Electrochemical Direct Air Capture of CO$_2$ using Redox-Active Textiles

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Program Overview

a. Funding
   $431,915

b. Overall Project Performance Dates
   February 2021 – February 2023

c. Project Participants
   University of Michigan
   University of Massachusetts Amherst

d. Overall Project Objective
   Develop high-surface area redox-active textile electrodes for electrochemical CO$_2$ capture from air
Technology Background

\[ Q + 2e^- + 2H_2O \leftrightarrow QH_2 + 2OH^- \]

**CO₂ invasion:** \( OH^- + CO_2(g) \rightarrow HCO_3^- \)

**CO₂ release:** \( HCO_3^- + H^+ \rightarrow CO_2(g) + H_2O \)

- Cheap electrodes and aqueous electrolytes enable scalable CO₂ capture
- System can be designed to limit O₂ transport to the electrode and oxidation of QH₂

Technical Approach/Project Scope

**Work Plan**

1. Synthesize PCET-active conductive textile electrodes using reactive vapor deposition
2. Integrate electrodes into CO$_2$-separating flow cells
3. Optimize energetic cost of CO$_2$ capture based on modeling

**Goal:** Benchtop demonstration of 100 stable CO$_2$ capture/release cycles from ambient air to $>5\%$ CO$_2$ with a working capacity of 100 mol CO$_2$/m$^3$ and $<100$ kJ/mol CO$_2$
Team and Facilities

University of Michigan

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University of Massachusetts Amherst

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Opportunities for Collaboration

- Modeling of PCET at the electrode/electrolyte interface and charge transport within the porous electrode
- Design of electrochemical cell and gas-liquid contactors for large scale prototyping
- Techno-economic analysis of the influence of electrode and cell cost on cost of captured CO₂