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Optimizing a new way for biological reduction of CO2

CO2 is an abundant carbon resource and a global challenge is to valorize it into energy. Biological ways for CO2 conversion into fuel are promising as they are selective and possible in physiological conditions. Recently, a new microbial process able to spontaneously convert CO2 into formate has been discovered at IEM. Comparing to other bioprocesses for CO2 conversion, the biocatalyst implemented does not need protein extraction, cofactor, H2, or light.

A thesis carried out between 2015 and 2018 allowed to approach the mechanism of this new CO2 bio-reduction pathway. It also showed that this bio-reduction was intensified by implementing the biocatalyst in a bio-electrolyzer. In this device, the biocatalyst uses electrons from a weekly polarized cathode and protons produced at the anode by water oxidation, which overcomes the limitation of the intracellular stock of protons and electrons. Solar energy can be used for the bio-electrolysis, leading to a fully sustainable process. In the tested conditions, the flow of reduced CO2 is comparable with those of photosynthetic microorganisms.

The goal of my thesis is to optimize the CO2-reducing bio-process developed at IEM. This goal is divided in three parts:

- to confirm the suspected CO2 reduction pathway by a genetic approach allowing to enhance the biocatalyst implementation and performances

- to optimize the bio-electrolyzer configuration; a gas-diffusion electrode made of different electrode materials will be tested

- to couple the intensified bio-electrolyzer with a subsequent bioprocess aiming to convert the formate originating from CO2 into alcohols, which are more valuable than formate.