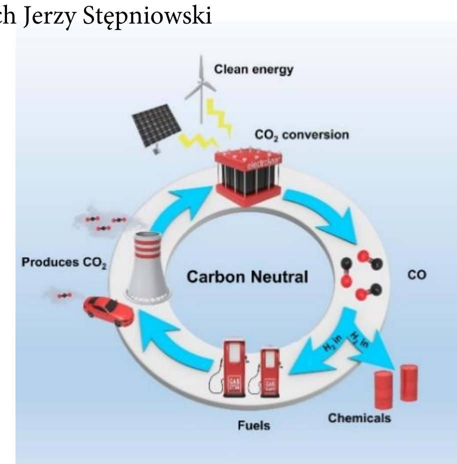
Electrochemically grown bimetallic Cu-Zn nanostructured catalysts for cost efficient electrochemical carbon dioxide reduction into added-value chemicals



Abstract

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One of the greenhouse gases impacting climate is carbon dioxide (CO_2) which is formed during fossil fuel combustion. The greater the CO_2 concentration in the atmosphere, the greater the global temperature and the more severe climate changes we experience. One of the solutions is CO_2 recycling by its reduction to so-called value-added chemical compounds like ethanol or ethylene that can be used again in the economy as fuels or reagents in chemical syntheses.

One of the approaches providing such a solution is an electrochemical carbon dioxide reduction reaction (eCO_2RR) where CO_2 is reduced to the above-mentioned C_{2+} chemicals. The crucial element in the reaction is a catalyst: due to thermodynamics, copper was found to be, so far, the best one. However, there are certain improvements that can be done, in order to enhance the catalysts performance, like increasing its selectivity towards specific compounds and avoiding undesired side reactions. Adding a second element, facilitating CO adsorption, like zinc, the development of a surface area and the formation of additional oxygen sites on the surface are anticipated to be the solution.

The proposed project is founded on the fabrication of Cu:Zn alloys libraries and subsequent screening of a wide range of Cu:Zn compositions with advanced electrochemical methods. Next, the selected materials will be subjected to electrochemical oxidation where nanostructured mixed oxides will be formed, providing a high surface area with oxygen sites. The formed catalysts will be subjected to physicochemical analyses, employing the advanced tool, providing information on their morphology, chemical and phase compositions. What is even more important, their catalytic performance will be examined and products of the eCO_2RR will be analyzed. In order to understand the reaction pathways, the experiments will be facilitated by theoretical computations. The mechanism of growth of the nanostructured oxides will be also investigated: at various stages of the electrochemical oxide growth the processes will be terminated and materials as well as the electrolytes in which the materials are grown, will be analyzed, to provide a coherent view on the occurring phenomena.

The project is founded on the **complementary experience and expertise of two Principal Investigators**: Wojciech J. Stępniowski, who works in the field of materials science & engineering, will synthesize electrochemically materials and provide routine examinations, while Nejc Hodnik, who works in the field of electrochemical reduction of carbon dioxide will perform electrochemical analyses, catalytic performance tests, advanced materials analyses and theoretical computations.