Nowadays, there is a global discussion on how to reduce the concentration of carbon dioxide in the atmosphere. Many methods are proposed for its capture, storage or processing into useful products. The methods associated with the storage of captured $CO_2$, e.g. in deeply located rock formations or on the seabeds, raise reasonable doubts. In connection with the above, attention was directed to attempts to use carbon dioxide as a substrate in the production of useful compounds, which may include methane, methanol, dimethyl ether or formic acid. This solution seems to be optimal considering not only the reduction of $CO_2$ concentration in the air, but also the production of valuable materials. However, there is a problem related to the need to use high pressure, temperature and multifunctional catalysts in the hydrogenation process due to the low reactivity of the $CO_2$ molecule. The solution to this problem is the initial conversion of carbon dioxide to carbon oxide, which is much more reactive. However, we must have efficient and stable catalysts for this purpose, which will ensure adequate selectivity towards CO production..

The preparation of catalysts with appropriate properties is a serious problem. The Department of Molecular Engineering at the Lodz University of Technology is conducting research on plasma methods for the preparation of a new generation of nanostructured catalysts. Plasma, i.e. ionized gas constituting the fourth state of matter, is generated in the reactor chamber by applying voltage, of different frequency, to parallel electrodes. Plasma deposition leads to the production of the desired layer on the surface of any carrier and is a very versatile method, which falls into the scope of "green chemistry" due to low energy consumption and almost waste-free production process. With this method, you can modify the surface of polymers, metals or other materials, giving them new unique properties, e.g. hydrophobic, anti-fungal or catalytic.

The aim of the project is to generate by plasma deposition using various types of organometallic complexes and various supports, a new class of thin-film catalytic systems active in the conversion of $CO_2$ to CO, in reactions such as $CO_2 + H_2$ or $CO_2 + CH_4$, what ultimately will lead to production of synthesis gas (mixture of CO and $H_2$) with a specific composition.

The plasma deposition method allows you to control, by means of variable process parameters, the properties of the resulting layers. The materials obtained in this way will be characterized using advanced spectroscopic and microscopic methods. The research will provide information on the molecular structure and nanostructure of catalytic systems. Catalytic tests, carried out in a gradientless reactor with perfect mixing, will allow to determine the influence of the structure of the obtained catalytic thin films on the efficiency of the $CO_2$ conversion to syngas.

The obtained research results will be a valuable complement to knowledge in the field of heterogeneous catalysis and will allow their practical use in $CO_2$ conversion processes.