splitting was first realized by Japanese research team Fujishima-Honda in 1972. This method employs a semiconducting material which absorbs in UV-Vis range and enables hydrogen gas production with as little as water and energy of sunlight reaching Earth. Hydrogen is currently one of the most attractive alternatives to fossil fuels.

The idea of employing sunlight – virtually inexhaustible source of energy, in order to catalyze various chemical reactions or generate electrical current is intensively studied nowadays. Electrons, which have been excited to from valence to conduction band create unoccupied state (positive charge) in an atom or atomic lattice are called "electron hole". In the case of photoactive semiconductors, high redox potential of electron-hole pair is exploited to catalyze various chemical reactions. This project involves using semiconducting eutectic composite, which upon excitation of sunlight splits water into oxygen and hydrogen gas. From the perspective of depletion of fossil fuels and greenhouse effect associated with their excessive exploitation – hydrogen is becoming attractive and renewable source of energy, which produces only water when combusted.

Series of analyses will be conducted, using state-of-the-art scientific equipment in order to determine the degree of degradation of photoactive eutectic materials in photoelectrochemical cells. These analyses will focus on conducting research over extended periods of time and high intensity of incident light, applying bias potential. Electrodes subjected to such examination will be prepared based on plates of $SrTiO_3$-$TiO_2$ eutectic composite obtained by the micro-pulling-down method at different pulling rates, which affects the size of the features in composite (structure refinement) and annealed in different atmospheres. The influence of modification on the stability of the active material will be assessed by comparison, i.e. results of initial material, optical and (photo)electrochemical characterization will be compared with results of same characterization methods obtained over consecutive cycles of photoelectrode exploitation in PEC cell.

Planned research involves investigation of changes in electrodes' morphology, thickness, optical and fotoelectrochemical changes, as well as changes in electrolyte's qualitative and quantitative parameters. This will enable to study the nature of kinetics of photoactive materials' degradation. Chemical resistance and stability of material is one of the most important parameters determining its feasibility for large scale use in PEC cells, due to the fact that water splitting reaction is often carried out in highly acidic or basic, with applied bias and high concentration of charge carriers within the materials, which add up to highly corrosive environment within photoelectrochemical cell.