TRAPS: Tunable Rapid-uptake AminoPolymer Aerogel Sorbent for direct air capture of CO_2

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U.S. Department of Energy

National Energy Technology Laboratory

Direct Air Capture Kickoff Meeting

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Program Overview

- Funding: $0.8M DOE & $0.2M Cost Share
- Period of performance: 18 months
- Team:

- Objectives:
  - Synthesize sorbent with high equilibrium capacity (4 mmol/g), rapid uptake rate (0.15 mmol g^{-1} min^{-1}), and long oxidative stability
  - Characterize sorbent in a fixed bed reactor at >25 g scale
  - Model performance and cost of a DAC process with the sorbent

Technology Background

Temperature swing sorbent based on PARC's porous polymer synthesis platform

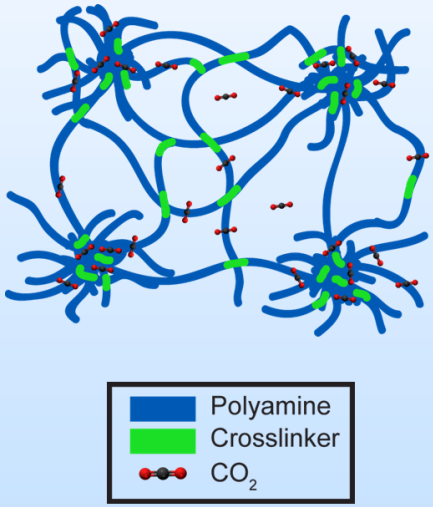
PARC aerogels:

- Moderate porosity
- Ambient dried/scalable
- High surface area
- Thin pore walls
- Tunable chemistry
- Variety of formfactors

Non-sorbent aerogels

Develop Sorbent

Key Innovation: Polyamine aerogel



Anticipated Benefits

High capacity: 4 mol CO_2 kg^{-1}
High amine content
Thin pore walls, 10s nm

Fast kinetics: 0.15 mol CO_2 kg^{-1} min^{-1}
Mesoporous (10s nm scale)
Specific surface area: 100-1000 m^2/g

Degradation resistance
Material structure

Low sensible heat load
Low inactive mass

Challenges:

- Adapting synthesis to incorporate amine
- Maximizing amine content without sacrificing pore structure
- Achieving long cycle life is a challenge for solid sorbents, in general

Technical Approach/Project Scope

PARC led

Aerogel formulation development

Maximize incorporation of amine monomer

Lab scale characterization

Show feasibility of meeting target properties

Scale-up and physical properties

(1) Produce sorbent for fixed bed testing
(2) Measure attrition/crush strength

LLNL led

Fixed bed sorbent testing

Demonstrate Target properties

Conceptual process design

Develop projections of cost and energy efficiency

Success Criteria:

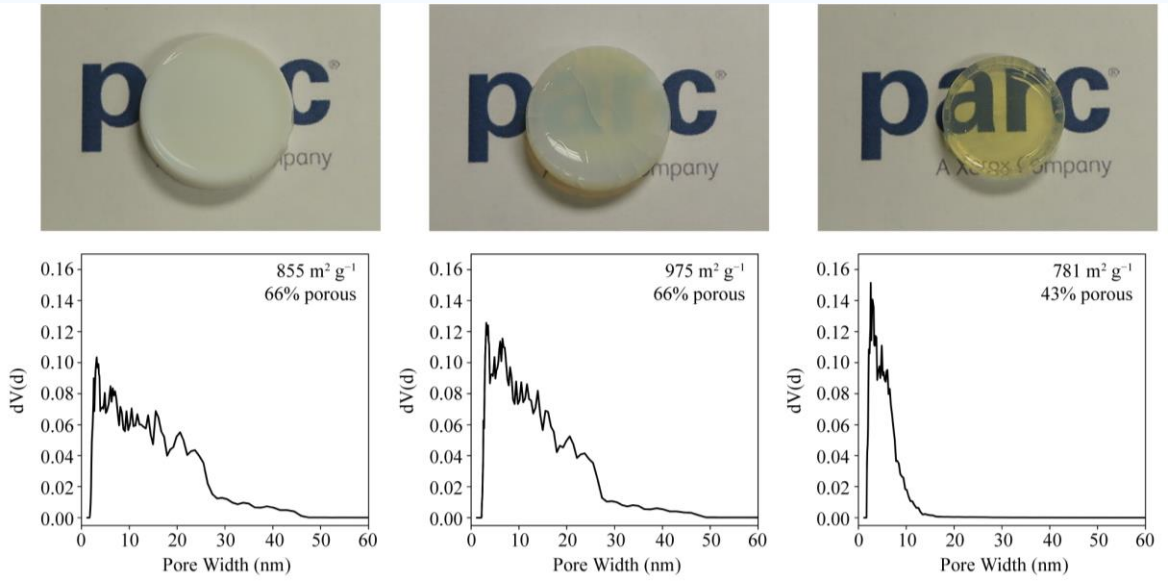
- Measure sorbent and physical properties in State Point Table
- Achieve CO_2 adsorption up to 4 mmol/g at 0.15 mmol/g/min and desorption down to 0.4 mmol/g at 0.3 mmol/g/min, at 400 ppm in air
- Conceptual process design and cost and performance projections to enable next stage development: integrated prototype and field testing

Current Status

Conventional method

PARC synthesis method

Non-sorbent, ambient-dried materials



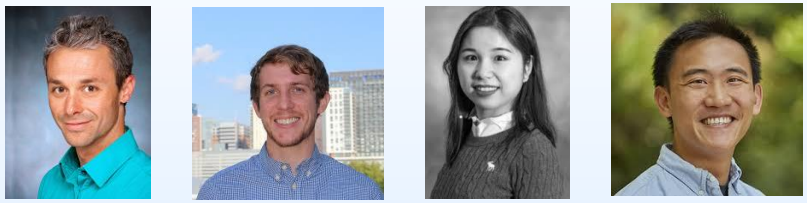
- Pore size and porosity control through proprietary synthesis conditions
- Surface area: surface functionalization, CO_2 uptake
- Porosity: heat capacity and thermal conductivity, durability

Team and Facilities

PARC Team

PI: Dr. Mahati Chintapalli
Dr. Gabriel Iftime
Dr. Stephen Meckler
Dr. Rahul Pandey

Livermore Team

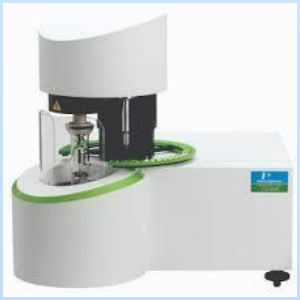


Team lead: Dr. Joshuah Stolaroff
Dr. Nathan Ellbracht
Dr. Wenqin Li
Dr. Simon Pang

Preliminary characterization @ PARC

Pore characteristics

Sorption

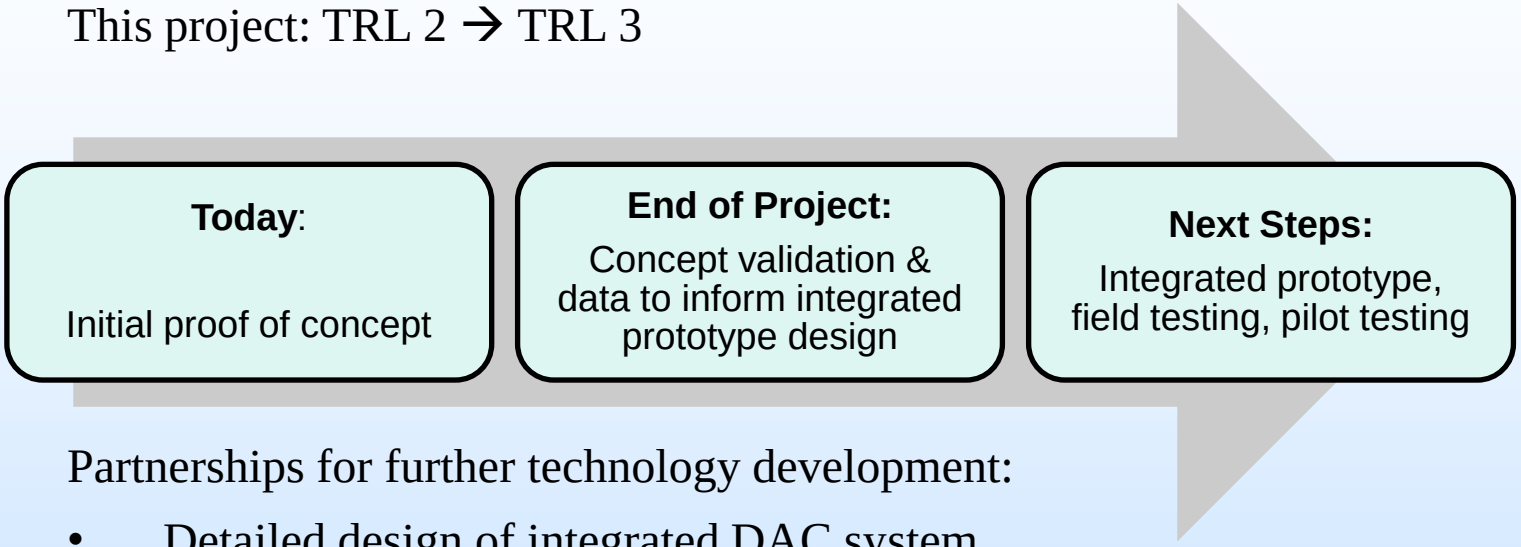


Fixed bed characterization @ LLNL

Gemini: custom fixed bed sorbent testing instrument

Opportunities for Collaboration

This project: TRL 2 → TRL 3



Partnerships for further technology development:

- Detailed design of integrated DAC system
- Passive or low pressure drop systems
- Field and pilot unit construction and testing
- Technology commercialization

Collaboration with PARC/Xerox: engage@parc.com

- Multidisciplinary research: materials, hardware systems, software
- Cleantech strategic business unit for technology commercialization