

Global energy consumption and environmental pollution have significantly increased due to growing world population. Therefore, it is necessary and urgent to find an appropriate remedy – a method that will be able to respond to the world’s energy demand and prevent the growing pollution of water and air.

Heterogeneous photocatalysis perfectly meets these requirements. Photoactive materials called photocatalysts, after activation with light, have proven to be successful for various important reactions, such as: (i) hydrogen generation from water, (ii) carbon dioxide fixation and conversion into useful fuels (“artificial photosynthesis”), and (iii) a removal of persistent organic pollutants and harmful microorganisms from water and air.

However, even though heterogeneous photocatalysis has been known and used in water and air purification processes, as well as energy conversion for over 50 years, some aspects of this process are still not fully clarified and understood. This mainly applies to reaction mechanisms, increment of the semiconductors’ photocatalytic activity as well as their efficient and cheap separation from the photocatalytic suspension. Moreover, combining two or even more challenges to be solved at the same time is difficult, and even almost impossible to succeed. Therefore, to comprehensively investigate heterogeneous photocatalysis, the attention should be put on a material, or group of materials, that are easy to obtain and have versatile properties, not limited to the photoactivity.

For example, diluted magnetic semiconductors (semimagnetic semiconductors) are a group of photoactive materials possessing additional feature, i.e., magnetic properties due to the presence of ferromagnetic elements (mainly iron, nickel, cobalt or gadolinium) incorporated into semiconductors’ crystal structure. Up to now, they have been mainly used in spintronics, but they have started to appear also in the photocatalysis field. However, in the available scientific literature there is no direct answer regarding the photocatalytic reactions’ mechanisms in the presence of those materials as well as any attempts focusing on magnetic separation and recycling. Additionally, there is no investigation regarding dependence of photo(electro)catalytic properties and reaction mechanism on the applied ferromagnetic dopant when the semiconductor is a spatially organized, faceted photocatalyst with particularly exposed single crystallographic planes, allowing for effective separation of generated charges (i.e. electrons and holes), and consequently, increased photoactivity of the material, in comparison to disordered structures.

In this regard, the aim of this project is to synthesize and characterize faceted semimagnetic semiconductors based on scheelite/perovskites (such as  $\text{BiVO}_4$ ,  $\text{Bi}_2\text{Mo}_3\text{O}_{12}$ ,  $\text{SrTiO}_3$ ) and simple oxide semiconductors (e.g.  $\text{TiO}_2$ ,  $\text{ZnO}$ ,  $\text{Cu}_2\text{O}$ ), which are characterized by both photocatalytic and magnetic properties due to the use of ferromagnetic dopants. An additional advantage of the selected semimagnetic semiconductors will be their antimicrobial properties, resulting from both the properties of the semiconductors themselves and the ferromagnet dopant characteristics. Comprehensive physicochemical and photo(electro)catalytic characterization of obtained faceted semimagnetic semiconductors’ structures will allow for the clarification of reaction mechanisms. Moreover, separation and recycling of obtained materials in magnetic field will have a beneficial effect on increasing the ecological aspect of heterogeneous photocatalysis.

Described here interdisciplinary research, standing in between of chemical sciences and materials science, will certainly have a positive impact on the development of those disciplines and broadening the knowledge in the field.

