Educational project summary

The scientific goal of the proposed project is to clarify the role of the interaction between the carrier and the active phase of the catalysts. In heterogeneous catalysis reactions take place on the contact gas – solid state. The catalysts generally consist of a carrier and an active phase. The support has a very large impact on the activity of the catalyst. Until today the carriers studies are limited to the application of various types of the compounds (typically oxides, silicates, zeolites, etc.) without regard to how the structure of the carrier affects the catalytic properties. There are reports that the support has specific structure, but the question of its effect on the catalytic properties up to now is poorly explored. Our earlier studies of silver and copper deposited on zirconium oxide catalysts showed that the reaction of methanol synthesis from a mixture of hydrogen and carbon monoxide or hydrogen and carbon dioxide, catalysts obtained based on tetrahedral phase of zirconium oxide are more efficient than the catalysts in which the monoclinic zirconia was used as the support.

In this project we have proposed studies which allow us to clarify whether such influence of the support structure is also present in the low temperature reaction of steam reforming of bio-ethanol towards hydrogen production. This reaction is currently extensively explored due to the fact that the combustion of fossil fuels, including coal, oil and natural gas, leads to the emission into the atmosphere huge amounts of impurities, which affects the balance of the carbon cycle. Today the economy is based on fossil fuels, which leads to the harmful effects of present and an uncertain future. Natural gas is the cleanest fuel (containing mostly methane), while petroleum and coal are composed of more complex compounds containing nitrogen and sulfur, which, during the combustion, leads to the release of nitrogen and sulfur, oxides particulates and products of incomplete combustion. These compounds are converted to methane in the upper layers of the atmosphere increasing the additionally greenhouse effect. One should be aware that massive carbon reservoirs that have for millions to hundreds of millions of years been buried deep beneath the earth now exist as carbon dioxide in our atmosphere due to fossil. The concentration of carbon dioxide in 2015 exceeded 400 ppm and this process is still accelerating. Onboard conversion of ethanol to hydrogen is apparently the ideal step in the efficient turnover of the petroleum economy to a hydrogen economy as there is no need for an extensive new infrastructure for fueling. Low temperature steam reforming of ethanol appears as processes capable of converting ethanol to hydrogen; however, this process is still in the research and development stage. This project aims to clarify the relationship between the physicochemical properties of the catalysts and their yield to hydrogen in this reaction and thus to contribute to the implementation of this technology.