The aim of the research project *"Tailoring multicomponent nanometric alloys formed on active support for designing the stable anodes of Solid Oxide Fuel Cells"* is to understand the phenomenon of the formation of multicomponent nanometric alloys on an active substrate for the controlled fabrication of novel anode materials for solid oxide fuel cells (SOFCs) powered by eco-fuels (e.g. bioethanol, biogas, LPG). SOFCs are devices capable of converting the supplied fuel and oxygen into electricity. The possibility of their operation in virtually any place where fuel is available, perfectly fits the concept of dispersed energy. Unfortunately, commercial cells with a standard Ni-YSZ cermet anode are optimized to work with hydrogen as a fuel, and the use of alternative fuels (e.g. eco-fuels) causes carbon deposition and poisoning the anode with impurities present in the fuel. Therefore, it is necessary to search for new anode materials capable of long-term and stable operation in these conditions.

One of the materials intensively investigated in recent times are perovskites with the general formula ABO_3, which, however, present low catalytic activity towards electrochemical oxidation of fuel. In order to increase the electrochemical activity, metal nanoparticles, e.g. nickel or cobalt, are applied to the surface of the perovskites. Unfortunately, applying nanoparticles has less control over their size and distribution. Moreover, at high temperatures, nanoparticles tend to agglomerate, which reduces catalytic properties. For this reason, it is becoming more and more popular to obtain nanometric precipitations in situ from perovskite structures under reducing conditions by means of the exolution method. Such nanoparticles are more strongly embedded in the material and less prone to agglomeration. Moreover, catalytic compounds obtained by exsolution are called "intelligent catalysts" because, depending on the conditions, nanoparticles may precipitate or partially re-enter the structure of the starting material. So far, however, literature reports have focused on the exsolution of monometallic nanoparticles from perovskite structures. Several scientific papers have suggested the beneficial effect of bi-instead of monometallic nanoparticles. An interesting method is also obtaining alloys by means of topotactic exsolution, during which the metal released from the structure forms an alloy with the metal deposited on the surface.

In connection with the above, a significant effort will be taken within the project to fabricate materials with a perovskite or fluorite structure, from which it will be possible to carry out the exolution process. Then, a layer of another catalytically active metal will be applied to the selected compounds, and under appropriate conditions (temperature, time), a formation of nanometric alloys will be forced. The obtained materials will be subjected to structural, electrical and catalytic tests and finally will be examined as alternative anode material in fuel cells powered by eco-fuels. The activity of individual materials will be analyzed according to the original scientific approach suggested by our research team based on simultaneous measurements of electrical properties and analysis of the outlet gas composition. In addition to experimental research, DFT simulations will also be carried out, aimed at predicting the properties of the separated nanoparticles and their alloys and their impact on the anode poisoning or carbon deposition.

The results of the project will significantly contribute to the current state of knowledge on catalytically active nanometric alloys obtained through topotactic exsolution. The project will help to determine the optimal composition and properties of the starting materials for the exsolution of metallic nanoparticles, as well as to determine the effect of different applied layers on the final alloy. The implementation of the project will complement the current knowledge on SOFCs directly powered by eco-fuels and help to find an alternative, better than commercially used anode materials for these cells.