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Interfacial Aspects of Polymer Based Photovoltaic Structures[1]

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Controlling thin film morphology is key in optimizing the efficiency of polymer-based photovoltaic (PV) devices. Poly(3-hexylthiophene) and [6,6]-penyl-C61 butyric acid methyl ester (P3HT:PCBM) based solar cell performance is dictated by nanostructure of the active layer, the interfaces between the active layer and the electrodes, and the P3HT chain orientation in the thin film. The above parameters were systematically studied by scanning transmission electron microscopy, scanning force microscopy, optical microscopy, grazing incident angle x- ray diffraction., dynamic secondary ion mass spectroscopy and near edge x-ray absorption fine structure analysis. The influence of thermal annealing on the morphology, interfaces and crystal structure was investigated in films that were either initially confined by two electrodes or confined by only one electrode. While the bulk morphology in these films were identical, significant differences in the concentration of components at the electrode interfaces were found, giving rise to a marked difference in performance. In addition, a model was established, based on the crystallization of the P3HTand the diffusion of the PCBM to describe the origins of the nanoscale morphology found in the active layer. The device performance parameters were quantitatively studied.

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