Design and synthesis of organic semiconductors for near-infrared optoelectronics

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In light harvesting and sensing devices such as organic solar cells (OSCs) and organic photodetectors (OPDs), accurate tuning of molecular orbital energy levels and absorption wavelengths are necessary to optimize device efficiency. A key reason is that OSCs still show low open-circuit voltages (V_{oc}) relative to their optical band gaps, attributed to non-radiative recombination. Moreover, a critical challenge arises in narrowing the bandgap with respect to the counterbalance between driving force and charge separation. However, the benefits of near-infrared (NIR) organic semiconductors remain comparatively unexplored in the context of OSCs and OPDs. A critical challenge arises as one decreases optical bandgaps (E_g^{opt}) with respect to the counterbalance between the driving force for charge separation and voltage loss in the solar cell devices. The structure-property relationships in NIR nonfullerene solar cells and photodetectors were studied through development of new materials.