

Air Stable Organic Photovoltaics from Small Molecules Acene Derivatives

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Photovoltaics are expected to play a major role in satisfying the long-term global demand for cheap and renewable energy. As such, solar cells technologies are currently the focus of intense academic and commercial research scrutiny. Within the broad and diverse photovoltaic field, organic small molecules appear to be particularly promising materials. Indeed, small molecules can be easy to synthesize and purify, are monodisperse, exhibit high carrier mobilities, and can be processed directly from solution. However, the molecular design of organic small molecules for device stability in ambient atmosphere, an absolutely crucial consideration, has received little attention. Therefore, we have focused our efforts on photovoltaics that are not only efficient but are also stable in the presence of oxygen. Here, we utilize derivatized pentacenes and other extended acene systems as the p-type donor materials in bilayer device architectures. By modifying the 6 and 13 positions of pentacene molecules with aromatic substituents, typical pentacene degradation pathways that adversely affect device performance are minimized. Such derivatized pentacenes afford not only stable device operation in ambient atmosphere but also energy conversion efficiencies greater than 1 %. We further extend our efforts to larger polycyclic aromatic ring systems such as hexabenzocoronene (HBC), which effectively consists of three fused and interpenetrating pentacene moieties. Devices that feature HBC as the donor material display surprisingly high efficiencies in air, which is interesting given the poor overlap between the solar spectrum and the absorbance of HBC. In addition, substitution of the HBC ring system with long alkyl chains leads to improved solution processability and simplified device fabrication. HBC derivatives therefore hold substantial promise as donor materials in bulk heterojunction device structures. It is important to note that solar cells manufactured from the materials described here require no encapsulation, allowing for facile device fabrication. Consequently, our materials show great promise for the manufacture of completely air-stable photovoltaics.