Purdue University

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3:45 Seminar

Place: ARMS 1010

PURDUE MATERIALS ENGINEERING

Infinite Possibilities

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ABSTRACT

Stopping fire and reducing gas permeability with nanobrick wall multilayer thin film coatings

Polyurethane foam in furniture and bedding is a highly flammable material, capable of completely destroying a home in less than 5 minutes. Many current flame retardant (FR) packages contain environmentally harmful compounds (e.g., brominated molecules). My laboratory (http://nanocomposites.tamu.edu/) has spent the past six years developing environmentally-benign FR nanocoatings for foam and fabric using layer-by-layer (LbL) assembly. LbL deposition involves exposing a substrate (e.g., fabric, foam, etc.) to solutions of oppositely charged ingredients. Each anionic (e.g., clay) and cationic (e.g., chitosan) layer is 1 – 100 nm thick. Thin films were assembled using "green" materials obtained from completely renewable sources. Ten bilayers of pH 6 chitosan (CH), as the cationic layer, and pH 10 clay as the anionic layer, were deposited on foam (30 nm thick and added 4 wt%). Only the outermost surface was charred after being exposed to the direct flame from a propane torch for 10 seconds. When cut open, white flexible foam was revealed under a black char layer. In related work, cotton fabric was treated with intumescent nanocoatings, composed of chitosan and phytic acid. This study marked the first fully renewable, intumescent nanocoating. It should also be noted that these nanocomposite films having 10 – 96 wt% clay, are completely transparent (%T > 95) and exhibit oxygen transmission rates (OTR) below 0.005 cm^3/m^2•day (and CO_2TR below 1 cm^3/m^2•day) at a film thickness below 100 nm. A study of similar assemblies, made with graphene oxide in place of clay, were the cover article of *Advanced Materials* in January 2013. More recently, we have used the LbL assembly technique to produce gas separation membranes with H_2/CO_2 selectivity that exceeds zeolite membranes (> 1000). Multilayer assemblies of branched polyethylenimine (PEI) / poly(acrylic acid) (PAA) were found to exceed the Robeson upper bound limits for H_2/N_2 and H_2/CO_2 separation, indicating a superior capability of H_2 separation compared to any other homogeneous and heterogeneous polymeric membranes. The exceptional oxygen barrier of these multilayer assemblies also makes them interesting for food and flexible electronics packaging.

SHORT BIO

Dr. Jaime Grunlan joined Texas A&M University as an Assistant Professor of Mechanical Engineering in July of 2004. 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 □m) using layer-by-layer assembly and the study of electrically and/or thermally conductive thick film (> 10 □m) nanocomposites. He won the NSF CAREER and 3M Untenured Faculty awards in 2007, the Dow 2009 Young Faculty Award, the 2010 Carl A. Dahlquist Award, the ISCST 2012 L.E. Scriven Young Investigator Award, and the 2013 E. D. Brockett Professorship for his work in these areas.