Dr. Larry Drummy visit 23 Feb 2012

This talk will focus on cutting-edge morphology characterization techniques applied to materials for power and energy applications.

Organic Photovoltaics:

The performance of bulk heterojunction organic photovoltaic devices is critically dependent on the morphology of the active layer. Here we describe the combination of two electron microscopy techniques to quantitatively examine the molecular level structure and mesoscopic domain morphology of the active layer of P3HT:PCBM bulk heterojunction solar cells. Energy-filtered transmission electron microscopy (EFTEM) revealed the nanoscopic, interpenetrating fibrillar structure of the phase separated blend, providing unique assignments of the P3HT-rich and PCBM-rich regions. Low-dose high-resolution electron microscopy (LD-HREM) provided direct images of the P3HT crystals and their orientation within the P3HT-rich domains.

Nanostructured dielectrics:

The unprecedented control over organic-inorganic hybrid nanomaterial structure afforded by polymer synthesis and functionalization techniques provides a toolbox for materials property design. For applications such as high energy density dielectrics, a high volume fraction of inorganic material is desired while maintaining an appropriate interparticle separation distance, thus avoiding percolation which leads to dielectric breakdown. We have functionalized the surface of oxide ($BaTiO_3$, TiO_2, SiO_2) nanoparticles with polymers (PS, PMMA) of controlled molecular weight and purified the resulting hybrid nanoparticles so that no unbound polymer remained. The resulting nanoparticles were assembled into films which showed increased dielectric constant with increasing volume fraction of inorganic, while maintaining their dielectric breakdown strength. Finally, 3D electron tomography and was used to develop structure-property relationships which showed that control of both the nano-structure (interparticle separation distance) and the meso-structure (void size) are critical to achieving the desired material properties.

Brief Bio:

Lawrence Drummy is a materials scientist at the Nanostructured and Biological Materials Branch, Materials and Manufacturing Directorate, Air Force Research Laboratory in Dayton, OH. He received his BS in Physics at Rensselaer Polytechnic Institute and PhD from the Department of Materials Science and Engineering at the University of Michigan. His current research includes quantitative morphology characterization of nanoparticles and nanocomposites using high resolution electron microscopy techniques and advanced tomography reconstruction algorithms.