UCFER- An Economically-Viable Technology for Production of Coal-derived Aerogel Insulation Envelope

University of Kentucky
Center for Applied Energy Research
Lexington, KY
http://www.caer.uky.edu/powergen/home.shtml

06-UKy-Y1-28

October 6, 2021

Objective

To develop An Economically-Viable Technology for Production of Coal-derived Aerogel Insulation Envelope

(Thermal Resistance R-values of 14 to 105)

Outline

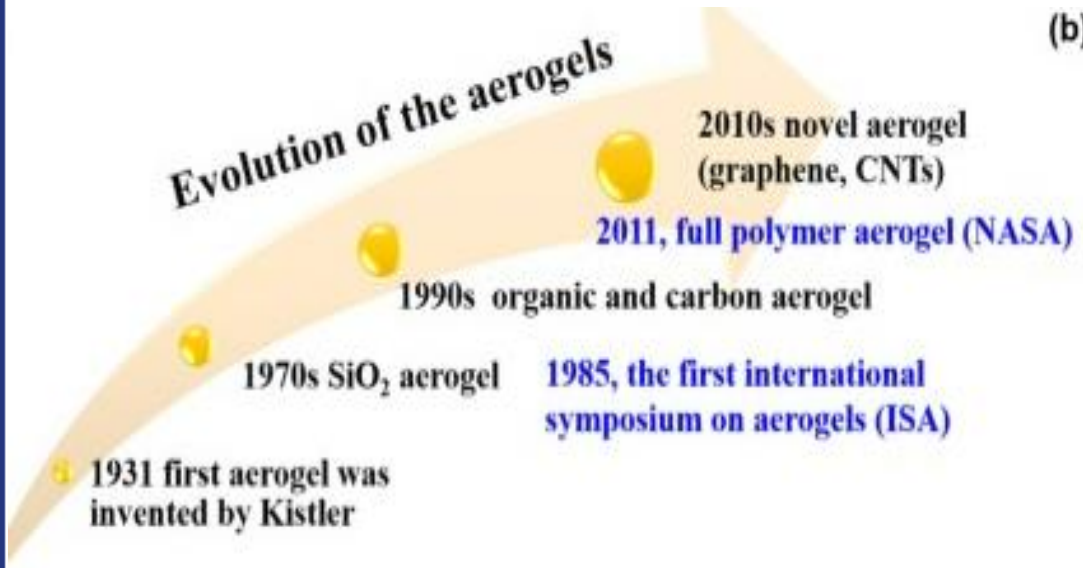
- **Background**
- **Objective**
- **Approach**
- **Project Details**

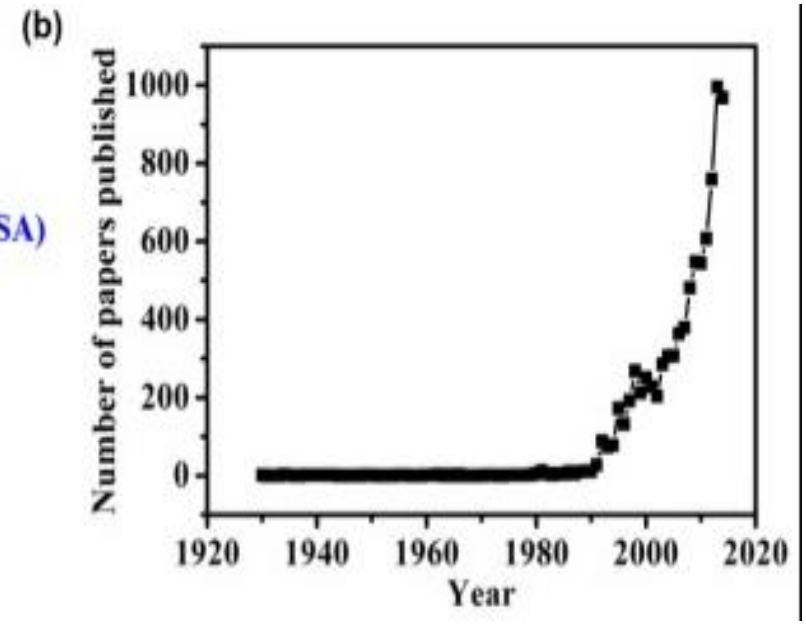
Background

DOE believes that advances in coal-derived building materials, such as carbon foam (graphitic or non-graphitic), roofing tiles, siding, insulation etc can be a viable way to provide:

- **Lower price or superior properties to existing building materials**
- **New value-chain of industrials that do not use coal in manufacturing process.**
- **Reduce GHG (CO_2) emissions**

Background
Evolution of Aereogel



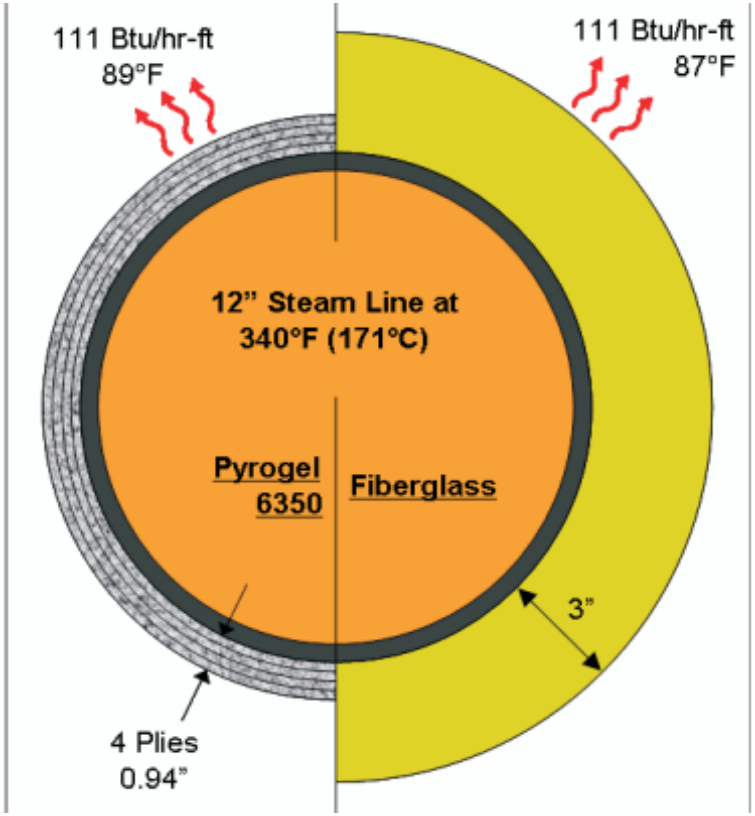


Compared to single component aerogel, plastic/metal oxide reinforced aerogel combined better flame retardance, physical strength and thermal conductivity

R-value: 0.024 W/m/K
BET: >200 m^2/g
>95% macroporosity
>500 ^oC stable

Background
Federal and Industrial Programs

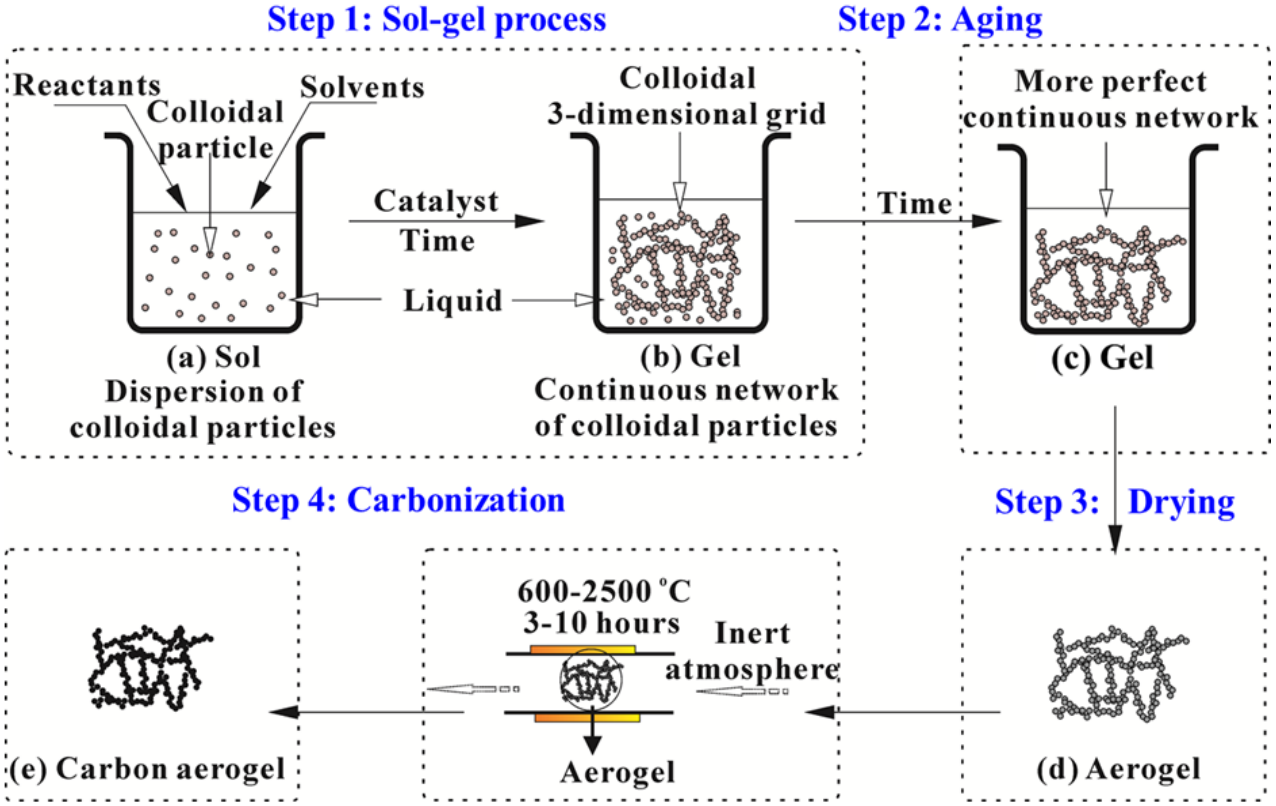
EERE- BTO report



Less than 1" of aerogel-based insulation is equivalent to 3" of fiberglass. The aerogel-based insulation also requires 20% less cladding and binding

Provided by industrial partners

Background
General Approaches for Carbon Aerogel Foam



+ Step 4 is not necessary for current program because of physical strength is necessary
+ Coal depolymerization is the most critical step:
  Concentrated HCl/HNO_3 solvent
>120 °C operation, >24 hour reaction, four steps

Nature Communication 2013

Objective

UCFER- An Economically-Viable Technology for Production of Coal-derived Aerogel Insulation Envelope

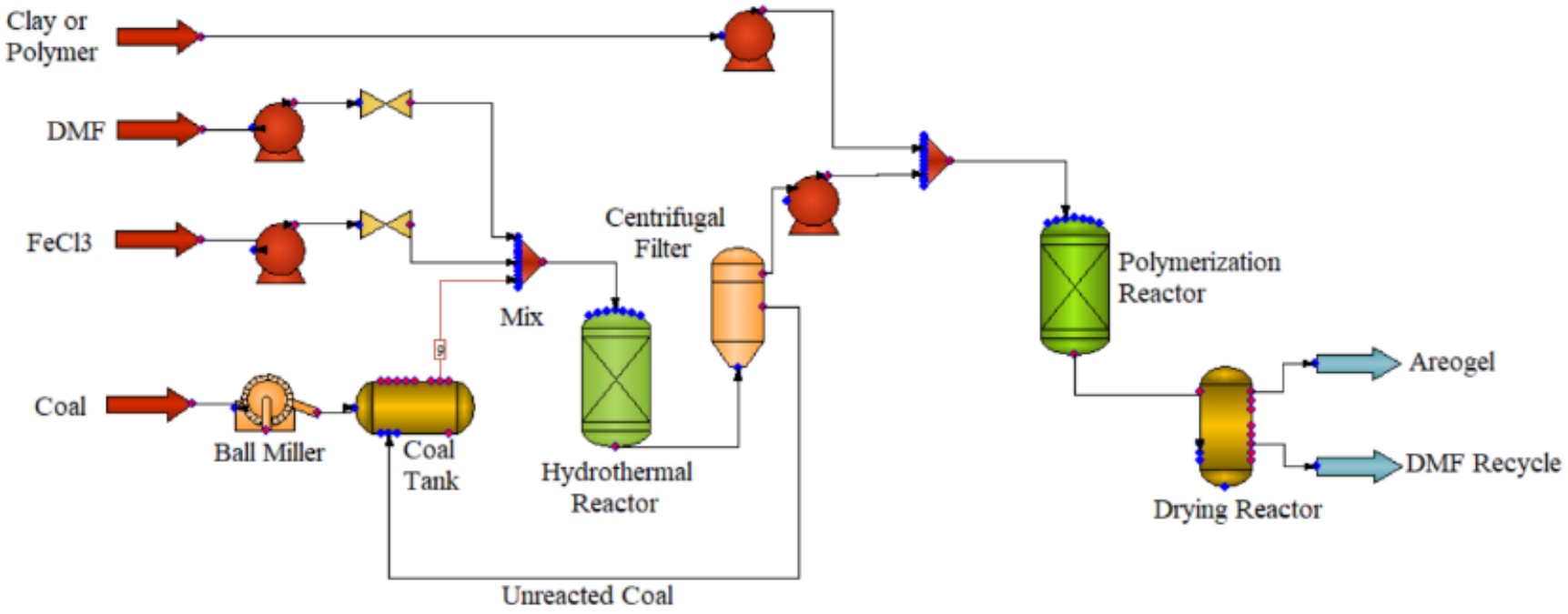
- **Demonstration of depolymerization of coal into carbon nano-particle under mild condition: (<150 ^{o}C, <2 hour, <0.3MPa)**

- **Validate production of PVC (~15%) or Clay- reinforced carbon aerogel production**

(yield >30%, >1Kg/day, density ~2.4 g/cm3 and BET area 300 m^2/g.)

- **Thermo-mechanical characterization of coal-derived aerogel envelopes**

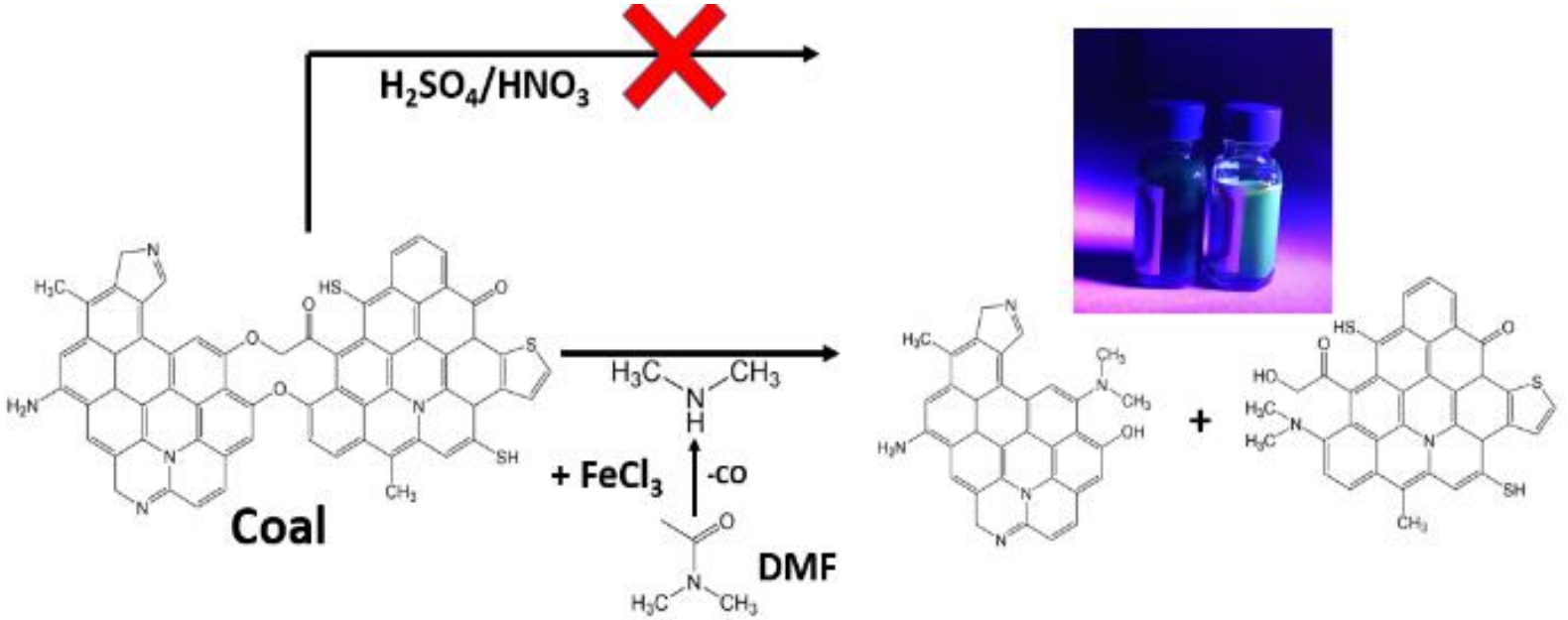
Summary of Patented Technical Approach

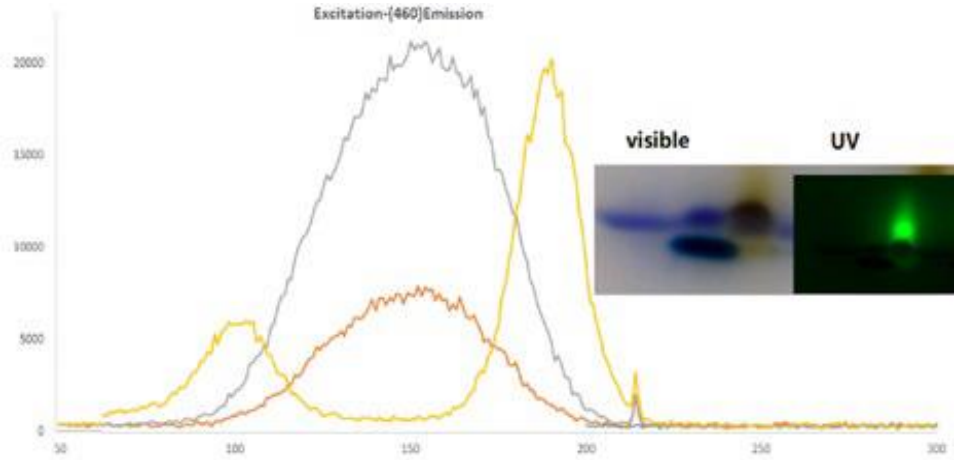


WO 2021041897 and US 2019-62893385

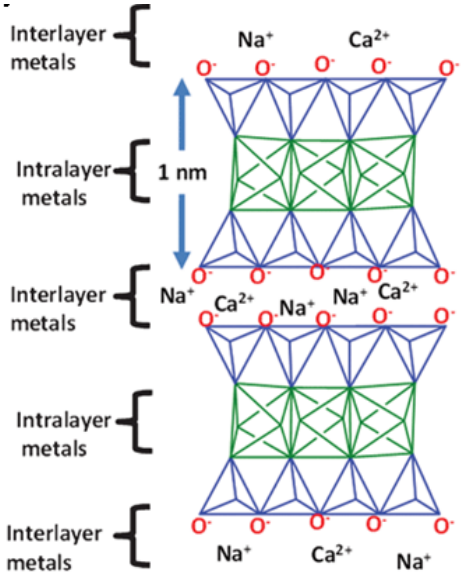
Dr. Tian and George Institute of Technology

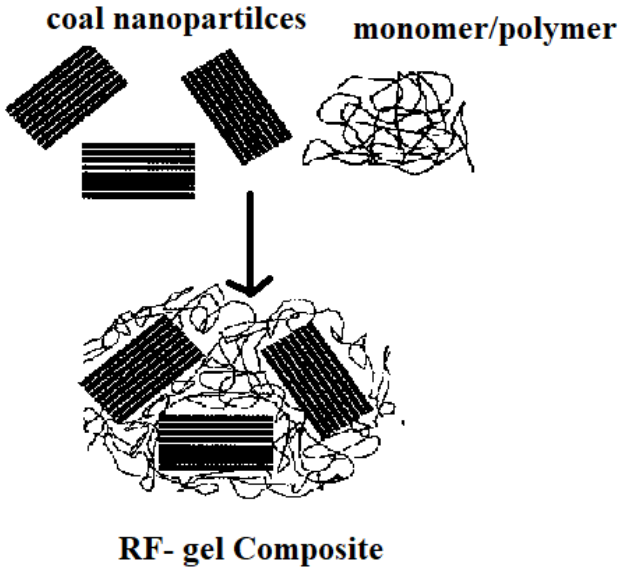
Success Validation of Carbon Quantum Dots Production from Coal





Success Validation of Carbon Aerogel (Foam) for Carbon Nanoparticles





Success Validation of Coal-derived Building Envelope, Carbon Foam, and Carbon Fibers Developed in Dr. Tian's Lab

Project Schedule

TASK NAME	TEAM MEMBER	Year 1				Year 2			
		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Task 1. Process Optimization of Carbon Nanoparticle Synthesis	Tian,NETL								
Task 2: Production validation of coal-derived aerogel	Gupta, Tian								
Subtask 2.1 Preparation of aerogel									
Subtask 2.2 Drying of coal derived aerogel									
Task 3: Production validation of Coal Derived Aerogel Applications in Infrastructure Systems	Hota, Tian, NETL								
Subtask 3.1 Mass Production									
Subtask 3.2 Thermo-mechanical Characterization									
Subtask 3.3 Cost Analyses									

Collaboration Work with NETL

+ NETL's multiple-wavelength Raman or in-situ SEM/TEM

+ Technical/economic communication

+Technical discussion with Research Team, possibly with industrial partners

Acknowledgements

Bruce Miller (Penn State) and Omer Bakshi (NETL)
All UCFER Management

UKy-Center of Applied Energy Research
Dr. Kunlei Liu