Sub-department of Environmental Technology

Combining *Chemo*- and *Bio*-Electro-Catalytic Synthesis of Chemicals

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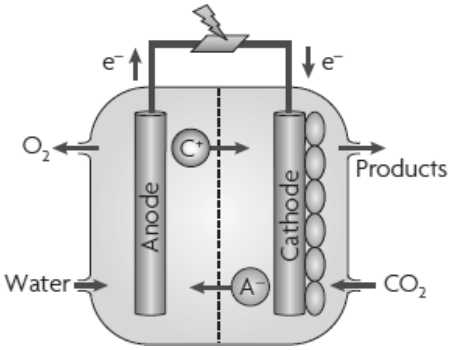
Motivation

CO_2 is the primary contributor to global warming. The conversion of waste CO_2 into valuable products has been proposed by many researchers. A novel mechanism is microbial electro-synthesis (MES), in which electrochemically active microbes use renewable electricity to convert CO_2 in organic molecules. MES is considered more efficient and sustainable than photosynthetic bio-fuel production.

Technological challenge



The MES cell consists of an anode and cathode, separated by a membrane. A schematic is given here. At the anode, water is oxidized and releases protons and electrons (e^-). The latter are transferred through an external circuit to the cathode, where microbes use e^- they directly accept from the electrode to convert CO_2 into products (e.g. volatile fatty acids, methane and short alcohols).

Although promising (80% reported coulombic efficiency for acetate), MES still faces challenges that limit its application. Three main challenges will be addressed as part of this research project: *a*. MES is limited by the e^- transfer from the electrode to the microbes (i.e. low current density); *b*. the product spectrum of MES is limited; *c*. product separation is inefficient due to high solubility, product inhibition, biodegradation and/or toxicity.

Methodology

In order to address these limitations, we will evaluate the incorporation of metal catalysts on the bio-cathode of an MES cell, thus combining electro-catalysis and MES. Cu, Ni, and Fe catalysts are selected based on their ability to convert CO_2 with high efficiency at ambient conditions. Carbonaceous materials, such as carbon nanotubes, have been used both as support for metal catalysts and as electrode materials for MES, and will therefore be employed. The set-up that will be constructed to evaluate the concept is shown below (depicted to operate with a bio-anode and chemical cathode).

The challenge is to investigate and develop different electro-catalytic bio-cathodes, resulting in improved operation of the MES process. The project will be performed in collaboration with the Biobased Chemistry and Technology (BCT) group of WUR.

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