Importance of Polymer Acceptors with High Electron Mobility for Producing Additive-Free High-Performance All-Polymer Solar Cells

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High-performance all-polymer solar cells (all-PSCs) were fabricated without any solvent additives or thermal treatments by using novel naphthalene diimide (NDI)-based alternating copolymers as electron acceptors. We found that the high electron transport ability of the polymer acceptor is one of the most important requirements for producing high-performance, additive-free all-PSCs. To control the planarity of the polymer backbone and optimize electron mobility, we introduced three different electron-rich units (i.e., thiophene (T), bithiophene (T2), and thienylene-vinylene-thienylene (TVT)) into the NDI-based polymers. Particularly, P(NDI-TVT) polymers exhibited the highest electron mobility (2.31 cm2 V-1 s-1) in organic field effect transistors due to the enhanced degree of coplanarity. Also, the high electron mobility of P(NDI-TVT) facilitated electron transport in all-PSC blends, resulting in the well-balanced hole/electron mobility ratio. Thus, all-PSCs based on P(NDI-TVT) acceptor exhibited the high efficiency of 4.25% without any solvent additives or thermal treatments.