Every year, the world's energy demand increases due to the still-growing population and the consequent expansion of industrialization. There is no reason to believe that this situation will change. In 2023, the world's electricity production was 29,479.05 TWh, almost 70% of which came from non-renewable sources. It leads to the depletion of energy sources, such as coal and gas deposits. One possible solution to these problems is using alternative energy sources: wind, biomass and solar. The most abundant source of renewable energy is the sun. Solar energy is the only one likely to meet humanity's energy needs. Assuming 100% conversion efficiency, we could meet the annual energy demand in one hour. Despite this, in 2023 only about 5.5% of all electricity was produced from solar energy. Moreover, due to the lack of continuity in its production (cloud cover occurring, lack of sunshine at night), the large-scale photovoltaic systems used to date cause a strain on electric power systems. There is, therefore, a need to improve ways of converting solar energy.

Besides photovoltaics, which converts solar energy into electricity, photoelectrochemical water splitting is another promising strategy for harnessing solar energy. It involves the breakdown of water molecules into oxygen and hydrogen under exposure to solar light. A typical photoelectrochemical cell consists of two electrodes (at least one must interact with sunlight and is called a photoelectrode) immersed in an electrolyte and connected by an external electrical circuit. On one electrode (anode) the oxidation of water and the evolution of oxygen (O_2) occurs, and on the other electrode (cathode) the reduction of water to hydrogen (H_2) takes place. Hydrogen, as an energy carrier, plays an important role in the future of sustainable energy development. It is a medium that can help transform our energy system into a cleaner and greener. Burning hydrogen does not produce carbon dioxide or other carbon compounds that pollute the environment, which is an important factor in the struggle with climate change. Hydrogen can be used as a fuel in fuel cells, which convert chemical energy into electricity, with the only byproduct being pure water. Unfortunately, the process of photoelectrochemical water splitting is still not efficient enough for us to use daily. The main problem is photoelectrodes, most of which have a short operating time.

The ternary sulfide $ZnIn_2S_4$ is a material that is active in the visible light range and is environmentally friendly. It is a promising photoanode material, but damaging quickly during operation. A possible way to improve the stability of $ZnIn_2S_4$-based photoanodes is to coat them with a protective layer (cocatalyst/protector layer). Considering the published research and preliminary studies of $ZnIn_2S_4$ layers, cobalt compounds are the most suitable. Cobalt oxide Co3O4 was chosen, which is commercially available and has already been successfully used for other photoanode materials. Using Nafion as a binder for Co_3O_4 film formation brings additional benefits. It is a good candidate as a barrier material, improving the reaction mechanism on the photoanode surface.

The main goal of this project is to study the effect of the Co_3O_4-Nafion protective layers on the properties of photoanodes based on $ZnIn_2S_4$ layers. Co_3O_4 with Nafion as the binder will be deposited using a dip coating method, which involves immersing the substrate in a mixture of Nafion and Co_3O_4. It is a simple method of depositing thin films that does not require specialized equipment. The layered photoanodes will be studied by photoelectrochemical methods and solid-state physics techniques. The main project aim is to study the effect of Co_3O_4-Nafion layers on the working time of the photoanode during photoelectrochemical water splitting.