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Hierarchical Nanocomposites for Device Applications

JAMES WATKINS, University of Massachusetts

We have outlined templating strategies for electronic and optical device fabrication that include self-assembly of well-ordered polymer/nanoparticle hybrids and nanoimprint lithography using novel materials sets. Using additive-driven self-assembly, for example, we demonstrate the formation of periodic nanocomposites with tunable magnetic and optical characteristics containing up to 70 wt. % of metal, metal oxide and/or semiconducting nanoparticles through phase specific interactions of the particles with either linear block copolymer or brush block copolymer (BBCP) templates. The BBCP templates provide direct access to large domain spacings for optical applications and spontaneous alignment within large volume elements. We have further developed highly filled nanoparticle/polymer hybrids for applications that require tailored dielectric constant or refractive index and a new imprinting process that allows direct printing of patterned 2-D and 3-D crystalline metal oxide films and composites with feature sizes of less than 100 nm. Applications in flexible electronics, light and energy management, and sensors and will be discussed.