the ENERGY lab

PROJECT FACTS

Carbon Sequestration

High-Performance Sorbents for Carbon Dioxide Capture from Air

Background

Increased attention is being placed on research into technologies that capture and store carbon dioxide (CO_2). Carbon capture and storage (CCS) technologies offer great potential for reducing CO_2 emissions and, in turn, mitigating global climate change without adversely influencing energy use or hindering economic growth.

Deploying these technologies in commercial-scale applications requires a significantly expanded workforce trained in various CCS specialties that are currently under-represented in the United States. Education and training activities are needed to develop a future generation of geologists, scientists, and engineers who possess the skills required for implementing and deploying CCS technologies.

The U.S. Department of Energy's (DOE) National Energy Technology Laboratory (NETL) has selected 43 projects to receive more than $12.7 million in funding, the majority of which is provided by the American Recovery and Reinvestment Act (ARRA) of 2009, to conduct geologic sequestration training and support fundamental research projects for graduate and undergraduate students throughout the United States. These projects will include such critical topics as simulation and risk assessment; monitoring, verification, and accounting (MVA); geological related analytical tools; methods to interpret geophysical models; well completion and integrity for long-term CO_2 storage; and CO_2 capture.

Project Description

NETL is partnering with the Georgia Institute of Technology (GT) to perform a combined experimental and modeling study of air capture of CO_2 using low-cost, high-capacity sorbents (a material used to absorb liquid or gas) including, but not limited to, mesoporous (material containing pores with diameters between 2 and 50 nanometers) solids functionalized with hyperbranched amino-polymers (highly branched, three-dimensional macromolecules). Understanding the response of these materials as a function of ambient humidity and temperature will be crucial to optimizing cyclic operations with useful yields of CO_2 and minimal energy input. Adsorption/desorption cycles will be optimized for energy inputs coming from solar thermal sources, and the viability of using air capture for generating both sequestration-ready CO_2 and CO_2 for algae-biofuel processes will be considered.

GT will characterize the behavior of three classes of amine (organic compounds of nitrogen in which one or more hydrogen atoms has been replaced by a hydrocarbon radical) sorbents for air capture. Amine sorbents supported on mesoporous silica will be synthesized and CO_2 adsorption on these sorbents will be measured from both

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PARTNERS

None

PROJECT DURATION

Start Date
12/01/2009

End Date
11/30/2012

COST

Total Project Value
$299,831

DOE/Non-DOE Share
$299,831/$0

Government funding for this project is provided in whole or in part through the American Recovery and Reinvestment Act.

ambient air and prepared gas mixtures at low CO_2 partial pressures over the full range of humidity. Data obtained from these experiments will be used to model the time-averaged CO_2 capture rate possible from sorbents using temperature/humidity data from geographic locations relevant for CO_2 sequestration as a function of the energy input into the capture process. In parallel with these efforts using supported amine sorbents, exploratory experiments and molecular modeling will be used to consider the viability of metal-organic framework materials for air capture. These exploratory studies will increase the potential for future development of metal organic framework materials for this application to be assessed.

Goals/Objectives

The goal of this project is to gather fundamental data on the potential use of amine-based and metal-organic framework (MOF) based sorbents for air capture of CO_2. Project research will examine three distinct classes of amine-based sorbents: (1) those based on impregnation (physical adsorption) of amine-containing small molecules or performed oligomeric/polymeric amines into porous supports; (2) those based on covalent binding of amines to the surface of a support through use of silane (SiH_4) coupling agents; and (3) those based on in situ surface polymerization of reactive amine monomers, creating covalently-bound amines.

Benefits

The project will make an immediate and important contribution to the knowledge base available regarding air capture by providing a cost-effective technology that captures CO_2 from ambient air; solving the problems associated with transporting large volumes of CO_2 from large point source emitters) to sites suitable for geological sequestration; having an impact on distributed emissions sources (e.g., vehicles) that are currently considered beyond the reach of carbon capture technologies; and providing carefully characterized data on the adsorption capacity of amine-based sorbents at the low CO_2 partial pressures relevant for air capture as functions of humidity and temperature with both ambient air and prepared gas mixtures.

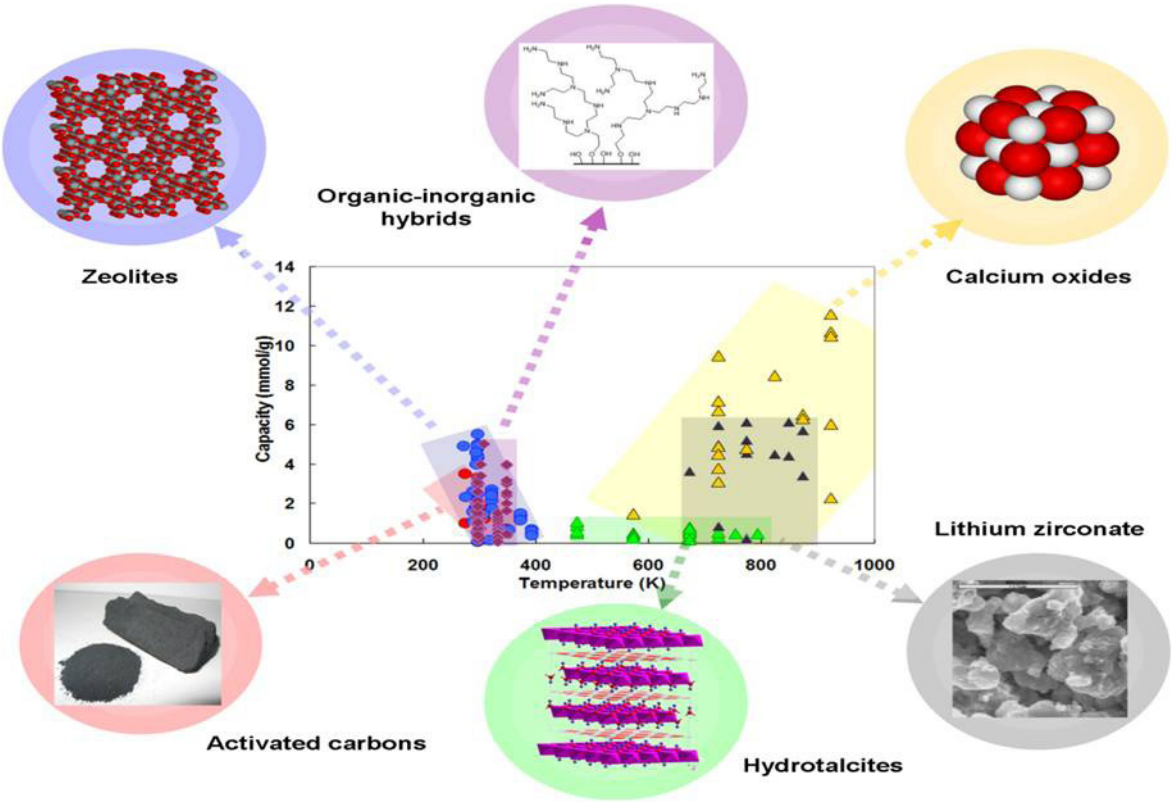

Figure 1. Potential adsorbent materials for CO_2 capture