Using Self-Assembly to Control Nanoscale Morphology in Semiconducting Polymers for Application in Organic Photovoltaics

Organic photovoltaics (OPVs) have the benefit of low cost and ease of processing compared to their silicon counterparts. A typical OPV consists of a semiconducting polymer that acts as the electron donor and primary photoabsorber blended with an electron acceptor, often a C60 fullerene derivative. The two components must then be blended on a fine enough length scale that enables efficient electron transfer while still separated enough to maintain a high conductivity within each component. It can however be difficult to create an optimal morphology of each component in a reproducible manner. The talk will cover three different ways of tuning and controlling the self-assembly of semiconducting polymers to control the nanoscale architecture. First, we will explore changing the crystallinity of the polymer component as a way to tune the resulting morphology and device performance. Next, an inorganic host will be used as a method of straightening individual chains of semiconducting polymers to dramatically improve the hole mobility along the polymer backbone. We show that high hole mobilities are not limited to crystalline polymers but rather to the presence of kinks in the polymer chains. In the last section, we present an alternative way to straighten polymer chains through self-assembly in water to create 3D conductive networks. Upon the addition of a charged fullerene derivative to this network, long-lived polarons are created in solution that are stable for days. All of these methods show that self-assembly can be used to enhance the morphology of the polymer and thus can be used to improve the performance of organic photovoltaics.

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