Electro-swing adsorption for high efficiency direct air capture

DE-AR0001248

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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: ARPA-E – $500k
b. Project start date: 04/08/2020; End date: 04/07/2022
c. Project Participants: Verdox, Inc.
d. Overall Project Objectives:

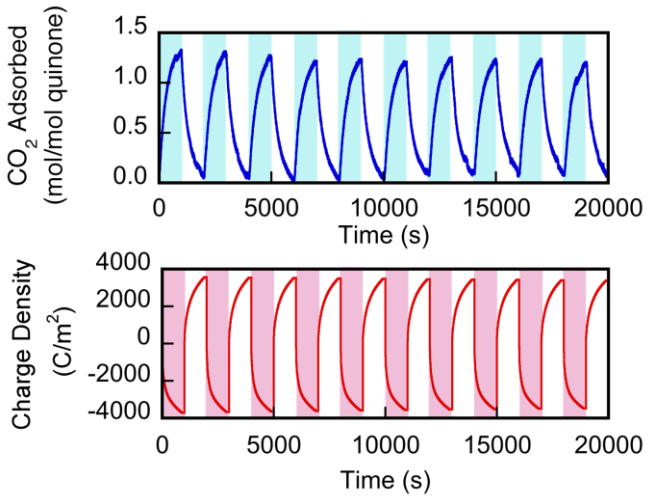
Demonstration of ESA DAC system with:

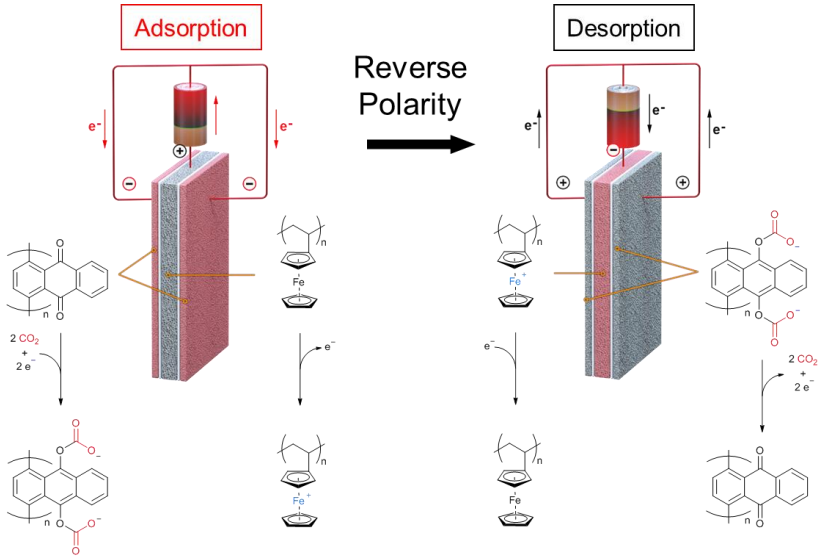
- High cycling durability of electrodes
- High electrode utilization
- Fast cycles

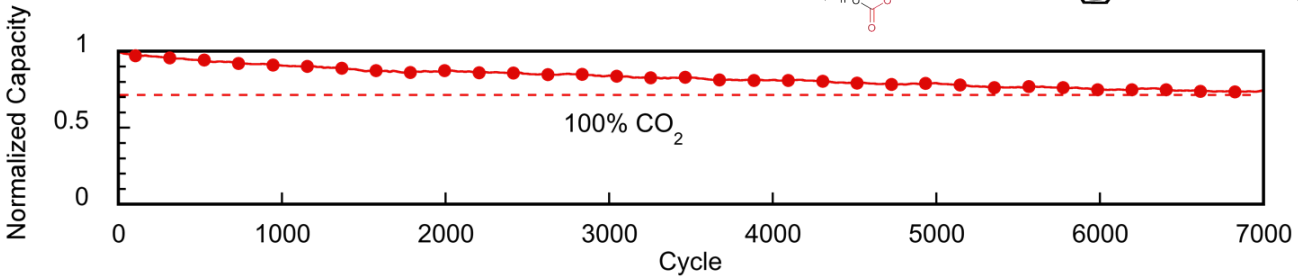
Perform techno-economic analysis showing pathway to cost of \$100/ton CO_2 or less

Technology Background

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







Retention of capacity upon cycling is a challenge

US Patent 10,464,018

Technical Approach/Project Scope

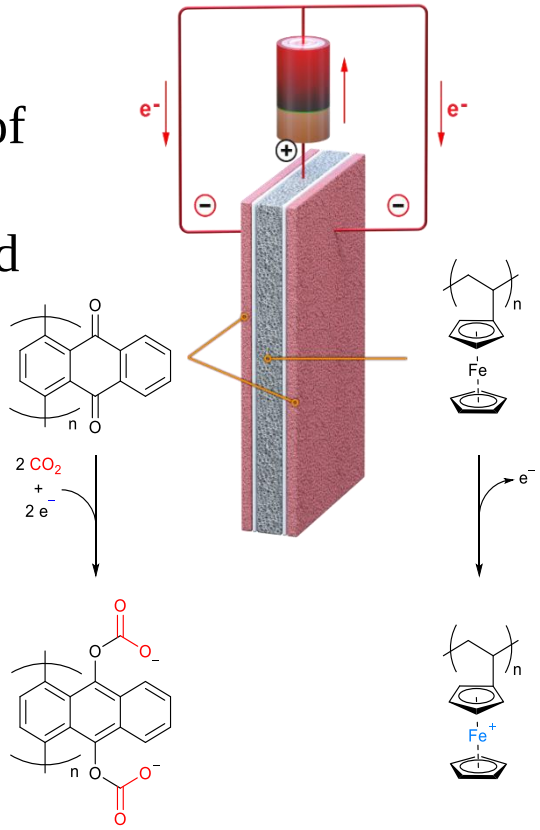
Work plan involves:

Phase I (Year 1)

- Development of robust material which allow retention of cell capacity upon cycling
- Development of electrochemical cells for fast cycles and low energy capture
- Technoeconomic analysis

Phase II (Year 2)

- Further improvement of material and cell performance
- Demonstration of DAC
- Technoeconomic analysis



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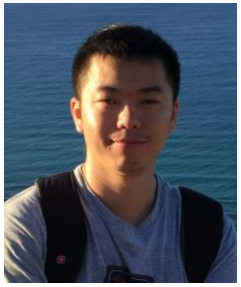
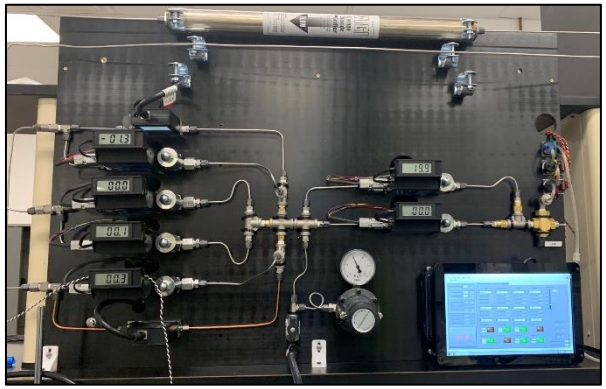
Team and Facilities







Project Team:
Sahag Voskian (PI)
Cameron Rogers
Bhooshan Popere
Zhijiang Tang
Casey Manning

Verdox labs (Woburn, MA)

- Synthesis station
- Multi-range, multi-gas mixer
- Multi-channel cycler
- Multi-cell testing

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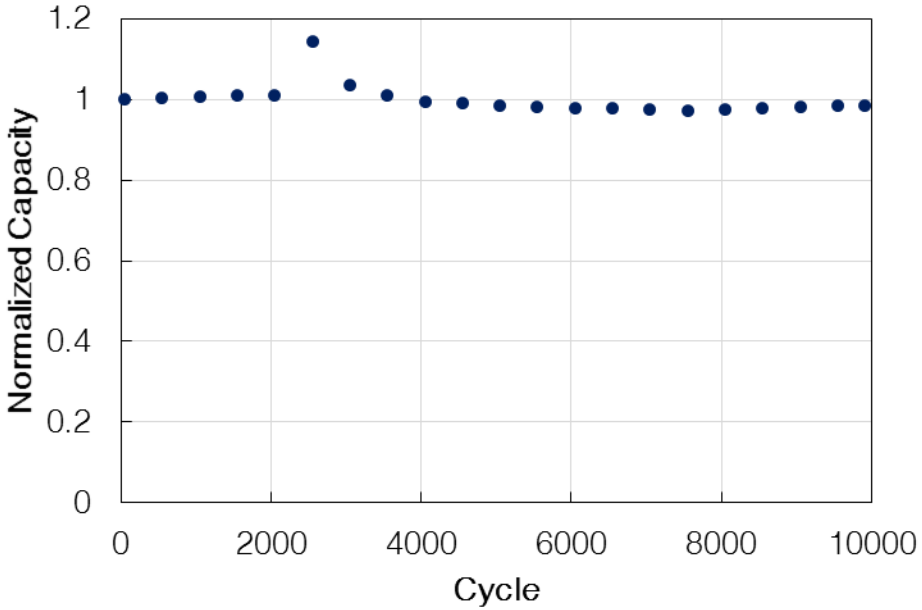
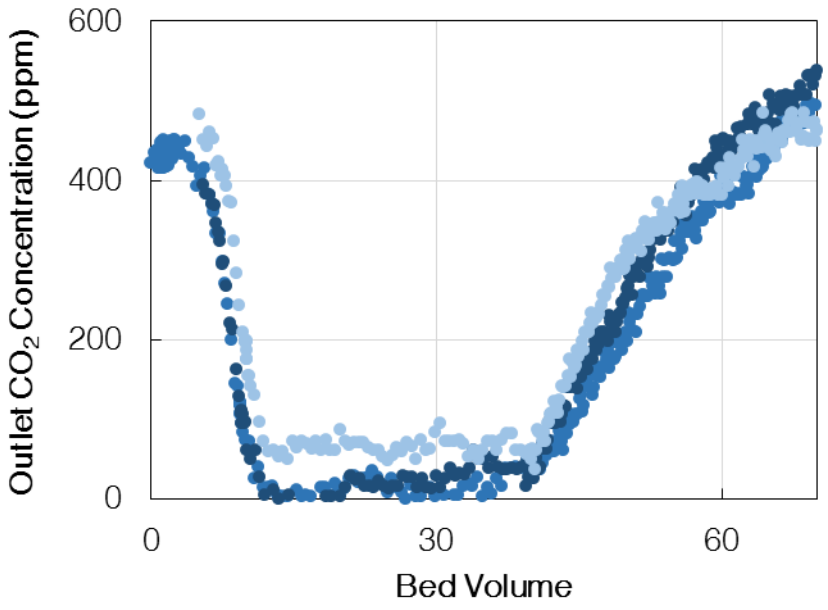
Progress and Current Status of Project





Novel material synthesized which demonstrate:

- Retention of > 97% capacity over > 10k cycles,
- Electrode utilization > 94%
- Faradaic efficiency >92%

Capture of CO_2 at 400 ppm demonstrated over multiple cycles

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)
- Design and fabrication of units
- Process Engineering – Integration of ESA DAC into other processes