One of the most important challenges facing humanity today is to provide a clean and renewable energy source. Hydrogen energy can serve as a highly energy-dense fuel with clean combustion byproducts. Currently, most non-renewable sources are used for hydrogen production, such as natural gas and coal reformation, coke ovens, chlor-alkali process, and others. An environmentally friendly approach includes hydrogen generation from water in photocatalytic, electrochemical, or photoelectrochemical (PEC) processes.

The key element in PEC cells (*Fig.1.*) is the material from which the photoelectrode is made. Despite extensive studies on new materials for photoanodes performed over the years to enhance the solar-to-hydrogen (STH) conversion yield in water splitting, several challenges persist. These include issues related to solar energy absorption, separation efficiency of light-induced charge carriers, and long-term chemical stability. One possible strategy to solve the abovementioned problems is the design of nanostructured, gradient-doped photoelectrodes. The proposed solution within the project is to obtain layers of anodic tungsten oxide doped with transition metals (Cr, Mn, Fe, Co, Ni, Cu) with a precisely defined doping profile across the material thickness. Such structure of the electrode is intended to improve the absorption of sunlight and charge separation, which will result in higher STH conversion efficiency.

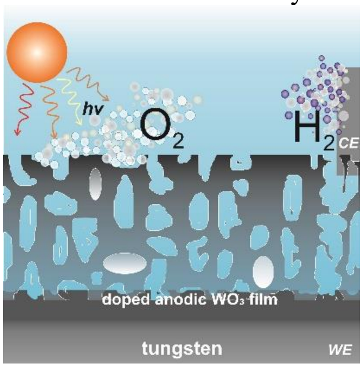

Fig. 1. *Schematic representation of the PEC system based on doped anodic tungsten oxide for photoelectrochemical hydrogen production using solar energy.*

Therefore, this project aims to develop and optimize the electrochemical method for the fabrication of photoactive single- and multi-component tungsten oxide layers with a gradient composition for photoelectrochemical hydrogen production. Furthermore, an important objective is to comprehend the mechanism of ion incorporation into anodic tungsten oxide film during in-situ doping. This involves undertaking systematic characterization of morphology, composition, optical, electrochemical, semiconducting, spectroelectrochemical, and photoelectrochemical properties of the newly developed photoactive materials.

It is expected that the designed anodic materials based on tungsten oxide and the systematic assessment of their properties will expand knowledge in the field of materials synthesis using electrochemical methods, electrochemistry of nanomaterials, and design of functional materials properties. This project will contribute to economic and social development by obtaining innovative nanomaterials for the effective production of hydrogen using solar energy.