NanoGe Fall meeting

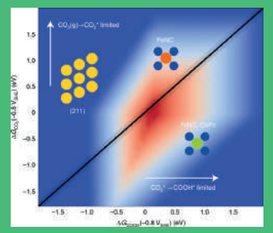
The SELECTCO2 consortium organised a symposium - ***#SolCat21. (Photo-)Electrocatalysis: From the Atomistic to System Scale*** during the online NanoGe Fall meeting on 18-20 October 2021. There were **12 invited speakers** and 29 in total. This event gave visibility to the project results, allowed for knowledge transfer outside the Consortium, encouraged future collaboration and favored exploitation opportunities.

https://www.nanoge.org/NFM21/symposia?t=5e4bfebb397fc479c7cd56ee

Publication

Unified mechanistic understanding of CO_2 reduction to CO on transition metal and single atom catalysts, S. Vijay, W. Ju, S. Brückner, S.-C. Tsang, P. Strasser & K. Chan, *Nature Catalysis*, 4, 1024–1031 (2021)

https://doi.org/10.1038/s41929-021-00705-y



Consortium

- Industrie De Nora
- Coordinator Technical University of Denmark
- Technical University Berlin
- Delft University of Technology
- Swiss Federal Institute of Technology Lausanne
- RINA Consulting SpA
- University of Surrey
- Pretexo
- SLAC National Accelerator Laboratory

Website: www.selectco2.eu

SELECT CO2

NEWSLETTER #2
FEBRUARY 2022

SELECTIVE ELECTROCHEMICAL REDUCTION OF CO_2 TO HIGH VALUE CHEMICALS

SELECTCO2 moving towards its objectives !

2021 was a successful second year for the EU funded project SELECTCO2, with both **new membranes and gas diffusion electrodes** developed for CO_2 electrolysis. In parallel, the **mechanisms of CO_2 electrolysis to CO** on single site catalysts has been resolve resulting in a **Nature Catalysis publication**, as well as the branching point between ethylene and ethanol production on copper. **Environmental analysis** has shown that CO_2 electrolysis is an **excellent way to negate CO_2 emissions.**

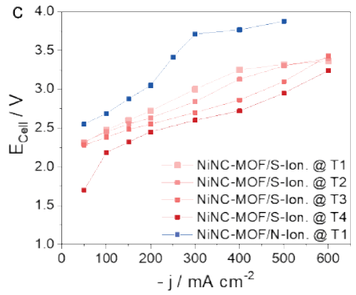
In the following year we expect to produce **more robust membranes and effective gas diffusion electrodes**. We expect these along with enhancements in **catalyst design** and **mass transfer optimizations** to allow us to achieve **highly efficient** (> 40% energy efficiency) **high current density** (>200 mA/cm2) selective (> 80%) conversion into either CO, ethylene or ethanol.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 851441.

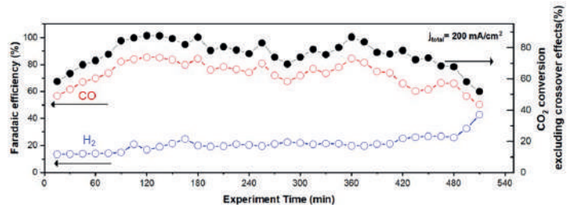
Highlights

- **De Nora** has been able to successfully integrate a variety of CO_2 to CO, ethanol, and ethylene producing catalysts into their gas diffusion electrodes. The approach taken is **easily scalable** providing a route to take newly developed catalysts and rapidly integrate them into a variety of different gas diffusion layers.
- **University of Surrey** has tuned their newly developed membrane to **reduce costs**, as well as improve water management and ionic conductivity issues.
- **Denmark Techinal University** has developed an electrochemical mass spectrometry approach that can **measure volatile CO_2 electrolysis products** such as acetaldehyde and ethanol.

CO_2 to CO selectivities & conversion rate

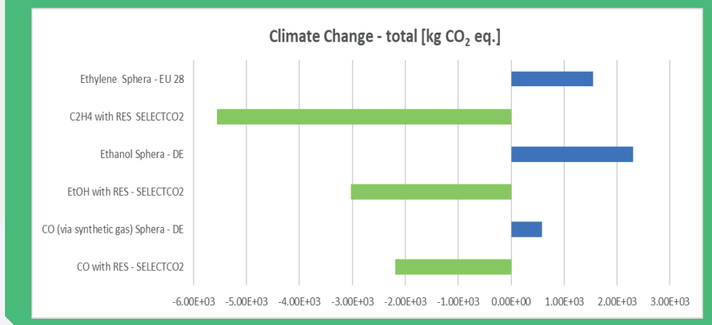


Technical University Berlin has been able to achieve high CO_2 to CO selectivities (85-98%) using single site catalysts and have been able to operate at impressively low cell voltages.



Denmark Techinal University was able to show ~80% conversion of CO_2 to CO for 8 hours (excluding CO_2 crossing over to the anode)

Reduction of $CO_{2\ eq.}$ emissions



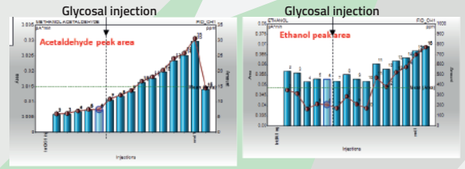
Compared to benchmark routes to obtain the targeted products, **RINA-C** has shown that the SELECTCO2 technologies have the potential to achieve **significant savings in terms of $CO_{2\ eq.}$ emissions** (even $CO_{2\ eq.}$ negative emissions may be obtained at the point of production due to carbon capture and utilisation approach of SELECTCO2 solutions)

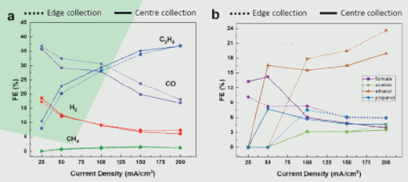
Main Achievements

Ethylene production

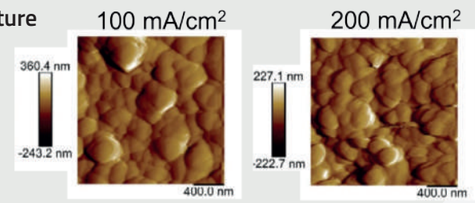
Technical University of Delft:

- Has shown that the insertion of glyoxal (CO_2 reduction intermediate) has a substantial influence on **acetaldehyde production**, but a lesser effect on ethanol production.





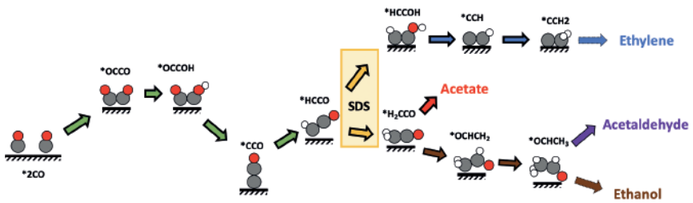
- Has observed a notable difference in **ethanol efficiencies** when comparing the center versus the edge of a device. This effect was seen in 1M KOH (left graphs), but not is 1M $KHCO_3$, entailing a more complex mass transfer effects when operating in alkaline.
- Was able to monitor **catalyst surface structure** while operating at current densities up to 200 mA/cm^2.



Membranes & ionomers

At University of Surrey, efforts into **developing radiation-grafted anion-exchange membranes (RG-AEMs),** tailored to CO2RR cells, have now successfully down-selected substrate type and thickness, head-group chemistry, amination protocol, and optimal IEC range. RG-AEMs have been found to **perform as well as commercial benchmark AEMs**, with **less brittleness** for added ease of handling. Work in the final year of the project will focus on elucidating the correct combination of additional functionalities to ensure optimal water and ion transport through the RG-AEMs.

Denmark Techinal University has been able to computationally understand the CO_2 reduction mechanism and has found the most likely branching point between ethanol and ethylene.



CO_2 reduction mechanism