2007-2008 Materials Council Seminar Series

Georgia Institute of Technology

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"Dispersion and Self-Assembly of Nanospheres and Nanorods in Polymer Nanocomposite Films"

Tuesday, October 16, 2007
Verco Classroom 299 – LOVE Bldg.
3:00-4:00PM

ABSTRACT

Self-assembly in polymer films containing nanoparticles (NPs) can result in novel nano to micro-scale structures with attractive electrical, opto-electronic, magnetic, mechanical and other properties depending on the choice of NP and polymer system. In this talk we explore both in-situ and ex-situ routes to disperse NPs in homopolymers, polymer blends and block copolymers. By tuning thermodynamics and directing phase evolution, novel morphologies and structures are obtained in (1) polymer blend films containing silica nanospheres, (2) in-situ formed silver nanospheres in homopolymer and block copolymer films and (3) gold nanorods in lamellae forming block copolymer films. In demixed polymer blends, NP location is controlled by polymer brushes grafted to the surface.[1] Depending on their volume fraction, NPs that locate at the interface are found to stabilize bicontinuous 3D or discrete 2D structures. Silver NPs are synthesized in-situ by thermal decomposition in homopolymer[2] and block copolymer films[3]. Silver segregation leads to tailored surface properties in homopolymer nanocomposites. For block copolymer films, competition between NP formation and copolymer self-assembly results in a surface decorated with an aligned array of NPs.[3] The kinetics of copolymer self-assembly into a perpendicular lamellae structure is slowed by the NPs. In the final example, nanorods consisting of Au modified with polyethylene glycol are selectively located and confined within the lamellar domains of a block copolymer. These rods orient with their long axis parallel to lamellae orientation. These studies provide a stronger foundation for understanding how model systems form nano to micro-scale structures and, hopefully, will motivate improvements in designing functional polymer nanocomposite systems. For example, by fine-tuning the morphology of semiconducting polymer blends containing additives, more efficient photovoltaic devices would result. [4]

[1] Chung et al., "Self Regulated Structures in Nanocomposites by Directed Nanoparticle Assembly," Nano Letters, 5, 1878 (2005); "Internal Phase Separation Destabilizes Multicomponent Polymer Films," Macromolecules, 40, 384 (2007).

[2] Deshmukh and Composto "Surface Segregation and Formation of Silver Nanoparticles Created in-situ in Poly(methyl methacrylate Films)," Chemistry of Materials, 19, 745 (2007);

[3] Deshmukh et. al, "Nanoscale Block Copolymer Templates Decorated by Nanoparticle Arrays," Macromolecules, 40, 6316 (2007).

[4] Janssen et. al., "Polymer-Fullerene Bulk Heterojunction Solar Cells," MRS Bulletin, 30, 33 (2005).

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