The role of ionic liquids in CO_2 photoconversion

One of the most important aims of the long-term EU strategy is achieving the Paris Agreement temperature objectives and leading to the transition towards a net-zero-greenhouse emissions economy. Hence, CO_2 capture and conversion has been acknowledged as an important research and development priority of UE to achieve 2050 climate objectives. Thus, overcoming past barriers in CO_2 conversion into valuable chemicals using solar energy would bring us closer to these challenging goals.

Heterogeneous photocatalysis proposes at the same time the utilization of CO_2, as well as the production of valuable hydrocarbons (such as methane or methanol) using solar radiation. The development of CO_2 photoconversion processes needs the design of new materials, not only photoactive but also able to capture and preconcentrate CO_2. In view of this, the proposed project is focused on the development and characterization of a novel group of photocatalysts in the form of Cu, Ag-based metal-organic frameworks (MOFs) modified by amino acid-based ionic liquids (ILs) to effectively capture and convert CO_2 into valuable hydrocarbons utilizing visible light (Figure 1). MOFs have appeared as the most promising materials for CO_2 capture due to their exceptionally high surface area, adjustable micropore size, designable surface properties, and chemical flexibility. Modification of MOFs by amino acid-based ILs (more sustainable as synthesized using renewable resources) should enhance CO_2 sorption capacity of the photocatalyst. Cu and Ag ions/clusters included in MOFs structure will show additional catalytic activity, enhancing the overall efficiency of the hybrid system resulting in increased yield of CO_2 photoconversion. Moreover, understanding the interactions between CO_2 and ILs/MOFs surface will explain the role of ionic liquids in CO_2 photoconversion process, what is the main objective of this project.

The proposed project consists of seven main tasks related to the preparation of MOFs for CO_2 photoconversion and their modification by ILs. The MOFs and IL/MOFs structures and their surface properties will be examined by various combined analytical techniques. In addition, the adsorption capacities of MOFs and ILs/MOFs will be determined to understand the adsorption-desorption processes occurring during photocatalytic CO_2 conversion, and their impact on photoconversion yield. The efficiency of CO_2 photoconversion will be investigated in the gas and liquid phase. The role of ILs in CO_2 photoconversion over ILs/MOFs photocatalysts will be examined by *in situ* studies.

The most significant outcomes of this project will be related to the development of a pioneering class of Cu, Ag-based MOFs modified by amino acid-based ionic liquids and new insights into the excitation mechanism and species involved in the photochemical reaction occurring at the surface of novel materials. The fundamental understanding generated through the project will eventually force the development of other research areas beyond heterogeneous photocatalysis, such as catalysis and gases storage. The proposed research will have an interdisciplinary character, therefore the involved team members have experience in heterogeneous photocatalysis and ionic liquid properties. The research will be performed at University of Gdansk, University of Gdansk in cooperation with Ionic Liquid Group from the University of Pisa (Italy) and the specialist in Computational Material Science from Yachay Tech University (Ecuador).

Moreover, it is expected that the breakthrough in CO_2 photoconversion technology could affect in long-term development in "clean" energy production sector, finally resulting in reducing CO_2 emissions to the atmosphere and increasing the use of energy from renewable sources. New technologies will impact on the competitiveness of Polish companies, international trade, and employment in R&D sector.

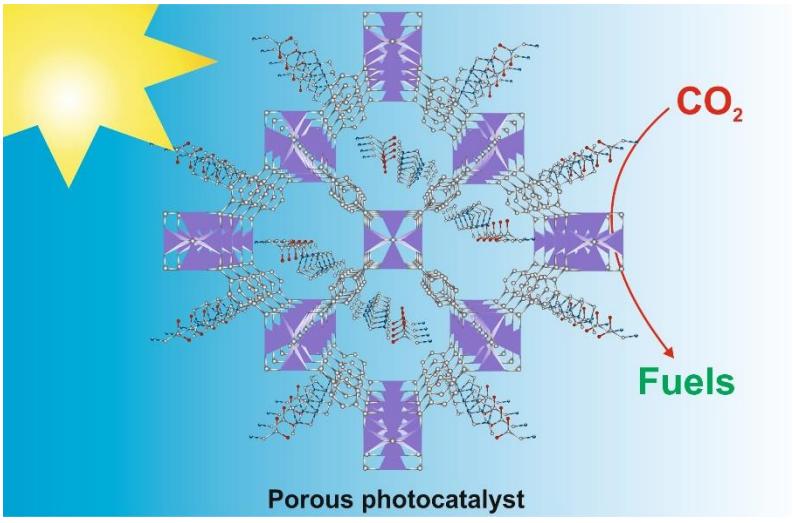

Figure 1. General idea of the proposed project