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Suppressed degradation process of PBDB-TF-T1:BTP-4F-12 solar cells with solid additive EH-P

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Solid additives have garnered significant attention due to their numerous advantages over liquid additives, which could help to enhance the device performance and stability of organic solar cells. In this study, we explore the potential of the polymer EH-P as a solid additive in green-solvent-based PBDB-TF-T1:BTP-4F-12 solar cells. Even tiny amounts of EH-P doping significantly improve device performance. For the reference solar cell without any additive, we found that cell device degradation is not caused by chemical reoxidation but by changes in crystallinity and microstructure evolution during aging in air under illumination. Operando GIWAXS and GISAXS are used to investigate this structure evolution. We discovered a three-stage degradation process for the reference cell. In general, the d spacing and crystallite coherence length decrease while the domain sizes increase, which causes the loss of JSC and FF. Furthermore, a decomposed component is detected in GIWAXS and GISAXS, which corresponds to the loss of VOC. EH-P doping effectively suppresses the evolution of crystallinity and domain sizes, enhancing device stability under illumination in the air. The detailed evolution of the donor and acceptor is further analyzed via separated-fitting the π-π stacking signal, and EH-P is found to be more effective for the acceptor. This demonstrates the promising potential of EH-P doping in solar cell technology.

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