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Fully conjugated block copolymers for organic photovoltaics

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Weak intermolecular interactions and disorder at junctions of different organic materials limit the performance and stability of organic interfaces and hence the applicability of organic semiconductors to electronic devices. Our approach has focused on utilizing block copolymer architectures –where critical interfaces are controlled and stabilized by covalent bonds– to provide the hierarchical structure needed for high-performance organic electronics from self-assembled soft materials. For example, we have demonstrated control of donor-acceptor heterojunctions through microphase-separated conjugated block copolymers to achieve 3% power conversion efficiencies in non-fullerene photovoltaics. Characterization through X-ray scattering and electron microscopy reveals that the efficient performance of block copolymer solar cells is due to self-assembly into mesoscale lamellar morphologies with primarily face-on crystallite orientations. Furthermore, incorporating the donor-acceptor interface within the molecular structure facilitates studies of charge transfer processes, where we can systematically modulate the chemical structure and energetics to perturb exciton dissociation and charge recombination.