# Inorganic Materials & catalysis
# Electrocatalysis

**Research Project – Emiel Hensen/Marta Figueiredo/Tim Wissink**

IMC
INORGANIC MATERIALS & CATALYSIS

## Electrocatalytic $CO_2$ reduction to synthesize formic acid
## From waste product to chemicals

### Background

The worlds demand for energy and products is rapidly increasing. As most of it is produced from fossil resources, the $CO_2$ concentration in the atmosphere is rising. In a search for new sources for products and energy storage, attempts are made to use the waste product $CO_2$ as a source for valuable chemicals. Formic acid is one such molecule that is widely used as feedstock in chemical industry[1] and is promising as a hydrogen carrier for on demand energy storage and production.[2] Formic acid can be produced using renewable energy and $CO_2$ from air.

The goal for this project is to obtain a high efficiency catalyst that will be studied for improving stability under industrially relevant conditions. Several catalytic materials have been proposed in literature and can achieve high faradaic efficiencies (>90%).[3] Nevertheless, for industrial implementation, several challenges need to be addressed. Formic acid is acidic but required in high concentrations to decrease downstream separation costs. Currently, the stability of the catalyst is poor and worsens with decreasing pH. Also, large current densities are required with low overpotential catalysts to decrease the capital and operational costs.

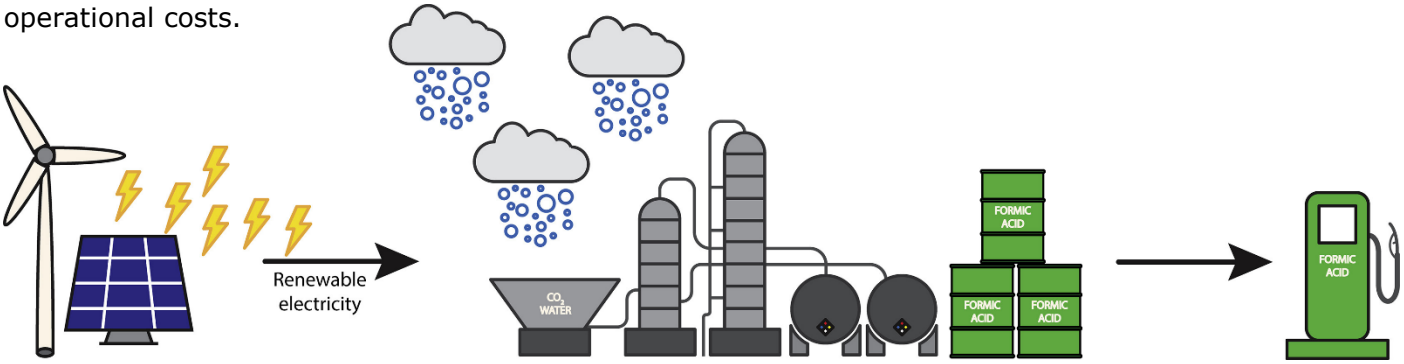


*Figure 1: Schematic overview of formic acid production from $CO_2$ and renewable energy[2]*

### Research objectives and techniques:

- Development of novel catalysts for the electroreduction of $CO_2$ and $H_2O$ towards formic acid
- Improve stability and durability of of catalyst with aid of catalyst characterization with physical techniques such as XPS, RAMAN, XRD, and TEM.
- Reaction mechanism study with common electrochemical techniques (e.g. Cyclic Voltammetry, Linear Sweep Voltammetry) and complementary analytical techniques (e.g. GC-MS, HPLC, NMR)
- Optimization of the reaction in a flow cell configuration for industrial relevant applications

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[3] G. Liu, T. Tran-Phu, H. Chen, and A. Tricoli, "A Review of Metal- and Metal-Oxide-Based Heterogeneous Catalysts for Electroreduction of Carbon Dioxide," *Adv. Sustain. Syst.*, vol. 2, pp. 1–13, Aug. 2018.