Electrochemical Direct Air Capture of CO_2 using Redox-Active Textiles

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David Kwabi (University of Michigan)
Trisha L. Andrew (University of Massachusetts Amherst)

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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

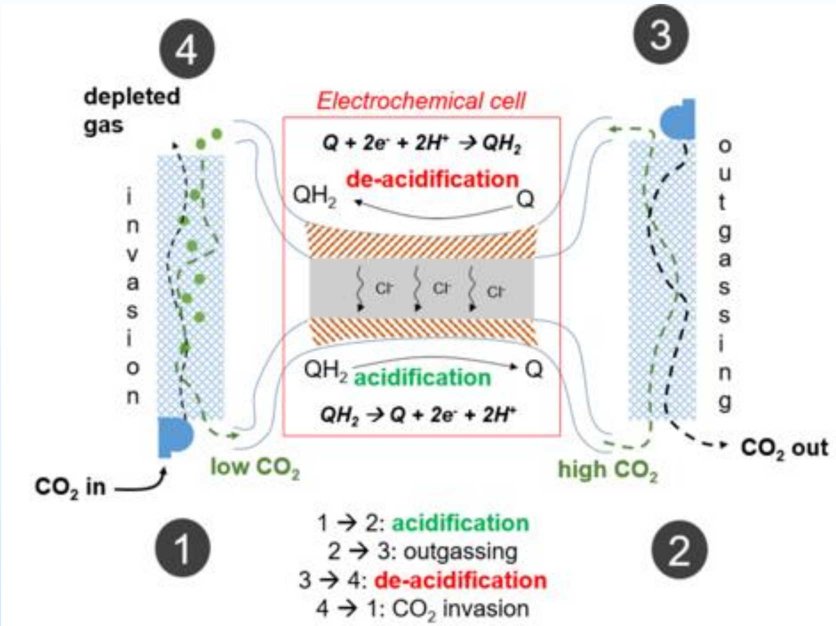
University of Massachusetts Amherst

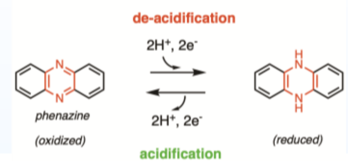
d. Overall Project Objective

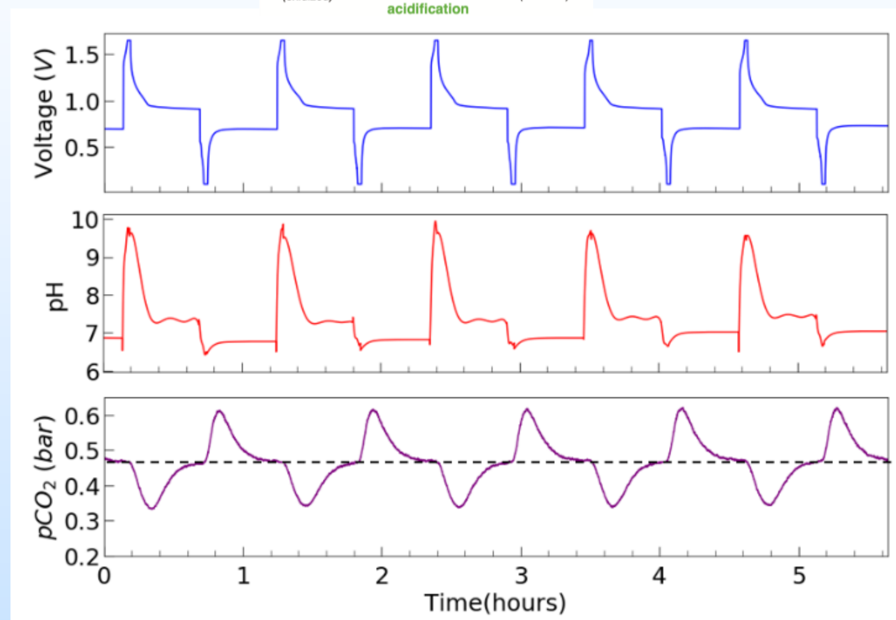
Develop high-surface area redox-active textile electrodes for electrochemical CO_2 capture from air

Technology Background

$Q + 2e^- + 2H_2O \leftrightarrow QH_2 + \mathbf{2OH^-}$







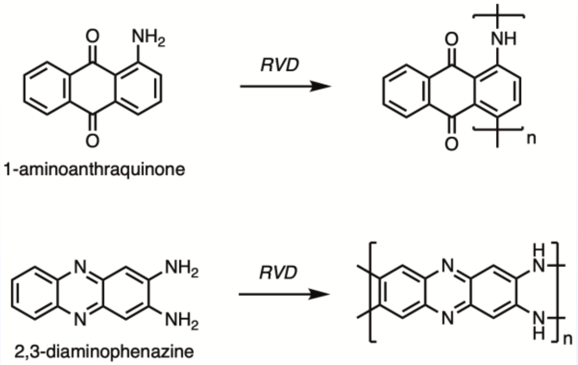
CO_2 invasion: $OH^- + CO_{2(g)} \rightarrow HCO_3^-$

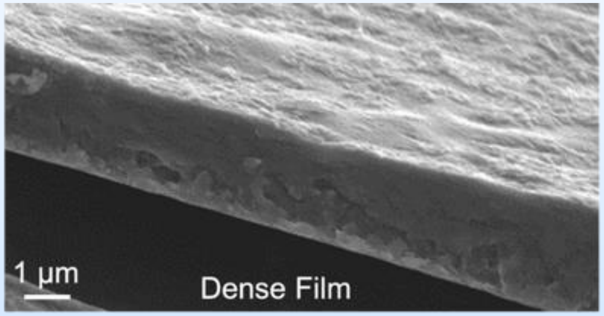
CO_2 release: $HCO_3^- + H^+ \rightarrow CO_{2(g)} + H_2O$

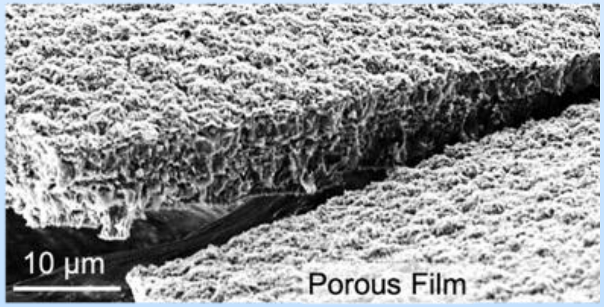
Jin, S.; Wu, M.; Gordon, R. G.; Aziz, M. J.; Kwabi, D. G. pH swing cycle for CO2 capture electrochemically driven through proton-coupled electron transfer. *Energy & Environmental Science* ***2020***

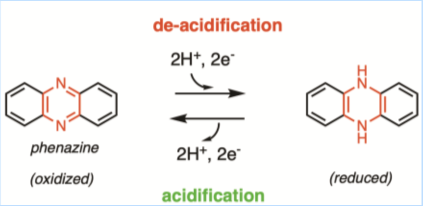
- Cheap electrodes and aqueous electrolytes enable scalable CO_2 capture
- System can be designed to limit O_2 transport to the electrode and oxidation of QH_2

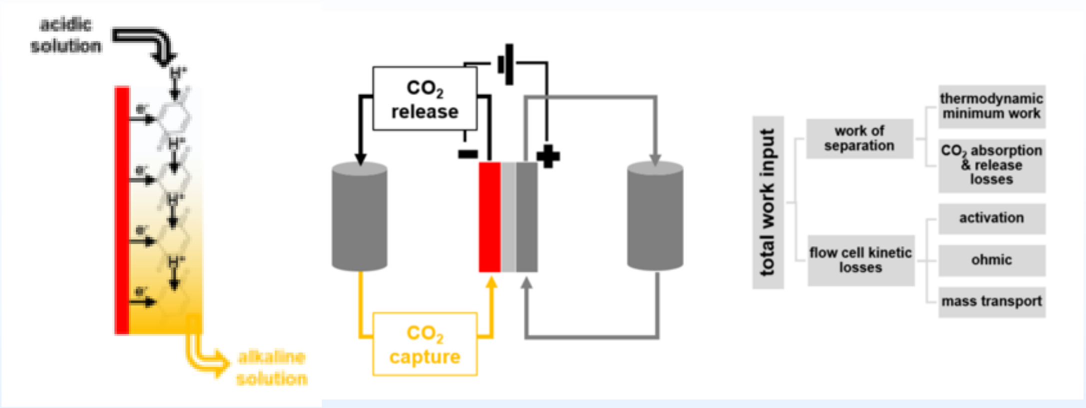
Technical Approach/Project Scope











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_{CO2}/m^3 and < 100 kJ/mol_{CO2}

Team and Facilities

University of Michigan

David Kwabi

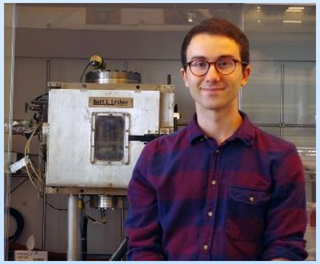
Fawaz Ali

Sanat Modak

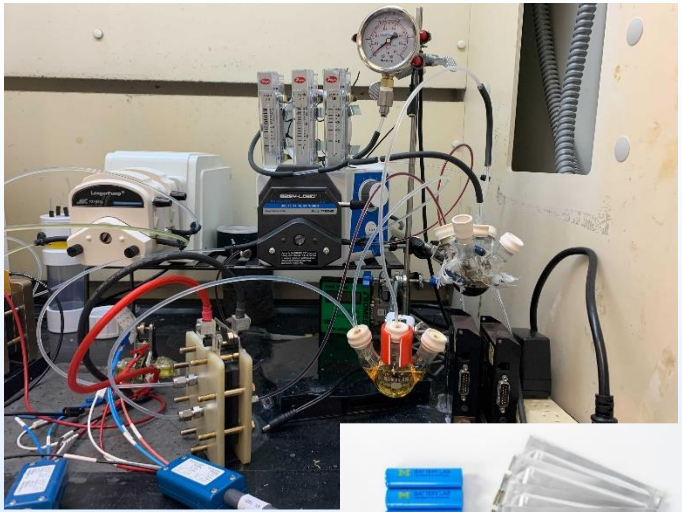
University of Massachusetts Amherst

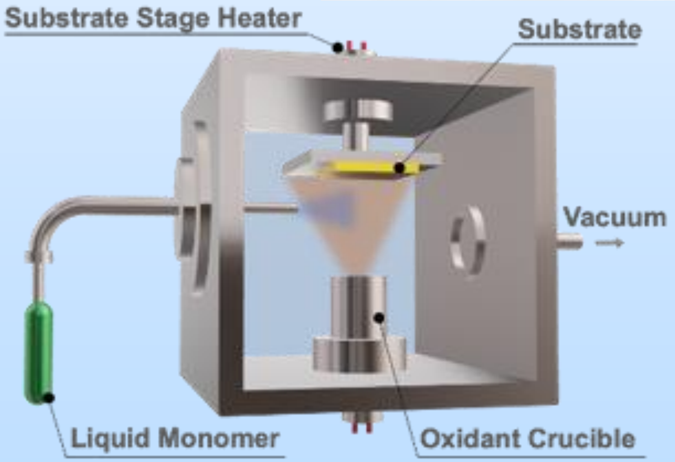
Trisha L. Andrew

David Bilger

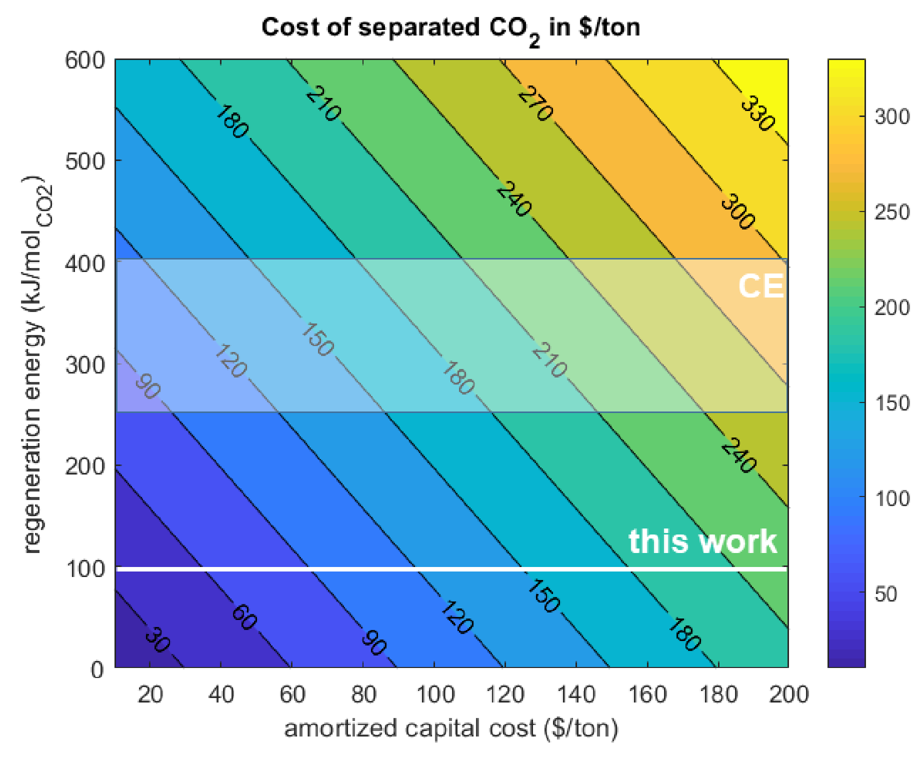


Wesley Viola





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 CO_2