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Do reduced aggregation and crystallinity really help to improve the photovoltaic performance of terpolymer acceptors in all-polymer solar cells?

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Terpolymerization is a widely used method to control crystallinity of the semiconducting polymers which has been exploited to improve the photovoltaic performance of all-polymer solar cells (all-PSCs). Applying this strategy to the well-studied n-type polymer acceptor PNDI2OD-T2, different amounts of 3-n-octylthiophene (OT) are used to partially replace the bithiophene (T2) unit, resulting in three newly-synthesized terpolymer acceptors PNDI-OTx where x = 5%, 10%, or 15%. Another copolymer, namely PNDI2OD-C8T2, consisting of naphthalene diimide (NDI) copolymerised with 3-n-octylbithiophene (C8T2) is also synthesized for comparison. The experimental X-ray characterizations suggest that the molecular orientation of π-conjugated backbone in PNDI-OTx is slightly impacted and thin film crystallinity is systematically tuned by varying x, evidenced by near edge X-ray absorption fine structure (NEXAFS) and grazing incidence wide angle X-ray scattering (GIWAXS) measurements, respectively. However, the photovoltaic performance of all-PSCs based on J71:PNDI-OTx and J71:PNDI2OD-C8T2 blends are much lower than that of the reference J71:PNDI2OD-T2 system. Extensive morphological studies suggest that reduced crystallinity is likely to have a little influence on vertical phase separation and crystallinity of resulting blends as revealed by peak fits from NEXAFS and GIWAXS experiments. However, the reduced crystallinity is detrimental for morphology of the blend films, with coarser phase separation found in J71:PNDI-OTx and J71:PNDI2OD-C8T2 blends compared to J71:PNDI2OD-T2 blends, confirmed by resonant soft X-ray scattering. The results here challenge the common view that reduced crystallinity is the key parameter in controlling the morphology for enabling high-performing all-PSCs.

Level of Expertise

Student

Presenter Gender

Man

Pronouns

He/Him

Which facility did you use for your research

Australian Synchrotron

Students Only - Are you interested in AINSE student funding

Yes

Do you wish to take part in the Student Poster Slam

Condition of submission

Yes

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