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Controlled Nanomorphology of Hybrid Organic/Inorganic Multi-Component Composites through Cooperative Non-Covalent Interactions

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Abstract
Hybrid organic–inorganic nanocomposite polymers, with inorganic nanoparticles embedded in organic matrix have emerged as a special category of multifunctional materials. With rational materials design, these hybrids can show the synergistic effect of the properties from both phases. Homogenous dispersion and orderly arrangement of the organic and inorganic components are key in their functionalities. By controlling the interface and corresponding interfacial interactions between the organic and inorganic entities, we have developed a logical approach to form stable and controlled hybrid nanofiber structures. We demonstrate the formation of hybrid polymer/quantum dots (or iron oxide nanoparticles) nanocomposites through non-covalent interactions (hydrogen bonding, ionic interactions, etc.). We show that by synthesizing conjugated polymers with specific functionalities, capping nanoparticles with different ligands, we can specifically assemble them into a well-ordered core/shell structure. Besides possessing the excellent conducting properties of the polymer, the resulting nanocomposites also show some added value, such as broader light absorption range when combined with PbS quantum dots, magnetic properties when combined with iron oxide nanoparticles. Further characterization under solar cell operation condition demonstrates their potential application for solar energy harvesting. We believe that this composite nanofiber strategy could be used to generate a wide variety of polymer/nanoparticle hybrid nanocomposites. Also, the achievement of homogeneous dispersion of inorganic species into a polymer matrix may offer opportunities to build a unified hybrid nanocomposite platform for different technical applications.

Keywords: organic photovoltaic, conjugated polymer, quantum dot, magnetic nanoparticles, self-assembly