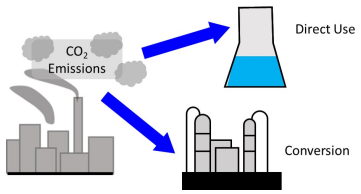
An Intensified Electro-Catalytic Process for Production of Formic Acid from Power Plant CO_2 Emissions (FE0031720)

Center for Applied Energy Research

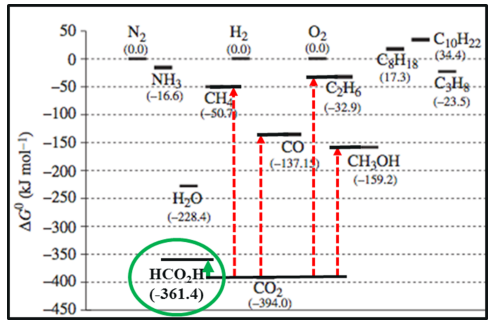
Introduction

UK CAER aims to decrease the cost of CO_2 capture from coal-derived sources through novel electrochemical methods to convert CO_2 into formic acid.



Formic acid (HCO_2H) has been selected as the target due to:

1) Lowest Gibbs energy input
1) Lowest atomic input (protons + electrons)
2) Potential for expanding the commercial market for formic acid



Project Overview

Develop and test a novel electro-catalytic method to produce high-value formic acid from coal-derived CO_2 as a strategy to offset the cost of CO_2 capture.

The project involves the development and testing of an engineered catalyst to selectively reduce CO_2 directly and exclusively to formic acid, along with process intensification and numerous aspects of a novel reactor design.

Project Period: 1/1/2019 - 6/30/2021 (30 months)

Funding: Federal - $800K; Cost share - $201K; Total - $1M

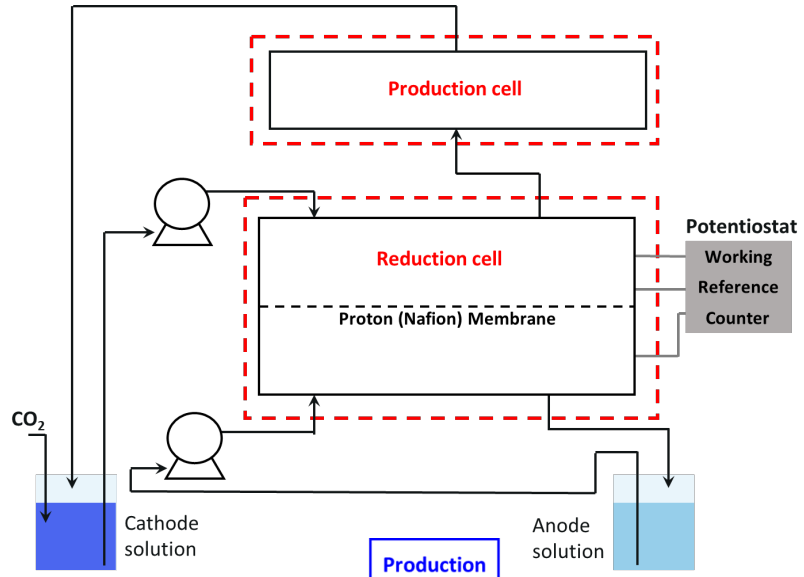
Project Team: UK CAER and UNIST

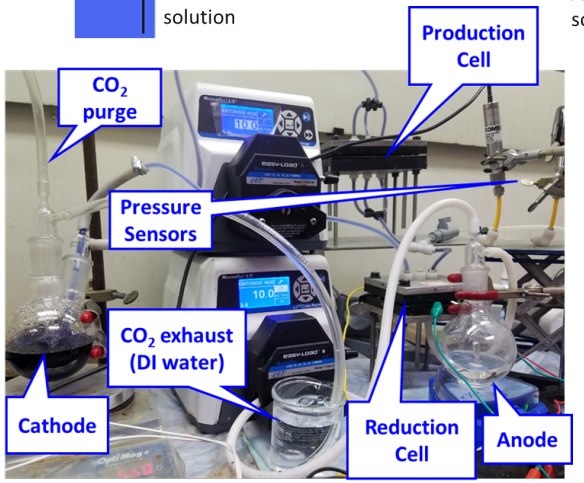
NETL Project Manager: Naomi O'Neil

Center for Applied Energy Research

UNIST Ulsan National Institute of Science and Technology

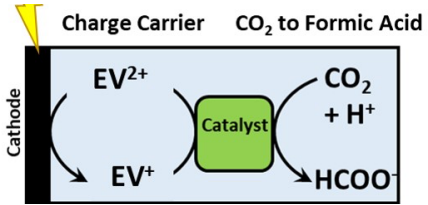
UK CAER Andora Process





Production cell contains an engineered catalyst to specifically convert CO_2 into formic acid **Reduction cell** is where a charge carrier accepts an electron before flowing to the production cell where it is transferred to the catalyst

Charge carriers, such as ethyl viologen (EV), shuttle charge between the cathode and catalyst, enabling formic acid production from only protons and CO_2



Results

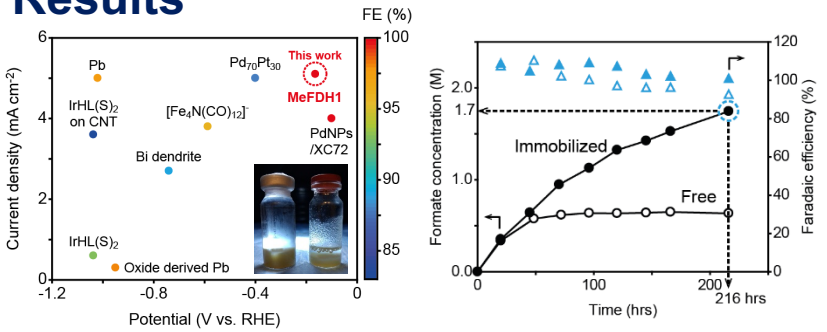


Fig. 1 and 2: Comparison between UNIST and other published catalyst for electrochemical CO_2 reduction.

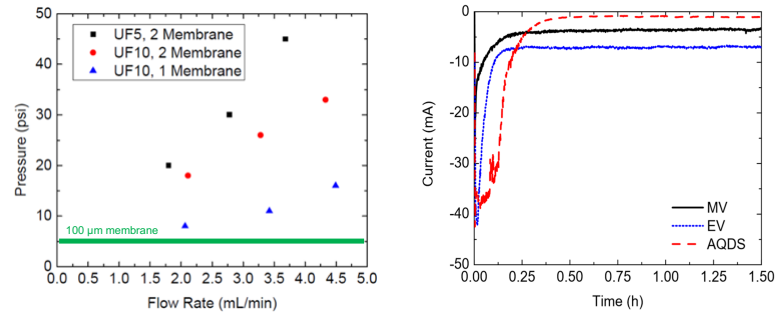
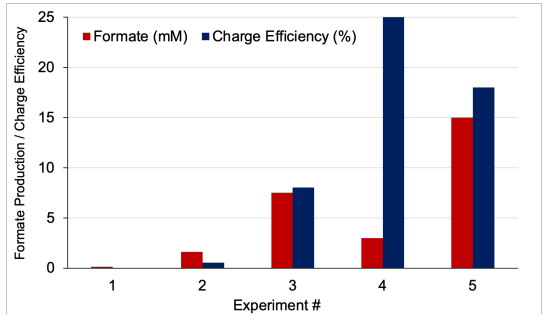


Fig. 3. Immobilization of the catalyst in the production cell using a mesh membrane enables high flow rates and minimal pressure. **Fig. 4.** Stability of charge carrier compounds after accepting electrons in the reduction cell.



Each step in this project has resulted in a significant improvement to both the formic acid (formate) production and charge efficiency in UK CAER Andora dual-cell flow-through process.

Remaining Work

- Increase formic acid production to final target of 100 mM
- Perform Life Cycle Analysis
- Conduct high-level TEA and evaluate the application of conventional formate separation techniques to this process