

Seminar Series

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5:00 PM – Room 200 Olin Hall

Advanced Carbon Fibers for Structural Applications: Role of Molecular Architecture and Nanotexture of Mesogens

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Abstract: Melt-spun polymeric and liquid crystalline precursors are being investigated to develop carbon fibers with controlled microstructure and properties. Discotic liquid crystalline mesophase pitch (MP) precursors result in a high degree of molecular orientation during fiber spinning. The resultant “radial” texture of the graphene planes leads to carbon fibers with a high graphitic content, high thermal conductivity, and high tensile modulus. However, the tensile strength is not high and the compressive strength is poor. By incorporating carbon nanotubes in an ultradilute concentration (0.1 wt%), we reported a dramatic effect on the resulting nanotexture. A high degree of graphitic crystallinity was retained as observed from a d_{002} spacing of 0.336 nm, with thermal conductivity predicted at 600 W/m.K. These fibers also possessed a uniform nanotexture that leads to a balance of tensile/compressive properties. The other carbon-fiber precursor, polyacrylonitrile (PAN), is more commonly used in commercial processes. Because of thermal degradation of molten PAN, the precursor fibers have to be spun by a solution route. As an alternative to solvent-based routes, we are developing a UV radiation-based route for processing of melt-spinnable PAN. The terpolymers were melt-spun in a suitable processing window, and successfully carbonized following our dual-mechanism of UV-crosslinking and thermo-oxidative stabilization. This environmentally attractive, solvent-free process has the potential to produce high-volume, low-cost carbon fibers for automotive and wind-turbine applications.

Bio-sketch: Prof. Amod Ogale serves as the Deputy Director of Center for Advanced Engineering Fibers and Films, an NSF-funded Engineering Research Center. His research focuses on the interface between novel polymer processing routes and microstructural control for carbon fibers and carbon matrix composites. Prof. Ogale’s group is investigating the rheology, microstructure, and ultrahigh temperature processing of mesophase precursors. Carbon nanotubes are being investigated for surface-anchoring of high carbon-yield mesogens for the development of high thermal conductivity carbon fibers and matrix with less severe anisotropy for potential use in the next-generation thermal management materials and Gen IV nuclear reactors. For low-cost carbon fibers in the automotive industry, Prof. Ogale and his team are developing a novel ultraviolet radiation-based stabilization process for melt-processable polyacrylonitrile precursor fibers. Prof. Ogale serves on the editorial review board of three journals, was the Technical Program Chair for the PPS Regional Meeting, Charleston (Oct 2008), and is co-organizing the next-US-based International Carbon Conference in Clemson in July 2010.