

Solution-processable, small molecule, organic semiconductors based on dibenzo[*b,def*]chrysene for use in organic electronic devices

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We report on organic electronic devices incorporating a new class of solution-processable small molecule semiconductors based upon the polycyclic aromatic hydrocarbon dibenzo[*b,def*]chrysene. UV-vis spectroscopy and photoluminescence (PL) studies show evidence of a high yield of photoinduced electron transfer in blends with the methanofullerene [6,6]-phenyl-C₆₁-butyric acid methyl ester (PCBM), which makes compounds based on the dibenzo[*b,def*]chrysene template suitable for use as an electron donor in solar cells. Bulk heterojunction solar cells efficiencies are found to be between 0.18-2.25% for derivatives with different side groups attached to the core dibenzo[*b,def*]chrysene. Charge carrier mobility and recombination kinetics are investigated using *photo*-charge extraction by linearly increased voltage (*Photo*-CELIV). The relationship between solar cell efficiencies and semiconductor mobilities for the family of compounds will be discussed. The rate of charge carrier recombination was also measured in the optimized blend which has shown reduced bimolecular recombination. In organic field effect transistor devices, across the series of neat compounds tested, charge mobility varies from 10⁻⁵ to 10⁻³ cm²/Vs. We have also used OFET devices to characterise bipolar charge transport in donor-acceptor blends of this type as used in solar cells. Irrespective of the measurement techniques, hole mobility in the blend film is reduced by more than one order of magnitude compared with that measured in a neat film of the dibenzo[*b,def*]chrysene. We propose that this is due to energetic disorder caused by disruption to the π -stacking of dibenzo[*b,def*]chrysenes by the presence of PCBM. It is demonstrated here for the first time that taken in consideration of excellent OPV results, the reduction in mobility of two small molecule blends can be tolerated to an extent. Finally, we will also present our recent results on evaporated dibenzo[*b,def*]chrysene based bilayer solar cells. Devices based on these materials with a C₆₀ n-type layer show power conversion efficiencies approaching 2%. These results show that bilayer devices can be used to separate morphology in bulk heterojunction devices from the intrinsic properties of the semiconductor and suggest the use of the bilayer device structure as a screening tool for materials discovery.