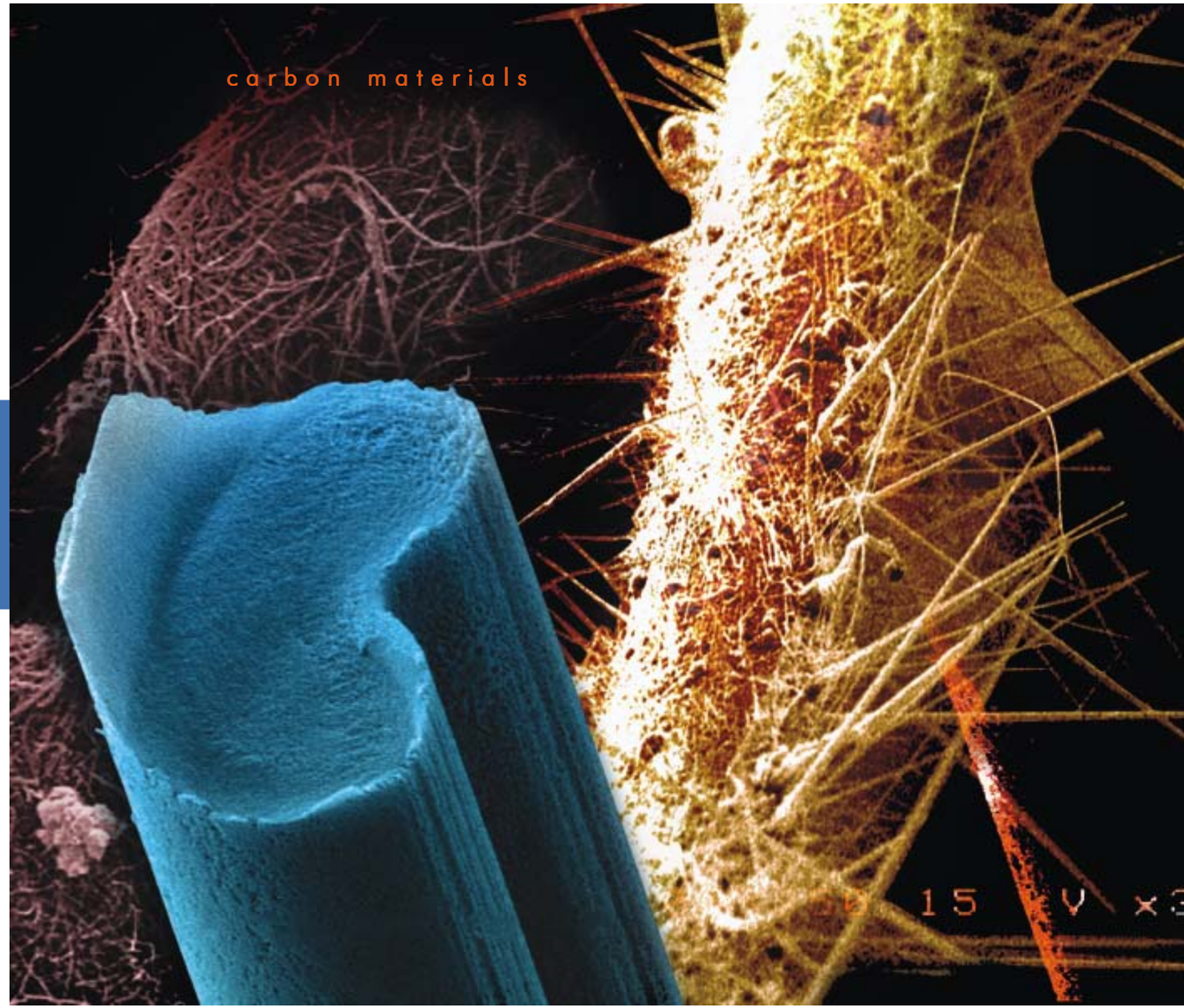
carbon materials

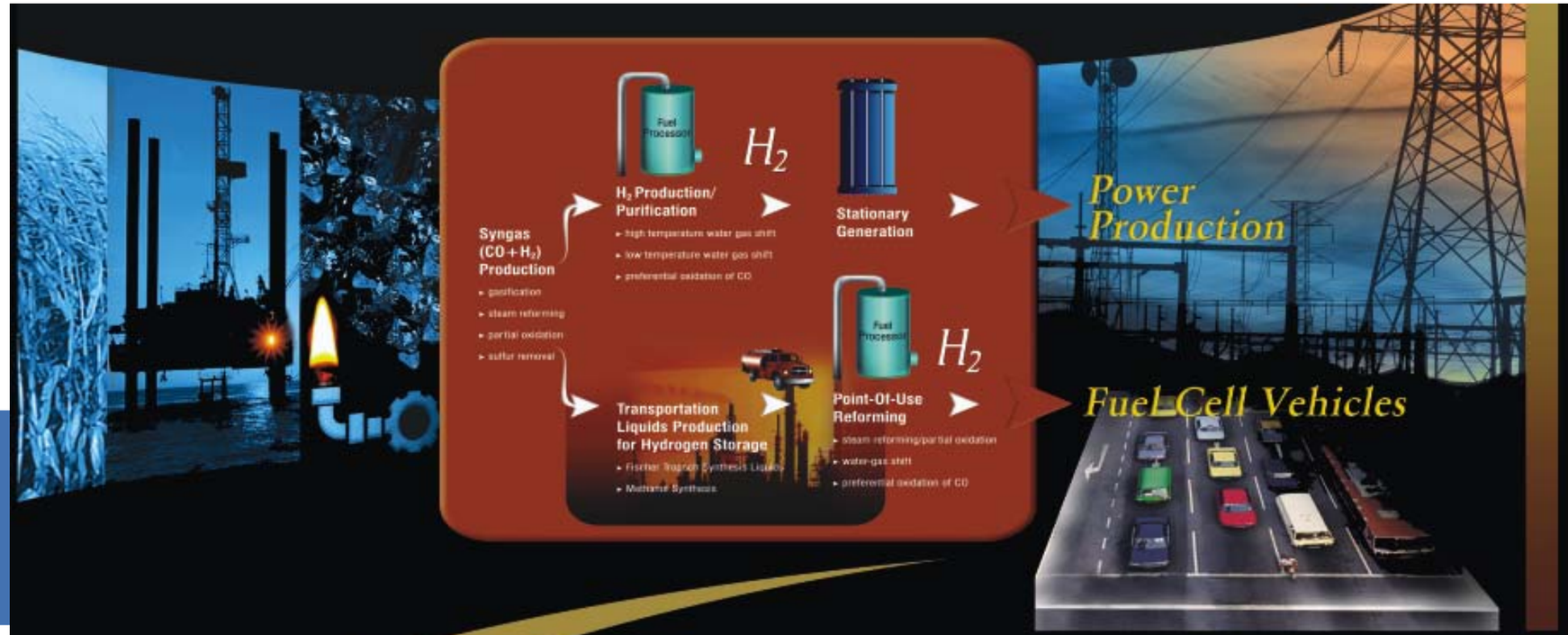


Carbon materials are used in many aspects of daily life, from activated carbons used for purifying drinking water to carbon fiber reinforced sporting goods to carbon black fillers for automotive tires, to glassy carbon coatings on medical implants. Carbon fibers are recognized as a strategic material for the defense, aerospace, and transportation industry. Primary metals manufacturing also rely heavily on the availability of high quality binders and cokes.

The Carbon Materials Group focuses on the development of new carbon materials and technologies to address energy and environmental needs. Emphasis is placed on development of viable processes for large-scale production of these materials and the transfer of resulting technologies to industry. In doing so, the group seeks to advance the scientific understanding of these materials through both fundamental and applied research to meet future needs in energy, nanotechnology, medicine, defense, automotive, aerospace and heavy industries.

Carbon materials derived from fossil resources remains a core activity, with particular emphasis on high value carbon materials from Kentucky coal. Work in this area includes the development of new technologies for producing carbon fibers for structural applications, binder pitches and cokes for aluminum manufacturing, and activated carbons with tailored adsorption characteristics. Related work has focused on the use of coal combustion and coal gasification by-products as mercury adsorbents.

The growth in high-tech applications of advanced carbon materials has fueled the demand for engineering materials with continually-improved mechanical properties. The Carbon Materials Group has developed processes for large scale production of carbon nanotubes in response to the demand for these high strength, highly conductive materials. Applications development for nanotubes focuses on their use in high strength composites, electromagnetic shielding applications, and electrochemical energy storage devices.



clean fuels
and chemicals

The CFC Group focuses on scientific principles pertaining to the development and demonstration of catalysts for energy conversion with an emphasis on industrial applications. Within this context, the catalytic conversion of coal synthesis gas to fuels and chemicals through Fischer-Tropsch synthesis has been under investigation for a number of years. More recent work has extended these earlier investigations to include the catalytic conversion of synthesis gas to hydrogen.

The Clean Fuels and Chemicals (CFC) laboratory is uniquely situated to focus on basic-energy needs and in particular to look to the future of clean-energy production. The laboratory contains a variety of reaction and characterization equipment that, coupled with a trained staff, is used to conduct fundamental and applied studies at a scale sufficient to satisfy industry.

Fuel cells are receiving widespread attention as an alternative source for clean energy production. There is a considerable effort underway to develop hydrogen as a preferred fuel both for its potential to reduce our dependence on imported oil and its numerous environmental benefits. Accordingly, researchers are investigating low-temperature water gas shift for hydrogen production. Also, in anticipation of future research directions, there is an increasing level of activity designed to take the lead with the development of environmental catalysis and catalysis for biomass upgrading.

Research performed by the CFC group focuses both on improving today's established technologies associated with the synthesis of liquid fuels and in furthering advanced technologies that will be commonplace tomorrow. In all of this there is an underlying objective of using catalysis to make coal a more environmentally friendly energy source.

environmental and coal technologies

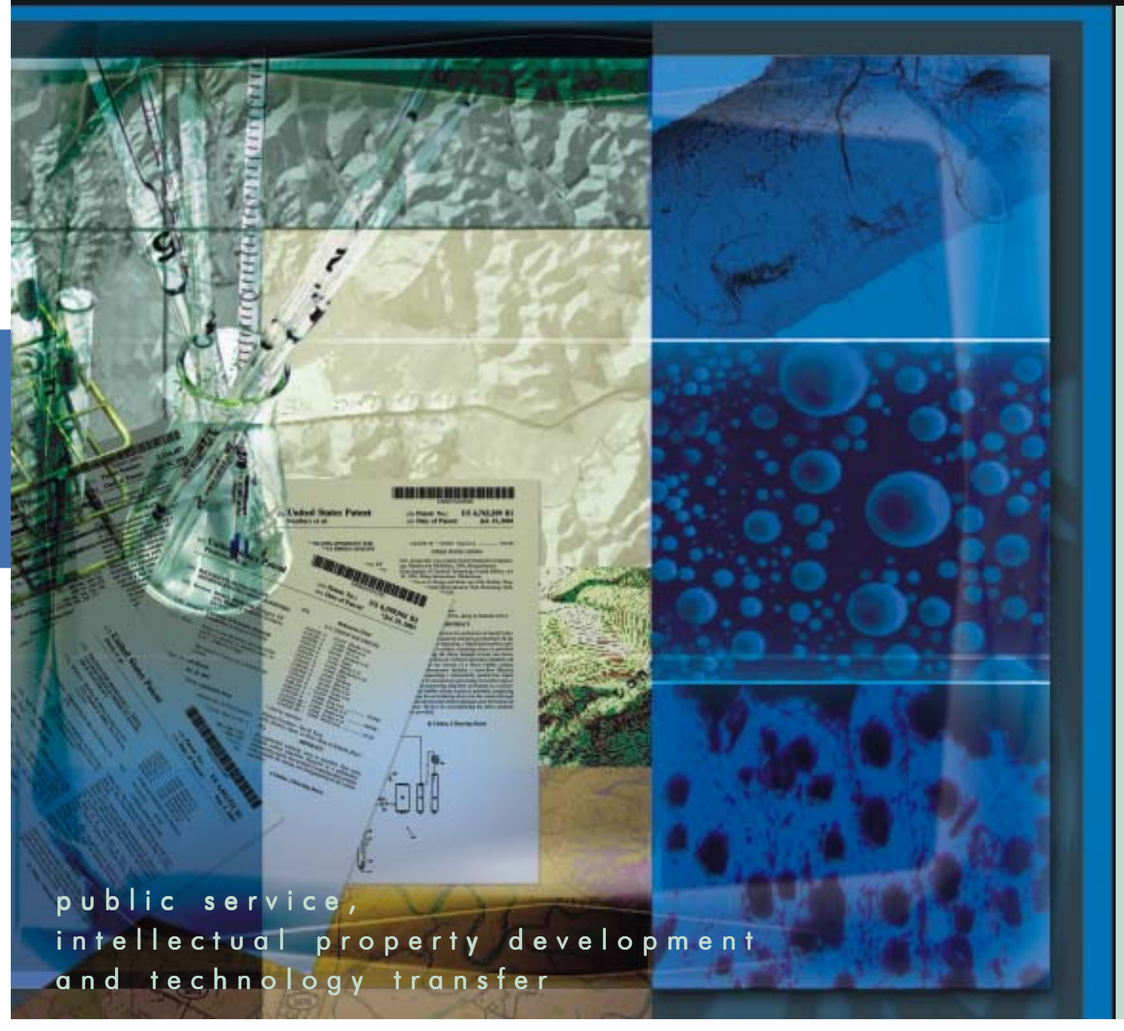
The mission of the Environmental and Coal Technologies Group (ECT) is to enhance the sustainable use of coal. Research covers the spectrum of topics from coal preparation to the ultimate fate of emissions and solid waste. This includes developing processes to remove carbon from coal ash in a useful form for re-use and to increase the use of ash in cement and concrete applications. Such developments lead to more efficient coal use and improved overall process economics since the recovered solid materials are value-added materials.

The various uses for the ash materials include the addition of increased quantities of fly ash to cement and using particular selected fractions to improve the performance of concrete mixes. This research is extended to assess possibilities for the beneficial use of residues from slagging gasifiers as well.

The research needs of a number of industrial groups are met by extensive collaboration and by combining CAER's expertise in the coal mining industry, power utilities, and in cement and concrete production and application. This is all based on a very thorough understanding of the underlying scientific phenomena.

Investigations include both laboratory and field work. The laboratory scale research takes place in laboratories for concrete, pozzolan and petrographic activities. Equipment for larger scale work is available in both a high bay area within the CAER building as well as in a separate laboratory building on the grounds. Field work at power stations, using specialized mobile research laboratories, is also performed.

The ECT Group provides the knowledge and techniques necessary to ensure the economically advantageous use of materials that in the past have been both a cost and environmental burden on the industries responsible for the electric generation upon which our society is dependent.



Among our most important aims is to assure that the benefits of research are brought into the widest possible use. We also have an obligation to protect intellectual property (IP), and make a return on the taxpayer's research investment. This is accomplished by a strategy of IP development and technology transfer, and by providing technical and analytical services. The objectives are to solve problems, bring new products to the market, create businesses and jobs, and stimulate economic development.

The process of developing and commercializing IP involves several steps, from an invention disclosure, to the establishment of proprietary rights through patents, copyrights or trade secrets, to a license to use or practice the know-how. Finding a potential licensee and demonstrating the efficacy of a particular innovation requires wide ranging technical discussions with client-industries. Samples and materials are often exchanged for testing, prototyping and cost-engineering. The licensee often requires collaboration in the early stages of process scale-up and product qualification.

Our efforts are manifest in a number of success stories. CAER was an early leader in Fluid Bed Combustion technology. We have licensed technology for dry and wet beneficiation of minerals, and advanced carbon fiber composites for environmental cleanup. In public service, we have one of the finest "open-access" catalyst testing facilities in the world. We staff the Kentucky Mine Map Repository - the largest collection of mine maps of any state - which has proven critically important in locating mine works and slurry ponds, and in mine safety and rescue. Our Industrial Support Initiative serves hundreds of clients each year with problem-focused services. Looking forward, we are pursuing licenses for the recovery and beneficial re-use of coal combustion by-products; pitch, char and binders from coal; and for high strength carbon nanotubes and related composite materials.