

# PROJECT FACTS

UNIVERSITY OF KENTUCKY CENTER FOR APPLIED ENERGY RESEARCH

## CARBON MATERIALS

### Activated Carbons

The high internal surface area and pore volume of activated carbons make them ideal materials as adsorbents, catalysts, or catalyst supports in gas and liquid-phase processes for purification and chemical recovery. Used in numerous domestic and industrial applications, they have traditionally been manufactured from a wide variety of materials, but more generally by activation of coals, petroleum residues, wood and other organic feedstocks, (e.g. coconut shell). The pitch-derived activated carbons fabricated at CAER are preferred in many applications as their properties and physical form, granules or fibers, can be controlled by selection of feedstock and process conditions. While coal-tar pitch, a coke oven byproduct, is one source of such materials, there are other routes that yield similar high-boiling aromatic coal liquids, including solvent extraction, hydrolysis, direct liquefaction and the by-products from coal gasification. Composition can be tailored to the application through the selection of the coal and reaction parameters, allowing considerable latitude in the preparation of precursors for different carbon products. The pitches have high-aromatic and low-aliphatic carbon content and give high yields on carbonization.

While granules are the traditional form of activated carbons, the ability to draw pitch into filaments and convert them into carbon fibers has been successfully exploited at these laboratories. The lack of structural order in the melt spun isotropic carbon fibers allows them to be readily activated and to develop porosity. Activation of the carbon fibers or granules is achieved by heating in steam or  $\text{CO}_2$  at temperatures in the range 800 to 950°C. High surface areas (up to 2000 $\text{m}^2/\text{g}$  compared to 1 $\text{m}^2/\text{g}$  before activation) are generated with a pore structure typified by a narrow distribution of micropores, (pore entrance diameter <2nm). Chemical activation (using al-kali metal hydroxides) offers another route to tailoring porosity in carbons, and provides tighter control of the pore-size distribution and structure. The characteristics of the activated carbons, and thus their adsorptive and catalytic properties, can be substantially altered, depending upon the type of pitch used. Those with high hetero-atom contents, derived from oil shale residues or low rank coals and lignites, generate active carbons with high mesopore (pore diameter 2-50nm) volumes, and thereby exhibit high catalytic activity for selective reactions.

Carbon fiber composites with open architecture can be fabricated from the activated fibers using high carbon yield resins. The open structure of the strong, rigid, highly permeable composites (monoliths) produced in various shapes at CAER, allows significant rates of fluid flow to be effectively distributed over a wide area of bed, minimizing the pressure drop across the bed. This is not an option for beds of granular carbons. Moreover, the small fiber diameter, ready access to the active surface, effectively eliminates mass transfer limitations, and allows rates of adsorption and desorption that are orders of magnitude faster than with granular activated carbons. Problems of channeling associated with granular beds are also obviated because of the uniform cross-section that is presented to the process flow.

#### CONTACT

Rodney Andrews  
UK CAER  
2540 Research Park Dr.  
Lexington, KY 40511  
Tel: (859) 257-0200  
Fax: (859) 257-0220  
[andrews@caer.uky.edu](mailto:andrews@caer.uky.edu)  
[www.caer.uky.edu](http://www.caer.uky.edu)

