PEVOX: Engineering of New Types of Vanadium Oxide Bronze-Based Heterostructures for Photoelectrocatalytic Energy Conversion

Regarding global challenges related to progressing climate threats, a key objective is to elaborate solutions that enable energy production from renewable sources in an environmentally friendly way. In this regard, one of the most promising strategies is concerned with the development of technologies and methods for producing green hydrogen. The photoelectrochemical (PEC) water-splitting process presents a particularly promising and forward-looking approach among various methods of green H_2 production. This process employs a semiconductor photoelectrode which absorbs solar energy and converts which initiates the decomposition of water via electrolysis. Consequently, as-obtained hydrogen is fabricated in an emission-free and sustainable manner. However, the primary challenges associated with advancing this technology predominantly pertain to enhancing the stability, efficiency, and cost-effectiveness of photoelectrode production.

Therefore, the main goal of the project is to develop advanced photoelectrodes capable of effectively converting solar radiation, enabling the production of hydrogen from water, including seawater. The "PEVOX" project will introduce new types of semiconductor materials for photoelectrochemical applications based on vanadium oxide bronzes (MVO) with lithium, beryllium, and ammonium ions, which, due to their ability to absorb radiation in the visible light (VIS) spectrum, will allow for effective conversion of sunlight into chemical energy (H_2) in PEC systems. Moreover, the developed MVOs will also be used to design more complex photoelectrodes based on SnO_2/MVO heterojunctions (Figure 1). The use of SnO_2 nanowires as a backbone semiconductor will boost the separation and transport of charge carriers, which is also one of the key conditions for the development of PEC technology. Subsequently, the most promising MVO materials will be selected based on their comprehensive characterization using both: advanced research techniques and theoretical calculations. To maximize the efficiency of the studied materials, special attention will be put on controlling concentration of surface defects, which allow for precise tuning of the band structure, directly influencing the effectiveness of the PEC process.

The feasibility of the proposed solution will be confirmed by conducting a series of photoelectrochemical tests, with particular attention to the stability of the obtained photoelectrodes, which is crucial for their long-term applicability. The potential for using the obtained photoanodes to produce hydrogen from seawater will also be verified.

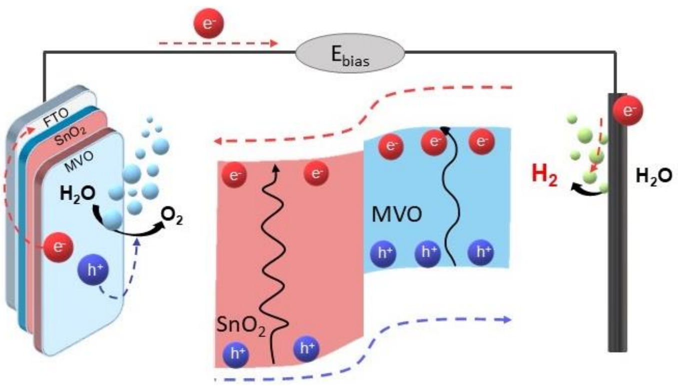

Figure 1. Schematic representation of a PEC system using the developed photoelectrode along with its band structure.