Electro-swing adsorption for high efficiency direct air capture

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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 CO₂ 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
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
Team and Facilities

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

**Verdax labs (Woburn, MA)**
- Synthesis station
- Multi-range, multi-gas mixer
- Multi-channel cycler
- Multi-cell testing
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