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

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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 CO₂
2. Mass transfer of CO₂ 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
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.
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