Improving Performance of Organic Solar Cells with P3HT-Based Diblock Copolymer

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Bulk Heterojunction organic polymer solar cells have great potential as a green, flexible and low-cost renewable energy source. Block copolymers are well known for phase separation in highly ordered nanostructures in scale of exciton diffusion length (15-20nm) for polymer solar cells. In this project, PS-b-P3HT diblock copolymer has been added into P3HT/PCBM blend system to improve the crystallization and morphology towards achieving high energy-conversion efficiency. As show in Figure 1, by blending in P3HT/PCBM composites, the energy-conversion efficiency has been improved. Compared with energy-conversion efficiency of 3.25% from the pure P3HT/PCBM blending system, the maximum efficiency has been increased to 4.11% with addition of P3HT-b-PS diblock copolymer in weight ratio of 5% in P3HT/PCBM blends. The effect of adding PS-b-P3HT diblock copolymer on the morphology and phase separation of P3HT/PCBM blend was systematically studied through AFM. The AFM phase images (Figure 2) clearly demonstrate that uniform morphology with interpenetrating nanoscale domains of P3HT and PCBM network has been achieved at 5% concentration of diblock copolymer, which is corresponding to the highest efficiency in this study. The uniform morphology with interpenetrating nanoscale P3HT/PCBM network increases the donor/acceptor interface areas and facilitates exciton separation, thus energy-conversion efficiency has been improved.

The crystallization of P3HT/PCBM thin film also plays a significant role for charge carrier transport and collection in bulk heterojunction organic solar cells. The x-ray diffraction patterns (Figure 3) show sharp peak at concentration of 5% diblock polymer, indicating better crystallization of active layer. In summary, our results show block copolymer approach represents a promising way to enhance the photovoltaic properties of bulk heterojunction organic polymer solar cells.

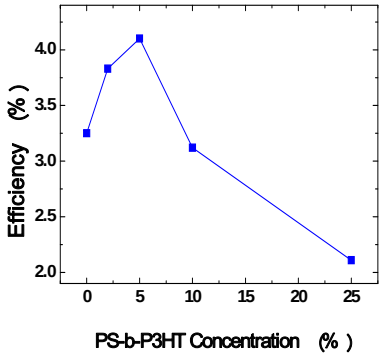

Figure 1

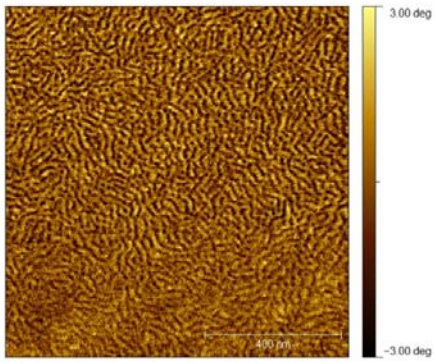

Figure 2

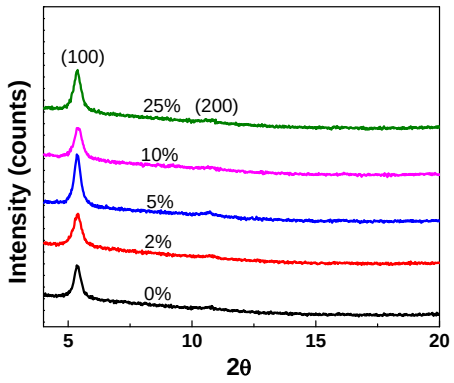

Figure 3

Key words: Bulk Heterojunction, Organic Polymer Solar Cells, DiBlock Copolymer, Morphology, Power-Conversion Efficiency