Federal Ministry of Education and Research

CO_2WIN Use Carbon Sustainably

ProMet – CO_2 to Propylene via eMethanol

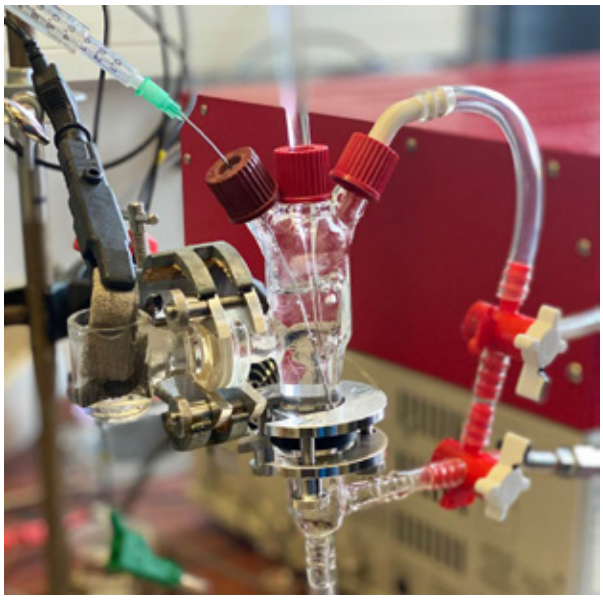
CO_2 as a sustainable source of carbon – Pathways to industrial application (CO_2-WIN)

The project "ProMet" aims at the development of a direct synthesis route of methanol from CO_2 by electrolysis. In the methanol-to-propylene process, methanol is the raw material for the production of propylene, an important basic chemical with an annual worldwide production of 100 million tons. Using electricity from renewable sources for the electrochemical conversion of CO_2 allows for a more sustainable production of both methanol and propylene. The project is funded as part of the funding measure "CO_2 as a sustainable source of carbon – Pathways to industrial utilization (CO_2-WIN)". The measure supports projects that utilize carbon dioxide as raw material for the German economy.

Green basic chemicals

The project "ProMet" develops a new competitive technology which allows for a more sustainable production of propylene. Propylene is an essential raw material in the chemical industry. The conventional propylene production is based on fossil raw materials.

The most important process step in the "ProMet" process is the the conversion of CO2 into eMethanol via electrolysis. eMethanol is electrochemically produced methanol. If the required electricity originates from renewable sources, a "green" methanol is produced, which results in a "green" propylene by applying the methanol-to-propylene (MTP) technology. "Green" means here less greenhouse gas emissions compared to the conventional procedure. Besides, the "ProMet" process makes CO_2 accessible as a raw material.



Laboratory test cell for catalyst screening.

The worldwide production of methanol and propylene mounts up to 86 and 100 million tons per year, respectively, with a yearly growth rate of seven and four per cent. A new sustainable route to methanol and propylene supplies a big market and allows to reduce greenhouse gas emissions to a great extent.

Electrochemical synthesis of methanol

Compared to the electrochemical conversion of CO_2 into formate or carbon monoxide (CO), the reaction to methanol is much more ambitious, since here six electrons per molecule CO_2 have to be transferred instead of only two. While the key features current efficiency and current density reaching values of more than 90 percent and more than 100 mA/cm² for converting CO_2 into formate or CO, for eMethanol only 46 percent current efficiency and ~10 mA/cm² current density are reported. The aim of the project "ProMet" is a current efficiency of at least 70 percent and current densities of less than 75 mA/cm² for converting CO_2 into eMethanol.

Alternative processes for the conversion of CO_2 into methanol require two to three process steps. Due to the single-step electrochemical synthesis of methanol from CO_2, the process should be intrinsically more beneficial, since resources are spared.

Scientific and economic expertise

The biggest challenge for the project is the identification of a catalyst for the electrochemical conversion of CO_2 into methanol, as well as the manufacture of a gas diffusion electrode (GDE) with this catalyst. GDEs show an extraordinary performance compared to routinely used planar electrodes if reactants from a gas phase and a liquid phase are involved.

The whole project comprises of six work packages (WP) and seven partners. At the Ruhr-University Bochum the screening to identify a proper catalyst will take place (WP1). The most promising materials will be manufactured to gas diffusion electrodes (GDEs), which will be electrochemically characterized and modeled (WP2). The best GDEs will be tested in a full electrolysis cell (WP3). In WP2 and WP3 the German Aerospace Center, the Clausthal University of Technology, and Covestro are involved. In WP4, process development, Fumatech will propose and develop proper membrane materials.

Further, Air Liquide will investigate the usage of eMethanol in the existing MTP process to evaluate the new raw material's suitability. The results will be used in the techno-economic analyses (WP5), performed by the RWTH Aachen University. Also at RWTH Aachen University, a holistic ecological study of the "ProMet" process compared to alternative processes will be carried out (WP6).

In the "ProMet" project a full process concept is developed for the conversion of CO_2 into propylene, and will be evaluated from technological, economical, and ecological perspectives.

"ProMet" investigates the production of climate friendly propylene.

Funding initiative
CO_2 as a sustainable source of carbon – Pathways to industrial utilization (CO_2-WIN)

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ProMet – CO_2 to Propylene via eMethanol

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