SMU Department of Mechanical Engineering

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"Nanobrick Walls for Gas Barrier and Flame Suppression and Polymer Nanocomposites for Thermoelectric Energy Conversion"

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Huitt-Zollars Pavilion

Abstract: The first part of this talk involves making multifunctional thin films, using layer-by-layer (LbL) assembly, within the Polymer NanoComposites (PNC) Laboratory (http://nanocomposites.tamu.edu/). LbL deposition involves exposing a substrate (e.g., plastic film, fabric, glass, etc.) to solutions of oppositely charged ingredients. Each anionic (e.g., clay) and cationic (e.g., polyethylenimine) layer is 1 – 100 nm thick depending on a variety of deposition conditions. We are producing nanocomposite films, with 10 – 80 wt% clay, that are completely transparent and exhibit oxygen transmission rates below 0.005 cm^3/m^2•day at a film thickness below 100 nm. These same "nano brick wall" assemblies are very conformal and able to impart flame resistance to foam and fabric by uniformly coating them three-dimensionally. In the case of cotton fabric, each 10 μm fiber is individually coated to create a nano brick wall shield. On foam, these coatings can cut the heat release rate (HRR) in half, relative to uncoated foam, and eliminate melt dripping. If there is time, segregated network (latex-based) composites containing carbon nanotubes (used to produce electricity from a thermal gradient) will be described. Thermoelectric materials harvest electricity from waste heat (or any temperature gradient in the environment). Nanotube-filled polymer composites can be viable for energy conversion. By combining double-walled carbon nanotubes (DWNT), stabilized with poly(3,4-ethylenedioxythiophene): poly(styrene sulfonate) in water, an electrical conductivity (σ) near 2000 S/cm is achieved in a poly(vinyl acetate) latex-based matrix. When combined with a Seebeck coefficient (S) above 40 μV/K, a power factor ($S^2\sigma$) above 370 $\mu W/m \cdot K^2$ is achieved at room temperature. All of the materials described are water-based and processing occurs under ambient conditions in most cases. Our work in these areas has been featured numerous times in *C&EN* and also highlighted in *Nature*, *ScienceNews* and various other scientific news outlets.

Bio: Dr. Jaime Grunlan joined Texas A&M University as an Assistant Professor of Mechanical Engineering in July of 2004, after spending three years at the Avery Research Center in Pasadena, CA as a Senior Research Engineer. He obtained a B.S. in Chemistry, with a Polymers & Coatings emphasis, from North Dakota State University and a Ph.D. from the University of Minnesota in Materials Science and Engineering. Prof. Grunlan was promoted to Associate Professor in September 2010 and more recently appointed the Gulf Oil/Thomas A. Dietz Career Development Professor I. His current research interests lie in both the development of multifunctional thin films (< 1 μm) using layer-by-layer assembly and the study of thermoelectric thick film nanocomposites (> 10 μm). He won the NSF CAREER and 3M Untenured Faculty awards in 2007, the Dow 2009 Young Faculty Award and the 2010 Carl A. Dahlquist Award, for his work in these areas. Dr. Grunlan also holds a joint appointment in Chemical Engineering and serves on the Executive Committee for Texas A&M's Materials Science and Engineering Program.