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Multilayer nanocoatings capable of separating gases, killing bacteria and stopping fire

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Abstract

Layer-by-layer (LbL) assembly is a conformal coating "platform" technology capable of imparting a multiplicity of functionalities on nearly any type of surface in a relatively environmentally friendly way. At its core, LbL is a solution deposition technique in which layers of cationic and anionic materials (e.g. nanoparticles, polymers and even biological molecules) are built up via electrostatic attractions in an alternating fashion, while controlling process variables such as pH, coating time, and concentration. Here we are producing nanocomposite multilayers (50 – 1000 nm thick), having 10 – 96 wt% clay, that are completely transparent and exhibit oxygen transmission rates below 0.005 cm^3/m^2•day. This exceptional oxygen barrier makes these coatings interesting for food, consumer products and flexible electronics packaging. These same 'nanobrick wall' assemblies are very conformal and able to impart flame resistance to highly flammable foam and fabric by uniformly coating the complex three-dimensional geometries. I'll also describe how all-polymer thin films can separate H_2 from N_2 (or CO_2) with selectivity greater than 2000, which exceeds other commonly used gas separation membranes (including zeolites). These films can also be produced with graphene oxide to generate high barrier and low sheet resistance. If there's time, our work on antimicrobial and UV-resistant films will also be described. All of these nanocoatings are water-based and processing occurs under ambient conditions in most cases. Furthermore, these nanocoatings can be deposited in a commercially-feasible manner. Our work in these areas has been highlighted in *C&EN*, *ScienceNews*, *Nature*, *Smithsonian Magazine*, *Chemistry World* and various scientific news outlets worldwide. For more information, please visit my website: http://nanocomposites.tamu.edu

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. Prof. Grunlan was promoted to Associate Professor in 2010 and then Professor in 2014. His research focuses on thermal and transport properties of nanocomposite materials, especially in the areas of thermoelectric energy generation, gas barrier and fire prevention. 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 2012 L.E. Scriven Young Investigator Award, sponsored by the ISCST, and the 2013 E. D. Brockett Professorship for his work in these areas. He has published over 100 journal papers and filed several patents. His current research group consists of 2 postdocs, 9 PhD candidates and 16 undergraduate researchers. Dr. Grunlan also holds joint appointments in Chemistry and Materials Science and Engineering.