FUNDAMENTALS FORUM
SESSION W28

Wednesday, May 4
1:30 p.m. – 5:15 p.m.
Room 202, Hynes Convention Center

1:30 p.m. – 2:15 p.m.
David A. Zumbrunnen
Warren H. Owen Duke Energy Professor
Department of Mechanical Engineering
Clemson University

Formation of Polymer Blends and Composites by Chaotic Advection

Due largely to a focus on mixing performance in the design of compounding equipment, polymer blends and composites may not be optimized with regard to structure, properties, and composition. Blending has been typically regarded as a mixing process, so the variety of producible structures in melts and attainable physical properties of resulting plastic materials have been constrained. In this presentation, a new smart blending technology is described where melt components and additives are more controllably organized into micron- and sub-micron arrangements. In some cases, nano-scale materials can be produced efficiently. 'Smart' denotes an ability to specify a variety of fine-scale structures in plastics via a computer keyboard that can be retained in extrusions of various forms or in injection molded parts. Chaotic advection is an enabling recent sub-field of fluid mechanics for smart blending since it provides a means to controllably stretch and fold viscous melt domains and evolve a multi-layer structure leading to derivative morphologies or indirectly manipulate solid additives. Recent advances in fluid mechanics have thereby been implemented to reconsider how blending is done and render structure development more controllable and predictable for applicable melts. Examples of important blend morphologies and structural distributions among solid additives in extrusions will be presented and related to property enhancements. Fundamental research issues and insights from computational blending models will also be highlighted to assist interested persons who may wish to begin related research.

2:15 p.m.-3:00 p.m.
Montgomery T. Shaw
DiBenedetto Distinguished Professor
Department of Chemical Engineering
University of Connecticut

Polymer Engineering of Fuel-Cell Membranes

The application of polymers in fuel cell membranes is a challenging and rewarding area for polymer scientists and engineers. For portable fuel cells running at moderate temperatures, polymer membranes can provide straightforward cell design and reliable performance, in addition to the usual attributes of ruggedness and facile processability. The membrane, which must separate the fuel and oxidant yet transport hydrogen ions, is the key polymer challenge because of the need for higher temperatures and greater chemical resistance for operation with methanol as the fuel. Our research has focused on methods for making highly acidic membranes based mainly on the high performance polymer poly(ether ketone ketone) (PEKK), and its blends with poly(ether imide) (PEI) or polyethersulfone (PES). We found that melt alignment of a SPEKK/PEI sample can increase the membrane conductivity increase of three orders of magnitude. Other methods of engineering the microstructure of the membrane have been examined, and will be described in detail.

3:00 p.m. – 3:45 p.m.
Claudius Feger and Gareth Hougham
IBM T.J. Watson Research Center
P.O. Box 218

Innovative Polymer Testing using Thermo-Mechanical Analysis Tools

A few years ago we demonstrated that the stress-strain behavior of thin (< 20 μm) polymer films can be measured well with a TMA. We now will describe three different TMA-based techniques to obtain a) highly accurate material properties, b) processing parameters, and c) predictive reliability data.