There are probably no people among us who would not realize the need to respond to the effects of global warming and to take actions that could reduce the generation of greenhouse gases. One of the many proposed methods is the use of solar energy. Solar energy in conjunction with a properly selected semiconductor or semiconductor system is used for photoelectrocatalytic water splittingas a result of which hydrogen gas can be obtained - the fuel of the future. There is a great demand for semiconductor materials with photocatalytic and photoelectrocatalytic properties which could act under solar light illumination. Many scientific groups have been engaged in modification of existing semiconductors towards tuning bandgap. Main trends in semiconductors photoanode materials engineering are among others: *i*) doping of the bulk SC structure, *ii*) surface sensibilisation using organic or inorganic dyes or polymeric films absorbing visible light, iii) using plasmonic effects by application of nobel metals nano-particles and many others.

It is worth noting that photointercalation, which strongly influences the photoelectrochemical and photocatalytic properties of layered materials, is currently not a subject of that much interest. Thus, the main objective of this project is to investigate the effect of photointercalation on the optical, structural, and, in particular, photoelectrochemical properties of layered materials such as transition metal oxides and sulfides (including WS_2, WSe_2, MoS_2, $MoSe_2$). The applicant has already observed a negative effect of photointercalation of alkali metal cations on the photoelectrochemical properties of MoO_3. Moreover, PI also proposed an easy way to eliminate the negative influence of photointercalation on the photoactive properties of WO_3, and the results were presented in a reputable journal (Applied Catalysis B: Environmental, IF = 22.1). However, to confirm the validity of the proposed solution, an in-depth investigation is needed for a broader range of layered materials. Apart from examining the effect of photointercalation for a large group of layered materials, methods of reducing the negative photointercalation impact on photoelectrochemical properties will also be sought.

PI would like to underline that the phenomenon of photointercalation has been known for many years. However, no one has so far shown that it can have a negative effect on photoanode performance. The layered materials are often used as photoanodes in the splitting of water under illumination. However, there is no detailed research in the literature on how the photointercalation process influences photoelectrochemical properties. The process of intercalation of alkali metal cations during illumination is completely omitted, but it plays an important role. In this project, particular attention is paid to two types of challenges related to: i) confirming the hypothesis that the photo-intercalation process affects the photoelectrochemical properties of layered materials and ii) finding methods that will allow to overcome the negative intercalation process taking place under the irradiation. The verification of the methods used and their modification will allow not only to study the effect of photointercalation on the properties of layered semiconductors, but also expand the spectrum of materials used in photoelectrochemical processes, which will significantly affect the development of the scientific field/technology that uses light in its research: optoelectronics, photocatalysis, photonics and others.