Abstract for the general public

Photocatalysis is important area of research and technology due to the transition to green energy (e.g. water splitting for hydrogen generation) and environmental protection (e.g. purification of drinking water). It is possible to utilize photoactive materials to do so using sunlight, but their main disadvantage is that currently used materials work in a relatively narrow wavelength range. Hydrogen is a natural carrier of renewable and clean energy, which production is free of greenhouse gasses and other pollution. As an energy source hydrogen can be named environment-friendly. The problems of transition to green energy are important towards they are closely related to the European Union's plans to achieve carbon neutrality in 2050 in whole EU, what was announced during COP25 climate conference in Madrid this year. On the other hand, the issue of water pollution and shortage has become one of the greatest challenges for humans with the increasing growth of world population as well as rapid development of world economy.

The main aim of the proposed project is to develop new nanostructured anodic oxides, which will works as photocatalysts active in broad range of UV-Vis. The main project strategy is used of anodization as a relatively cheap, easy and fast method to produce nanostructured oxide on the surface of valve metals and it's alloys. What is more, the anodizing conditions influence the morphological features (i.e. geometry and arrangement of nanopores) and properties of the resulting nanostructured oxide. Based on the our previous research the FeAl intermetallic phase with the content of 50 at% aluminum was selected as a starting material. As a benefit of the FeAl intermetallic anodization the nanoporous morphology with specific electrical (bandgap) properties could be recognized. Moreover, an initial research made on FeAl was revealed, that the bandgap of that anodic oxide made on FeAl can be tuned by change of anodization conditions, **from 3.51 eV (samples prepared at 5 V) to 2.09 eV (samples prepared at 17.5 V**), which is much broader than the range of bandgap of TiO_2 (3.02 – 3.20 eV) commonly used in photocatalysis. These pioneering on the global scale results clearly show that FeAl intermetallic phase anodization have high potential in use in environment applications, such as water splitting or water purification.

The goal of the proposal is to determine the impact of anodization conditions on the morphology and properties of nanostructured anodic material, made on the FeAl intermetallic alloy surface. **The designation of FeAl anodization mechanism will be done** in relation to both, pure iron and pure aluminium substrate. **Understanding the mechanism of FeAl anodization will allow controlled production of mixed anodic oxide layers with well-defined morphology, composition and properties. The influence of FeAl structure (e.g. grain size, type of boundary) on anodic oxide morphology will be also examined**. To achieve mentioned above goals, many anodization conditions, including: type, composition and viscosity of electrolytes, temperature, anodizing time etc., will be change to find the optimal method for the fabrication of photoactive material with desired properties. Also, the **influence of annealing conditions** (like time, temperature and temperature steps) **on the crystallinity, banggap and photoactivity of resulted material will be investigated**. Moreover, the attempts of preparing crystalline form of anodic mixed oxide *in situ* during anodization of FeAl will be done. The effect of the oxide morphology, composition and structure on its photoactivity in selected environmental application will be studied in details.

Realization of the proposed project will result in the development of new electrochemical methods of fabrication of nanostructured photocatalysts with extraordinary properties. Moreover, it will be possible to finely tune the properties of the catalytic materials by simple changing of conditions applied during electrochemical process. **We hope to achieve nanostructured material with high photoactivity in broad sunlight range of radiation for energy and environment photocatalytic applications.**