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Unraveling the morphology of a novel, high-efficient polymer solar cell using synchrotron-based techniques

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Organic solar cells are a next generation photovoltaic technology with the potential for a low cost of manufacturing and printing on flexible substrates. The efficiency of organic solar cells has increased rapidly, recently exceeding 9% efficiency. Understanding the morphology of the active layer of polymer based bulk heterojunction solar cells is necessary to further improve device performance. Here we comprehensively study the morphology of a novel electron donor polymer PBDTTT-EFT with efficiency of over 9%. The orientation and microstructure of the neat polymer films and in blend films with PC71BM are examined by using a combination of surface-sensitive near edge X-ray absorption fine structure (NEXAFS) spectroscopy from the soft X-ray beamline and bulk sensitive grazing incidence wide angle X-ray scattering (GIWAXS) collected at the SAXS/WAXS beamline. In the blend, a “face-on” orientation of PBDTTT-EFT is observed with π-π stacking normal to the substrate in the bulk of thin film, while a more “edge-on” orientation with side-chain-stacking normal to substrate is observed at the surface of the film. In organic solar cells, face-on structures enhance charge transport in the critical vertical direction. An edge-on orientation of PBDTTT at the hole extracting interface is not considered to be ideal for charge collection, but does not appear to adversely affect device performance. The additive 1,8-Diiodooctane is also used to improve the crystallization of PBDTTT-EFT and to control the aggregation of PC71BM.

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Summary

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