DESCRIPTION FOR THE GENERAL PUBLIC (IN ENGLISH)

Stopping the increase in the atmospheric CO_2 concentration, which is mainly caused by combustion of fossil fuels, is a challenge for the contemporary world. The question arises, how to reduce the concentration of CO_2 in the atmosphere. In recent years, it has been proposed to reduce CO_2 emissions by capturing CO_2 from flue gases and storing it in deep rock formations. It is a very expensive method and storage of compressed CO_2 is a matter of controversy. Therefore, new ways of utilization of the captured CO_2 are considered. It appears that the best way to solve the problem is to use carbon dioxide as a raw material for production of useful compounds such as methane, methanol, dimethyl ether, formic acid and others. This approach allows to reduce the concentration of CO_2 in the atmosphere and recycle of carbon via chemical conversion. Methanol and other chemicals mentioned above are typically produced by the reaction of hydrogen and carbon monoxide. The carbon monoxide may be replaced with carbon dioxide. However, the CO_2 molecule is much less reactive than CO and the process requires more drastic reaction conditions, controlled by temperature and pressure. The basic requirement for an efficient reaction of CO_2 with hydrogen is the use of more efficient catalysts than those applied in the reactions of CO and hydrogen.

Developing efficient catalysts for chemical conversion of CO_2 is a major challenge for science. The members of Department of Molecular Engineering at Lodz University of Technology conduct research on plasma methods for fabricating nanocatalysts. In the vacuum chamber of the reactor, a cold plasma is generated - state of matter, when a gas is ionized. Plasma technology is a very powerful method which opened the way towards new or modified materials with novel properties, otherwise unreachable. This technique allows to change the structure of the solid surface, giving it unique catalytic, hydrophobic or adhesion properties.

The aim of the project is to design at the molecular level and fabricate catalytic thin films of high activity and stability using a plasma method. A new generation of nanocatalytic structural packings, based on transition metal oxides, could be further applied in industrial catalitic reactors for the CO_2 hydrogenation processses.

Application of a plasma method allows producing layers with a thickness of several nanometers with precisely designed molecular structure. The production of complex nanostructures on different kinds of structural supports (wire-gauzes, sheet metal pieces) is possible by this method. The resulting thin films will be studied in terms of their molecular structure and nanostructure, using modern spectroscopic and microscopic techniques. In turn, kinetic studies will be carried out in the continuous flow catalytic reactor for the selected processes of CO_2 hydrogenation. These measurements will allow to assess the usefulness of new catalysts in terms of their practical application in reactions of CO_2 and hydrogen towards value-added compounds.

Undoubtedly, the present studies will make progress both in terms of research on a new generation of catalysts for the hydrogenation of CO_2 as well as searching for solutions to the climate crisis.