Layer-by-Layer Assembly of Multifunctional Nanocomposite Films for Flame Suppression and Other Types of Environmental Protection

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Abstract

This presentation will cover some of the work we are doing in the area of layer-by-layer (LbL) assembly of multifunctional thin films 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 300 nm. These same assemblies are very conformal and are 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. We'll also describe the ability to use the LbL process to impart UV and antimicrobial protection to plastic substrates. Much like the clay system, these could be deposited onto fibers or fabric. All of the materials described are water-based and processing occurs under ambient conditions in most cases. If there is time I will also briefly mention the work we are doing to develop thermoelectric polymer nanocomposites, which are capable of generating a voltage when exposed to a thermal gradient (i.e., harvesting energy from waste heat).

The Speaker

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. While at Avery Dennison, Dr. Grunlan studied a variety of polymeric systems with unique transport, biological, and/or optical behavior. At Minnesota, he studied segregated network composites using polymer emulsions and a variety of conductive nanoparticles. His current research interests lie in both the development of multifunctional thin films (< 1 μm) using layer-by-layer assembly and the study of electrically and/or thermally conductive thick film (> 10 μm) nanocomposites. He won the NSF CAREER and 3M Untenured Faculty awards in 2007, and the Dow 2009 Young Faculty 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.