Inorganic Materials & catalysis

Research Project – Emiel Hensen/Floriane Rollier

Title Electrochemical Fischer-Tropsch synthesis

Background

Increasing energy demand and fossil fuels scarcity encourage the ecological transition and the development of new sources of energy using wind, solar technologies or water force. The production of electricity via renewable sources undergoes a fluctuation of the output according to the weather. When an excess of energy is produced, these renewable electrons are nowadays lost. The electroreduction of small abundant molecules into fuels is a promising and achievable way of storing these electrons into chemical bonds.

Due to its abundance and non-toxicity, CO_2 is ideally suited as feedstock for fuels production such as light hydrocarbons and oxygenates (e.g. Methane, Ethylene, Ethanol, Propanol, etc.). CO_2 electroreduction (CO2ER) to fuels has been widely studied during the past decades but a lack of selective and active catalysts towards the formation of long chain products (C2+), having higher energy density than C1 products, does not allow upscaling to industrial level. During these studies, CO has been shown to be the key intermediate for C-C coupling process leading to C2+ products. Expecting better selectivity and efficiency in C2+ compounds production, using CO as reactant gas is seen as the electrochemical version of Fischer-Tropsch synthesis (e-FTS). The CO electroreduction (COER) to fuels will constitute the main part of the study in this project. The advantages of the electrochemical approach are the operation at mild reaction conditions compared to conventional FTS and the suitability for a start-stop configuration (particularly useful when using fluctuating sources of electricity).

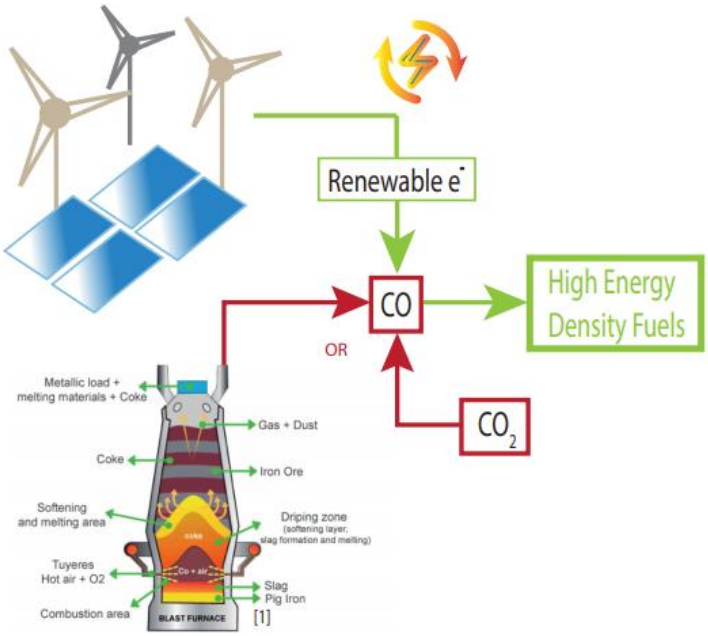

Figure 1 - Scheme of the Electrochemical Fischer-Tropsch synthesis process

According to the literature, copper was shown to be the only metal demonstrating ability to produce multi-carbon compounds in CO2ER and COER reaction. In this project, copper based catalysts will be studied and particularly bimetallic systems [2]. Composition, morphology and process parameters will be modified in order to enhance the production of C2+ compounds.

Techniques used:

- Electrochemical Characterization: Cyclic-voltammetry, Chrono-amperometry
- Physical Characterization: XRD, XPS, SEM, TEM, Physisorption N2,
- Chemical/Electrochemical synthesis
- Quantification of products: GC-MS for gas phase, GC and HPLC for liquid phase, NMR 1H

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[1] Thermofischer.com - the importance of metallurgical slags and their evaluation
[2] Nitopi et al., Chem. Rev. 2019, 119, 12, 7610–7672