One of the most important challenges for today's humanity is reduction of greenhouse gases and development of sustainable energy solutions. The main cause of progressive climatic changes is the emission of carbon dioxide, which has reached the highest recorded levels since the first reports appeared. Strategies for reduction of CO_2 emission include: decarbonisation (use of renewable energy sources), sequestration (CO_2 capture and storage) and recycling (conversion of CO_2 into other useful compounds). The most promising is the CO_2 reduction reaction (CO_2RR) as it can simultaneously meet the demands of reducing CO_2 emission and the production of valuable chemicals. The CO_2RR method is currently being studied in the development of new catalysts that enhance the efficiency and selectivity of the reaction.

Among the CO_2RR techniques used so far, electrochemical CO_2 reduction predominates over other methods (incl. thermo- or photochemical) due to the easily controlled course of reaction and mild conditions required. Within the catalysts for the electrochemical CO_2 reduction reaction, copper catalysts proved to be the best as they can catalyze the reaction towards the formation of hydrocarbons. However, they have some limitations related to the relatively low selectivity of the products formed in the reaction. Therefore, current research is focused on improving the activity and selectivity of copper-based catalysts. This can be achieved through *i.a.* a design of nano-scale catalytic materials, bimetallic systems and adjusting the parameters of reduction reaction. The latest literature reports indicate a high potential of a binary copper compound such as copper(I) nitride (Cu_3N). The unique structural, optical, electrical, and also catalytic properties of Cu_3N are known and studied for many applications. Its specific cubic structure allows on other atoms introduction into outer and inner crystal lattice. Research on Cu_3N toward catalysis of CO_2RR reaction indicates its ability to convert carbon dioxide to, among others, ethylene (Fig. 1). These promising properties and prospects of copper nitride made it the subject of our research.

The purpose of this project is on new copper nitride-based nanomaterials preparation and study in electrochemical CO_2 reduction reaction. During the research, various Cu_3N nanostructures with shapes of nanowires, nanocubes and nanoparticles will be obtained and characterized. Next challenge is the preparation Cu_3N-based bimetallic materials containing metals, such as Ag, Au, Zn and Sn and their characterization. The obtained materials will be tested in terms of their basic physicochemical and optical properties as well as electrochemical properties. Moreover, the influence of the composition, structure and shape of the obtained nanomaterials on their activity and selectivity in the CO_2 reduction reaction will be studied. Project outcomes will provide new knowledge on the catalytic activity of copper nitride and its materials. Research results will contribute to the development of new methods of CO_2 activation by changing the structural features of the catalyst. The novelty of the project is in basic structural chemistry and new catalytic properties of copper nitride with potential applications in carbon dioxide removal in the form of useful hydrocarbons or other organic compounds. Therefore, the research may be suitable in designing new sustainable energy solutions.

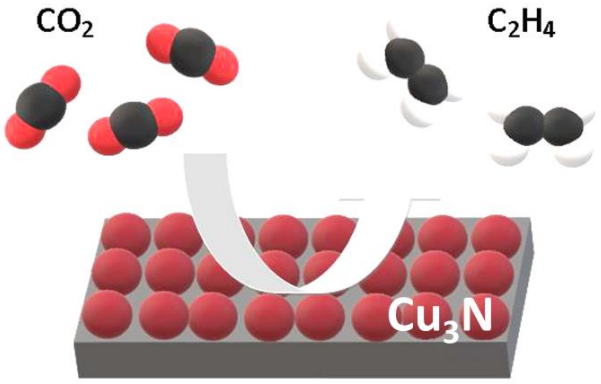

Fig. 1. Scheme of CO_2 reduction reaction to ethylene on Cu_3N catalyst.