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The new building of the Institute of Coal Chemistry in Gliwice

All About Carbon Materials

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Advanced carbonaceous materials developed at our Institute will find applications in such fields as medicine and industry

Founded in Gliwice in 1954, the Scientific Laboratory of the Department of Organic Chemistry, Polish Academy of Sciences, was the Academy's first chemical establishment in the Silesia Region. Prof. Włodzimierz Kisielow was appointed as the organizer and the first head of the Laboratory, which specialized in petroleum technology and petrochemistry. In 1970 the Laboratory was reorganized as the Petroleum and Coal Chemistry Department of the Polish Academy of Sciences, becoming a separate research institution in 1974. Research activities were at that time focused on fundamental and applied studies on the separation and chemical reactivity of hydrocarbons derived from petroleum feedstocks and on upgrading petroleum based products: oils, lubricants, asphalts, etc. Results achieved at that time led to the design of the first crude-oil distillation tower for Poland's Płock refinery.

In the wake of the first world petroleum crisis in the 1970s, the unit's scope of research was broadened to include coal science related subjects. Investigations led by Prof. A. Marzec developed a new, molecular-macromolecular model for the chemical structure of coal, still considered the best description of coal structure.

Starting in 1985, the unit's research began to focus on improving environmental protection in the use of coal as a fuel. Certain mechanisms of coal substance transformations were elucidated and many chemical and physical properties of solid and liquid coal-derived products were explained.

In 1988 the unit adopted its current name, as the Institute of Coal Chemistry of the Polish Academy of

Sciences. Since the 1990s, the Institute's lines of research have undergone a successive reorientation. Increasing attention is now being paid to researching carbonaceous materials, with special emphasis on the simultaneous development of studies on organic materials and materials for state-of-the-art technologies, as well as catalysts used in abating exhaust gas emission during the use of fossil fuels as an energy source. The Institute's interests are at present dominated by studies on organic materials and their chemical and physical properties. We investigate the possibilities for synthesizing polymeric-carbonaceous composites and creating durable products capable of withstanding extensive work under harsh conditions. Also studied are the relations between the composition and structure of a composite and its properties, the interfacial interactions between a carbonaceous material and the polymeric matrix, the kinetics of crosslinking, and the dielectric properties of composites. Methods of producing hybride composites (powdered carbonaceous filling with carbon fiber) exhibiting good mechanistic properties, high thermal stability and small specific density have been developed, as has a method for producing phenol composites with three dimensional carbon fabrics; these products have found application in the defense industry.

Intelligent materials

The Institute's research field also includes synthesis, structural studies and the characterization of carbonaceous materials, such as carbonization products of biological and composite-based materials, composites based on expanded graphite, composites containing a carbonaceous material and ceramic base, and carbonizates from bituminous coals. It is believed that carbonaceous materials obtained at our Institute will find applications in medicine, as bone tissue substitutes and oxymetry probes, as well as in industry, as adsorbents of liquid impurities or as catalyst supports.

One important aspect of the Institute's advanced materials studies involves non-linear nanostructural materials. Such structures are obtained at the Institute via the controlled self-association of copolymers in water solutions, by crosslinking the cores of micellar systems or directly as a result of controlled synthesis of highly branched macromolecules. Many of the products so obtained are subjected to modification with the aim of attaining stimuli-sensitive materials (or "intelligent materials") reacting to different stimuli, mainly to temperature. These materials may find application in the process of selective transport of various substances, including pharmaceuticals, as well as in the manufacture of micro- and nanosensors and actuators.

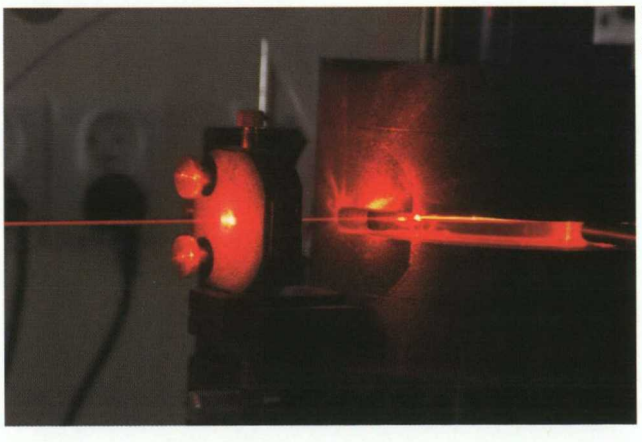
The Institute's studies on conducting polymers are focused on identifying the mechanisms of doping processes of oligomers and macromolecules displaying optoelectronic and electroluminescence properties. The use of these materials to manufacture elements of active layers in building appliances for transparent electronics and optoelectronics requires a supply of oligomeric molecules with a precisely defined structure and with specific redox and spectral properties.

Recent advances in developing catalysts for hydrotreating fuels with the aim of curbing pollution through the removal of nitrogen and sulfur were focused on developing new, effective catalysts for hydrodenitrogenation (HDN) and hydrodesulfurization (HDS) processes. Mechanistic studies have also been carried out on the hydrogenation stage of heteroaromatic compounds of nitrogen and sulfur, catalyzed by soluble metal complexes. Other lines of environmental protection research involve catalysts for nitric oxide removal from industrial plants and installations for burning fossil fuels (power and heating plants). The Institute's installation for catalyst research is used by Polish and French partners under the international project EUREKA for laboratory and pilot tests.

Despite insufficient funding, we have succeeded in acquiring or building the modern equipment indispensable for achieving our research projects: apparatus for molecular characterization of polymeric materials, for studying some types of catalysts, and acoustic spectroscopy apparatus for materials characterization.

Institute staff members have been involved in a number of Polish and EU-funded research grants. International collaboration programs not only contribute substantially to the modernization and reorientation of our research topics; they also improve our experimental capabilities and facilitate the exchange of ideas.

Another important area of the Institute of Coal Chemistry's scientific and organizational efforts is the recent establishment of the international European Graduate College of Advanced Polymeric Materials. The Institute has recently coordinated or is currently involved in a dozen or so international scientific projects and a variety of bilateral programs carried out in cooperation with 23 foreign scientific institutions. ■



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A laser light scattering goniometer for molecular characterization