Optimization of Electrode Material, Morphology and Geometry for Electro-Swing Direct Air Capture of Carbon Dioxide

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U.S. Department of Energy

National Energy Technology Laboratory

Direct Air Capture Kickoff Meeting

February 24-25, 2021

Program Overview

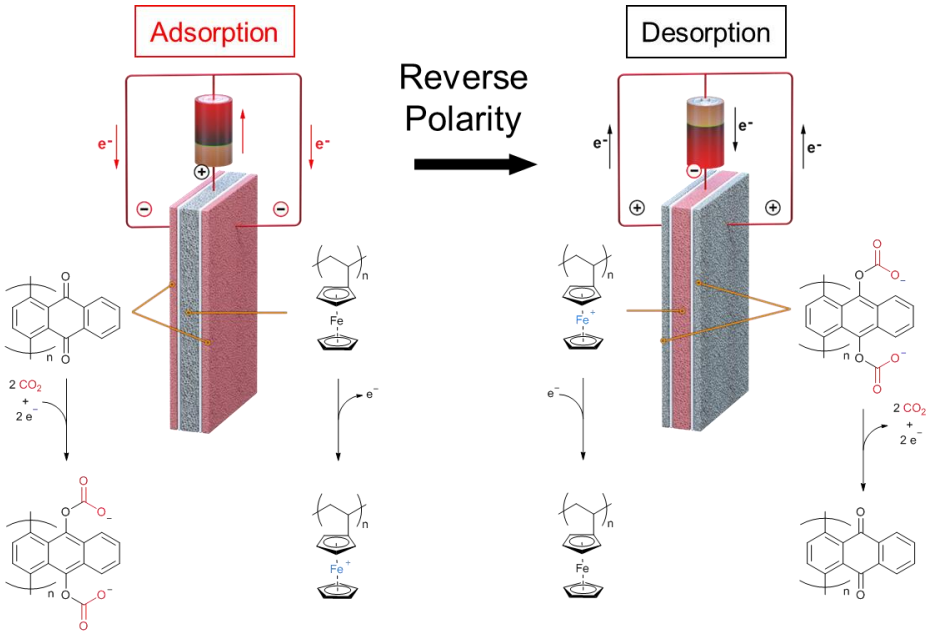
a. Funding: DOE – $250k
b. Project start date: 06/29/2020; End date: 04/28/2021
c. Project Participants: Verdox, Inc.
d. Overall Project Objectives

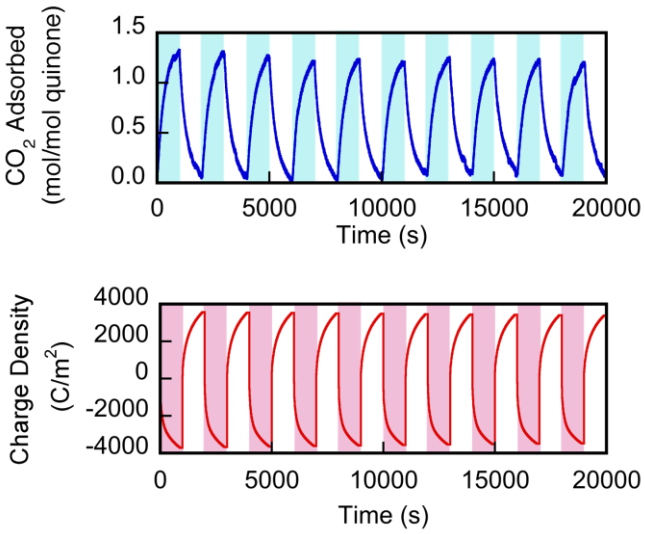
Optimize Electro-Swing Adsorption (ESA) system for DAC along three thrusts:

1. High selectivity to CO_2
2. Mass transfer of CO_2 into electrodes
3. Pressure drop in the flow channels

Technology Background

- Electro-Swing Adsorption: Capture during charge, release during discharge
- Binary affinity to CO_2 toggled electrochemically – Allows capture at 400 ppm





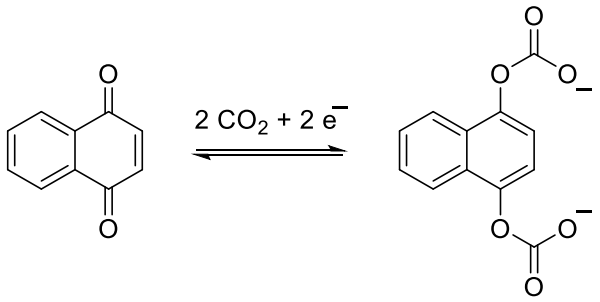
- Electrochemical system allows for high efficiency and cost effective DAC
- Selectivity, Mass transfer and pressure drop are some of the challenges

Verdox

US Patent 10,464,018

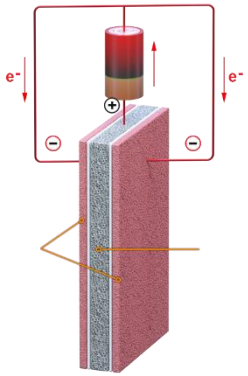
Technical Approach/Project Scope

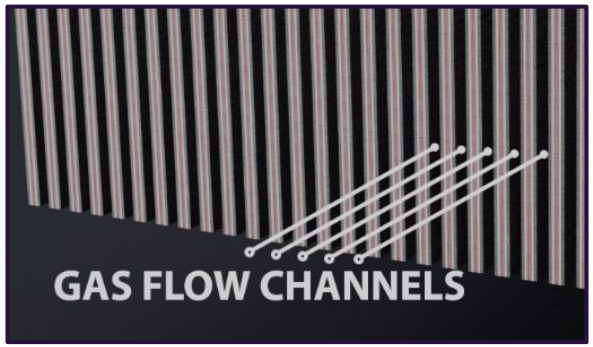
Optimize the components of the electrochemical cells to allow for the development of viable DAC systems



O1: High selectivity to CO_2 by tuning the redox material

O2: Improve the capture rate by optimizing the electrode morphology

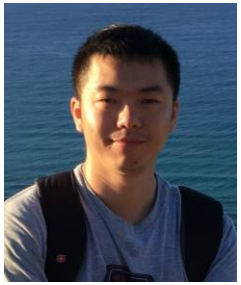




O3: Reduce pressure drop by optimizing channel geometry

Team and Facilities





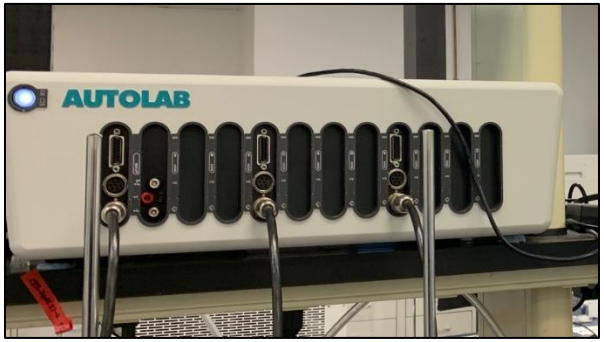

Project Team:

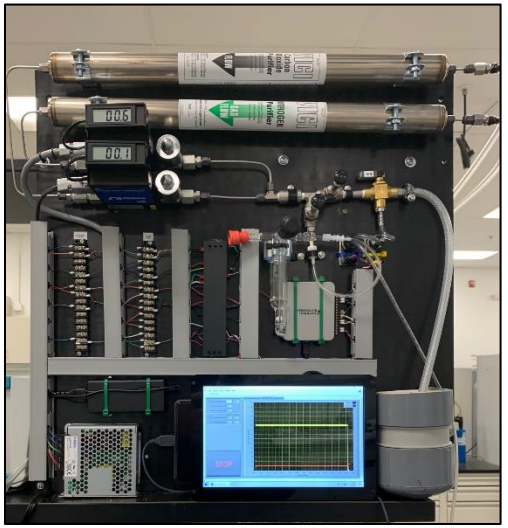
Sahag Voskian (PI)

Alex Reath

Zhijiang Tang

Sydney Morris

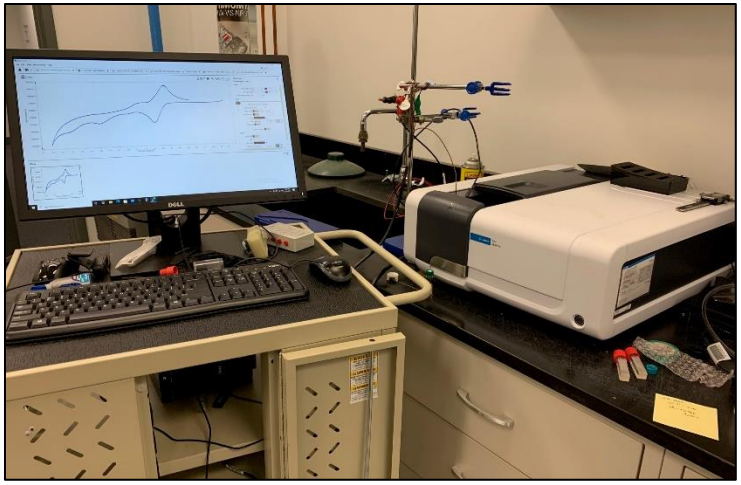




Verdox labs (Woburn, MA)

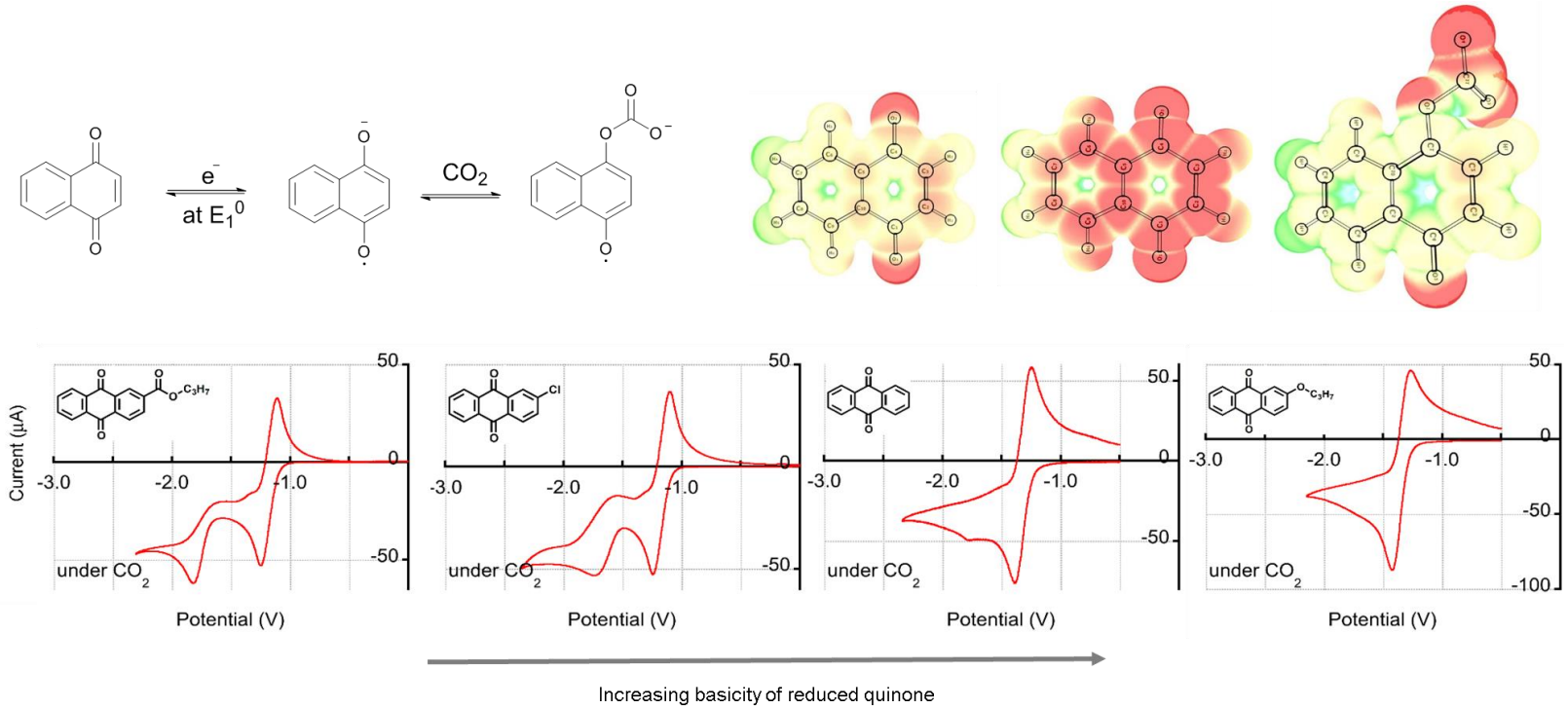
- Multichannel Potentiostat
- Gas mixer
- Mobile potentiostat + UV-vis

for testing solutions of redox active molecules under various gases.



Verdox

Progress and Current Status of Project



- Tuning the basicity of the redox molecule like anthraquinone or naphthoquinone to improve selectivity. High selectivity improves DAC energy efficiency
- Low pressure drop < 1,000 Pa achieved in channels

Opportunities for Collaboration

Verdox plans to leverage existing industrial processes and facilities to develop and commercialize ESA systems

Multiple opportunities for collaboration:

- Toll synthesis
- Roll-to-roll coating
- Electrochemical systems (e.g. batteries)
- Process Engineering – Integration of ESA DAC into other processes