Abstract CLUE

Clusters for CO_2 electrolysers to ethylene, full cSBO with a proposed starting date on 1 January 2022 and a proposed duration of 48 months, with partners VITO, KU Leuven and UAntwerpen.

CLUE aims to develop the **next generation CO_2 electrolyzers** for **sustainable production of ethylene** with reduced carbon footprint by designing novel, selective and highly robust electrocatalysts using an innovative approach based on **Cluster Beam Deposition (CBD) technology**. For electrochemical conversion of CO_2 to ethylene, stimulating results have recently been obtained mainly on copper-based catalysts, yielding relatively high Faradaic efficiency (FE ≈ 60-70%) and current densities (100-200 mA cm^{-2}) by using a flow cell with a gas diffusion electrode. Although the prospects for electrochemical ethylene production are promising, several challenges need to be overcome before industrial implementation: the full-cell energetic efficiency (EE) for ethylene production is ≤30%, operation window is narrow, electrocatalyst lifetime is poor (<200 hours). Achieving high selectivity for ethylene production with low energy input (**EE > 30%)** at **high production rates** (j > 300 mA cm^{-2}) for a **long-term operation** (> 1000 hours) remains a major challenge. Moreover, the capability of CO_2 electrolyzers to **utilize captured CO_2** has not been assessed so far, introducing additional uncertainties for industrial implementation given the limited **insights in electrocatalyst degradation and deactivation**. Within CLUE, CBD technology is used to deposit size-selected bi- and multimetallic clusters with a very high and controllable homogeneity and desired morphology on adequate electrodes. This allows for **steering electrocatalyst functionality** and hence **enhancing electrocatalyst performance** (selectivity, production rate and stability). Moreover, extensive **(*in situ*/*operando*) structural characterization** will enable to fundamentally **understand the structure-property relations during electrochemical operation under realistic conditions** (i.e. at high current density and with industrially-relevant CO_2 streams). The obtained insights will guide the cluster production to design electrodes with **improved stability** that will allow **avoiding, circumventing or minimizing electrode degradation or performance deterioration** in next generation CO_2 electrolyzer systems. A prototype electrolyzer will be fabricated for **long term operation** and durable and **cost-effective production of ethylene** from **captured CO_2** and renewable energy.

For substantive questions about this project proposal, please contact MOT3 representative Luc Van Ginneken (lvanginneken@catalisti.be; +32 477 979 947).