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Morphology Evolution of Molecular Weight Dependent P3HT: PCBM Solar Cells FENG LIU, DIAN CHEN, ALEJANDRO BRISENO, THOMAS RUSSELL, UMASS-Amherst — Effective strategies to maximize the performance of bulk heterojunction (BHJ) photovoltaic devices have to be developed and understood to realize their full potential. In BHJ solar cells, the morphology of the active layer is a critical issue to improve device efficiency. In this work, we choose poly(3-hexyl-thiophene) (P3HT) and phenyl-C61-butyric acid methyl ester (PCBM) system to study the morphology evolution. Different molecular weight P3HTs were synthesized by using Grignard Metathesis (GRIM) method. In device optimization, polymer with a molecular weight between 20k-30k shows the highest efficiency. It was observed that the as-spun P3HT: PCBM (1:1) blends do not have high order by GISAXS. Within a few seconds of thermal annealing at 150 $^\circ$ the crystallinity of P3HT increaased substantially and the polymer chains adopted an edge-on orientation. An-bicontinous morphology was also developed within this short thermal treatment. The *in situ* GISAXS experiment showed that P3HT of high molecular weight was more easily crystallized from a slowly evaporated chlorobenzene solution and their edge-on orientation is much more obvious than for the lower molecular weight P3HTs. DSC was used to study the thermal properties of P3HTs and P3HT: PCBM blend. The χ of P3HT-PCBM was also calculated by using melting point depression method.

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