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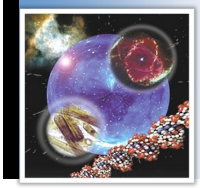
Self Assembly of Semiconducting Polymers for Nanostructured Optoelectronic Materials

Conjugated polymers have been investigated as active materials in optoelectronic applications such as light emitting devices, photovoltaic cells, and charge storage devices. These organic polymers are attractive alternatives to conventional inorganic materials because they can be synthesized and processed in solution, potentially reducing the cost and complexity of device manufacturing. Typical solution processing methods create amorphous polymer networks, which are often not optimal for electronic applications where electrical conduction is required. It would therefore be useful to be able to control the nanoscale structure of conjugated polymers in the solid state, and particularly to make straight chains to increase the electrical conductivity. To this end, we have designed several novel conjugated polymers with amphiphilic functionality. These polymers self assemble in solution to form cylindrical micelles, which also causes changes in the polymer conformations and interchain electronic interactions. We characterized the self assembly process and its effects on the polymers' optical properties by X-ray and visible light scattering, atomic force microscopy, and optical spectroscopy. Certain polymers also form gel networks reversibly at high concentrations. Rheological measurements of these gels indicate that they are formed by physical entanglements between semi-flexible polymer micelles, which could create a three dimensional conducting network. We have also used the self assembling properties of these polymers to make composite materials with nanoscale structural order. Like conventional surfactants, our amphiphilic polymer micelles can act as templates to direct the formation of bulk and thin film nanostructures with inorganic precursors such as silica, titania, and other semiconductors. In order to investigate the potential of these materials as active components of optoelectronic devices, we performed X-ray diffraction, optical spectroscopy, and fluorescence quenching experiments. These measurements indicate that the straight chain conformation of the polymers is maintained in the composites, and high luminescence quenching shows that the polymers transfer charge efficiently to the semiconducting frameworks. These properties suggest that these semiconducting polymer composite materials could function effectively as active components in solar cells, creating a new class of optoelectronic materials.



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