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

Abstract

Hybrid organic-inorganic materials have evolved into a remarkable class in the field of Materials Chemistry, as they combine the advantages of both the organic and inorganic worlds to be applicable for a wide range of technological applications. However, simple mixing of organic and inorganic components into one composite often results in structures that lack of long range order and precise arrangement. To solve this problem, we have developed a logical supramolecular approach to form stable and controlled hybrid nanocomposites for applications in next-generation photovoltaic (PV) technology. We demonstrate the formation of stable and controlled nanomorphology of polymer/quantum dots (QDs)/fullerene ternary blends. We show that by capping QDs with different ligands, synthesizing conjugated polymers and fullerene derivatives with different functional groups, we can specifically assemble them into a well-ordered core/shell structure through non-covalent interactions including hydrogen bonding, ionic interactions, etc. In the meantime, some added values, such as broader light absorption range when combined with PbS QDs, magnetic properties when combined with iron oxide nanoparticles, can be obtained. Our research can potentially help to gain a better control over the nanoscopic order and spatial arrangement of the inorganic building blocks relative to the organic moieties, and also contribute to a better understanding of the structure-property relationships at the microscopic and macroscopic scales.

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