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E Triple C - Electrons to close the carbon cycle

Concept evaluation, system development and process evaluation of hollow fiber geometry as gas diffuser and working electrode for electrochemical carbon dioxide and nitrogen activation.

Project number SI-20-03

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Partners AcelorMittal, Dow, TNO Energy Transition, Nouryon, OCI Nitrogen, Universiteit Twente, Yara

Budget 1 932 k€

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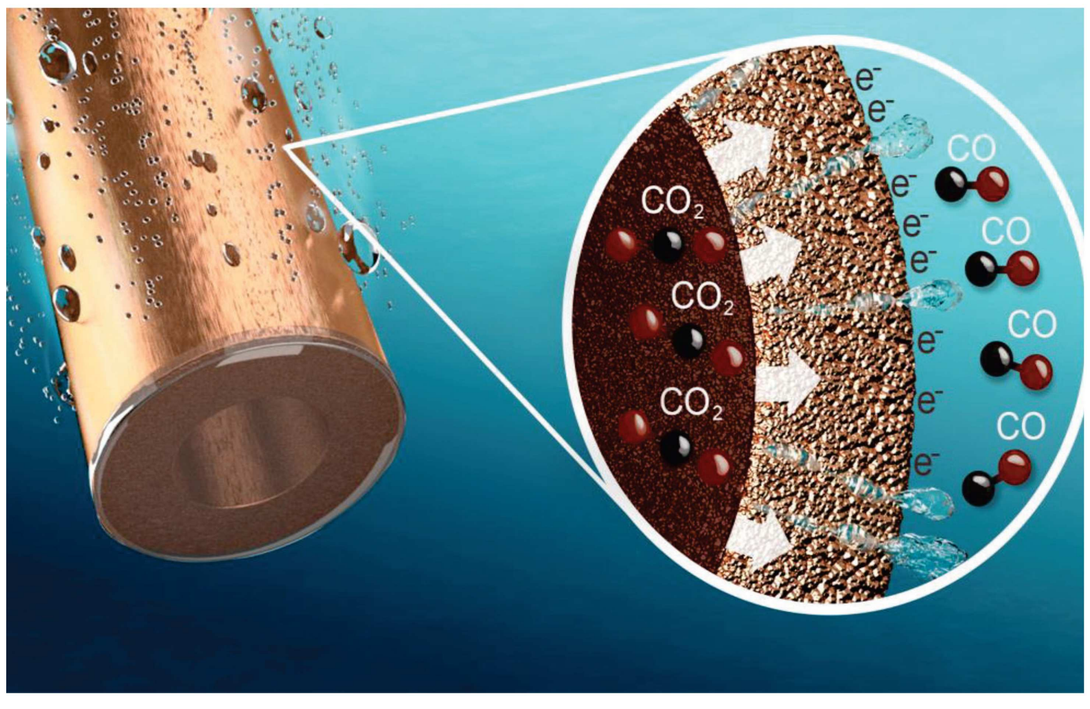
Motivation:

With the increasing amount of renewable electricity that is being produced, the **storage of renewable energy** into **chemical bonds** is gaining increasing interest. The project focuses on the conversion of respectively **nitric oxide to ammonia** and **carbon dioxide to carbon monoxide** using a novel **tubular catalyst**.

Objective:

Evaluation of the tubular electrochemical catalyst **concept** ('hollow fibers'), **system development** and **process evaluation** of the hollow fiber as gas diffuser and working electrode for the electrochemical conversion of nitric oxide to ammonia and carbon dioxide to carbon monoxide.



Copper hollow fiber electrode for carbon dioxide conversion. From DOI: 10.1038/ncomms10748.

NO_x to ammonia:

Current studies focus on applicability of hollow fiber based electrode for **nitric oxide** electroreduction into **ammonia**. The **influence of gas flow rate** through the fiber on current density as well as selectivity of reaction is investigated. When the fiber is operated in the mass transported limited regime, the current density improves with a higher flow rate.

Carbon dioxide to carbon monoxide:

The effect of **co-feeding carbon dioxide and carbon monoxide** on the carbon dioxide conversion of the copper hollow fibers is investigated. It is observed that the catalyst activity benefits from low carbon monoxide concentration near the catalyst surface. A publication regarding this study is under review.

Current research focuses on the effect of **geometry** (flat versus tubular) on the carbon dioxide conversion performance.

System development and process evaluation:

A fiber based **reactor** containing **multiple fibers** was developed. Both a low internal resistance and a high selectivity towards carbon monoxide were, amongs others, considered during the reactor design. An evaluation of the reactor's performance is planned for the near future.

Flat sheet carbon based copper gas diffusion electrodes:

Benchmark studies with flat sheet carbon based copper gas diffusion electrodes are performed. At the moment, the **effect of the ionomer content** of the GDE on its electrochemical performance is investigated. The amount of Nafion on the GDE's surface affects the selectivity towards CO. A publication regarding this study is under review.

Recent publication:

- Jong, R.P.H., Krzywda, P.M., Benes, N.E and Mul, G. (2020), *Preparation of Ti, Ti/TiC or Ti/TiN based hollow fibres with extremely low electrical resistivity*. DOI: 10.1039/D0RA04905K

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