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Influence of different side-chains on the morphology and device physics of all-polymer solar cells.

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Semiconducting polymers are interesting materials that can be used as the active layer in light-emitting diodes, transistors and solar cells. In a polymer solar cell, the blending of donor and acceptor materials is required to achieve effective charge generation. Historically, fullerene derivatives have been used as the acceptor material due their high electron affinity, but fullerenes only weakly absorb light and are more expensive than semiconducting polymers. Recently significant progress has been made with so-called all-polymer solar cells that use semiconducting polymers as both donor and acceptor, with power conversion efficiencies of 7.7% recently reported. Key to this recent increase in cell efficiency has been the tailoring of the chemical structure of the polymeric materials, in particular the structure of the side-chains used to solubilise these materials.

In this study, we study seek to understand the increase in cell efficiency that accompanies the replacement of oxygen atoms with thiophene moieties in the side chains of the donor polymer PTB7. Devices fabricated with PTB7 as the donor show an efficiency of 2.2%, while devices fabricated with the thiophene-substituted PBDTTT-EFT have an efficiency of 5%. A combination of lab-based (AFM, TEM) and synchrotron-based (NEXAFS spectroscopy, GIWAXS, R-SoXS) are used to characterise thin film microstructure, which is related to device physics and photophysics to paint a clear picture of the factors aiding in improvement of the performance.

Keywords

All-polymer solar cell, GIWAXS, NEXAFS, RSoXS, TEM, AFM

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