“Air-Stable Organic Photovoltaics”

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Abstract:

A major challenge for the commercialization and widespread adoption of organic photovoltaics (OPVs) is instability and short lifetimes resulting from many different degradation pathways. A major contributor to the degradation of OPVs is poly(3,4-ethylenedioxythiophene):poly(p-styrenesulfonate) (PEDOT:PSS), a common buffer layer, which can etch electrodes and migrate throughout devices. This degradation can be alleviated through structuring components via electrostatic layer-by-layer (eLbL) assembly (Figure 1a).[2,3] Anionic PEDOT:PSS and cationic functionalized polythiophenes were combined through eLbL with nanoscale control of thickness and precise, tunable work function from 4.6 to 3.8 eV.[4] The reduced work function permits the fabrication of efficient inverted OPV devices (Figure 1b) with power conversion efficiencies ranging from 0.2% to 5.6% depending on the cathodic buffer layer work function. The eLbL architecture stabilizes PEDOT:PSS components, leading to longer OPV lifetimes. We demonstrate long-term stability of poly[(3-hexylthiophene)-2,5-diyl] (P3HT):6,6-phenyl-C_{61}-butyric acid methyl ester (PC_{61}BM) PSCs under encapsulation for 10,000 h and air stable low bandgap polymer:PC_{71}BM devices for over 1500 h. These devices present a bright future for both efficient and stable organic photovoltaics.