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Quantifying the role of poly(3-hexylthiophene) and fullerene crystallinity on performance of polymer solar cells ENRIQUE GOMEZ, Penn State University — Continued development and improvement of polymer solar cells requires an understanding of structure-function relationships which encompass the morphology of the active layer and device performance. Through a combination of grazing-incidence X-ray diffraction and X-ray rocking scans, we have quantified the crystallinity of poly(3-hexylthiophene) (P3HT) and [6,6]-phenyl-C_{61}-butyric acid methyl ester (PCBM) in the active layer of bulk heterojunction polymer solar cells. We find that the device short-circuit is limited, to first order, by the PCBM crystallinity for a wide range of processing conditions. However, when the PCBM crystallinity is greater than 50% of the maximum crystallinity achievable in our samples through thermal annealing, the extent of P3HT out-of-plane π-stacking is directly correlated with the device short-circuit current. By quantifying the relationship between the crystallinity of both organic semiconductors of the active layer and device performance, we have developed a description of the complex interplay between structure and performance in polymer solar cells.

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