Master's thesis projects with PhD opportunity afterwards

Study background: Industrial Biotechnology, Chemical Engineering, Biotechnology/Biochemistry, Pharmaceutical Bioprocess Engineering

Project description:

Developing sustainable synthesis processes is a primary objective for the chemical industry since harsh process conditions and usage of fossil resources increase greenhouse gas emissions and the carbon footprint. Making use of CO_2 as a feedstock to produce value-added organic chemicals is an attractive opportunity to realize a circular carbon economy. Moreover, electric energy generated by solar panels or wind power stations could be saved in stable chemical products. We combined both aspects in a novel bio-electrochemical system (BES) in which a PEM electrolysis cell is coupled to a standard stirred tank bioreactor. Precious group metal-free (PGM-free) catalysts consisting of atomically dispersed active metal sites in nitrogen-doped porous carbon matrix (M-N-C where M= Co, Ni, Zn etc.) enabled electrocatalytic CO_2 reduction to CO (CO_2RR) in an aqueous environment. The acetogenic bacterium *Clostridium ragsdalei* directly converts CO into organic acids and alcohols. Besides, the competing hydrogen evolution reaction (HER) delivers H_2 as an additional electron carrier that can be consumed together with CO_2. Bacteria are more flexible towards the stoichiometry of their substrates (CO, H_2 and CO_2), demonstrating an advantage over chemical synthesis processes that often require exact stoichiometries.

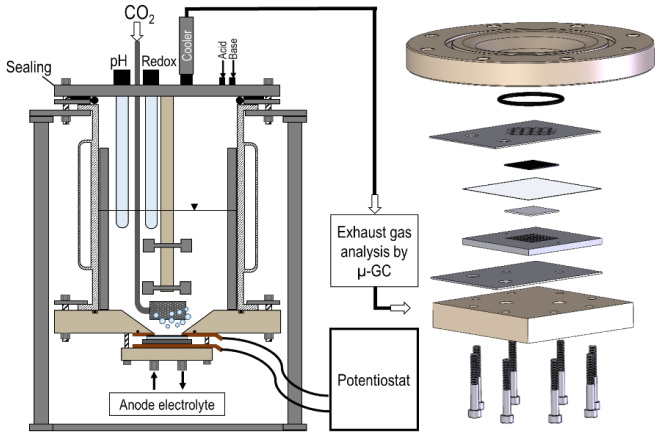

Figure 1: Design of the novel lab-scale bio-electrochemical system (BES, left) applying a modified standard stirred-tank bioreactor and the membrane-electrode-assembly (MEA, right).

https://www.epe.ed.tum.de/biovt/forschung/gasfermentation/bioelektrokatalyse-mit-acetogenen-mikroorganismen/

Possible objectives depending on your interests:

- New construction of membrane-electrode-assembly that allows CO_2 gassing directly into the cathode (Chemical engineering, Bioprocess engineering)
- M-N-C catalyst degradation study (all study programs)
- (Mixotrophic) Electrofermentations with *Clostridium ragsdalei* (all study programs)
- Study novel M-N-C catalysts in the single cell and BES in regards to selectivity, stability, total BES performance, different operation modes (all study programs)

More questions or interest in this topic?
Feel free to contact Irina Schwarz (irina.schwarz@tum.de)
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Possibility of a PhD in Berlin afterwards (Dr. Tim-Patrick Fellinger):
https://www.bam.de/Content/DE/Projekte/laufend/Ecat-Acetogens/ecat-acetogens.html