From Climate Gas to Raw Material

Chemists at LIKAT in Rostock are currently developing photocatalysts that use sunlight to convert the so-called climate gas CO_2 into important basic materials. They are investigating the optimisation of these catalysts and the corresponding reaction pathways in a project called PRODIGY, for which the BMBF has now granted funding of € 380,000 until 2023. This is the successor to the PROPHECY project, also funded by the BMBF, which in 2019 provided the first chemical insights into what is known as artificial photosynthesis and, based on this, suggested new concepts for carrying out the process.

Carbon dioxide is at the top of the list of climate-damaging emissions. In the long term, the aim of research is the industrial usage of CO_2 to produce important chemicals in large tonnages and thus also the reduction of this chemically inert climate gas. The work is being carried out under the leadership of Prof. Dr. Jennifer Strunk, member of the LIKAT board. Together with cooperation partners in Berlin, Oldenburg and Karlsruhe, her research group has succeeded in photocatalytically producing methane (CH_4), hydrogen (H_2) or mixtures of both - at room temperature and normal ambient pressure!

Up to now, the researchers have focused primarily on "converting CO_2 as simply and elegantly as possible," as Jennifer Strunk says. But the yield for industrial use was far too low, she says. Therefore, they want to increase the "added value" of the processes in the new project and produce higher-chain hydrocarbons that are indispensable for the chemical industry. These include alcohols, aldehydes, carboxylic acids and acetone. In addition to carbon dioxide, a photocatalyst and light, one further reaction partner is needed for the chemical reaction. Preference should be given to reaction partners that can also be obtained from biogas, such as methane, or short-chain olefins should be used.

Jennifer Strunk: "We still know too little about the molecular mechanisms of these reactions. These are considered worldwide to be the black box. PRODIGY will test a wide variety of catalysts under systematically changing reaction conditions. Possible catalysts include metal oxides that are active when exposed to sunlight. Among other things, the researchers want to optimize their semiconductor properties so that they respond to the broadest possible spectrum of sunlight and become active. Strunks team has won the physicists at the Helmholtz-Zentrum Berlin für Materialien und Energie for a cooperation.

According to Jennifer Strunk, it will still take a few years before the breakthrough is achieved. This is mainly due to the very demanding reaction setup: The experiments require highly purified conditions and a thorough verification of the test results by blind tests. CO_2 is so inert that even traces of other carbon compounds, for example from impurities, react more quickly

than the starting material itself. This undesirable side effect has long been underestimated internationally.

The participants in the predecessor project PROPHECY were able to prove precisely that the carbon in the end products definitely comes from the carbon of the CO_2, and not from plastic components on the apparatus. Even with this high technical level of work, LIKAT researchers occupy a leading position worldwide in the competition for future-oriented CO_2 conversion processes.