



PennState
College of Earth
and Mineral Sciences

Earth and Mineral Sciences

Energy Institute

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Coal Science & Technology



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Penn State has a long history of coal science and technology dating back to the 1930s and even earlier. We are one of the leading coal research centers internationally. Throughout our history we have been active in practically all aspects of coal research. Traditional research areas include coal combustion, coal processing, direct coal-to-liquids (including coal-derived jet fuel), coal gasification, coal structure, coal petrology, coal coking, environmental controls, coal beneficiation, coal water slurry, and coal ash-chemistry with all ranks of coal. In addition, our emerging areas of coal research include enhanced coalbed methane and CO₂ sequestration in coal, oxy-combustion, advanced coal gasification, co-firing coal-biomass, ionic liquids treatment, microwave applications to coal, application of X-ray computed tomography technique, and others. We are one of the two National Research Centers in Coal.

* Non-mining coal-theses date back to the early 1900s

Research

Stationary Combustion/Gasification and Co-Firing with Biomass

The Institute has laboratory- and pilot-scale combustion units as well as a gasifying unit with the flexibility to evaluate impacts of fuel beneficiation, fuel utilization, various pollution control approaches, materials use, ash chemistry, and the suitability and challenges of firing or gasifying biomass and other renewable feedstocks either individually or concurrently with coal.

Carbon Capture and Storage

Anthropogenic CO₂ emissions along with other greenhouse gases are contributing to the rapid change in global climate. Many of the largest point sources of CO₂ emissions are in the electric utility sector along with cement and other energy intensive industries. Accordingly, several research programs are being conducted at the EMS Energy Institute in the areas of carbon capture and storage:

- Development of a high-capacity CO₂ molecular basket to remove CO₂ from power plant flue gas

- Oxycombustion and IGCC research to produce a concentrated CO₂ stream
 - Computational fluid dynamics for model development
 - Kinetic studies of pyrolysis/gasification/combustion of coal and biomass chars
- CO₂ sequestration in unmineable coal seams
 - Molecular level modeling of coal structure and interaction with CO₂, CH₄, and H₂O
 - Core studies under confining stress on capacity with coal behavior being monitored with X-ray Computed Tomography
 - Influence of water forms on sequestration kinetics and capacity

Coal Characterization

We characterize coal, its char, ash, liquid, and gaseous products. We perform both traditional and advanced coal characterization, which includes coal handling, grindability, cleaning, trace element partitioning, oxidation, petrology, proximate, ultimate, fluidity, as well as X-ray computed tomography, laser desorption ionization mass-spectroscopy, and NMR.

Coal and Char Molecular Modeling

We have advanced the ability to generate large-scale, accurate, molecular representations of coals and chars rapidly with relative ease. We use these molecular representations, constrained by experimental data, to explore chemical and physical structural differences, interaction with gases and solvents, reactivity, solvent extraction, char formation, primary thermolysis and direct liquefaction.

Coal and Mineral Matter (Ash) Transformations

We study the influence of gaseous atmosphere, temperature, and pressure on mineral matter transformations and ash formation.

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