ELECTROCHEMICAL ANALYSIS OF NEAR-INFRARED DYES FOR POLYMER SOLAR CELLS

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Polymer solar cells are garnering significant interest for terrestrial photovoltaics due to their potential low cost compared to conventional crystalline solar cells such as silicon-based devices. However, efficiencies of polymer solar cells are limited in part by a mismatch of the active layer response with respect to the one sun AM1.5 solar spectrum. Application of near infrared (NIR) absorbing dyes into the devices has been theoretically shown to increase efficiencies to nearly ten percent. Candidate dyes for NIR enhancement were evaluated for the appropriate energy-level cascade to facilitate exciton dissociation and prevent recombination of charge carriers. Measurements from optical absorption and cyclic voltammetry were used to calculate bandgaps, electron affinities, and ionization potentials for each of the dyes as well as the respective polymers and fullerenes in a conventional bulk heterojunction device. Dyes selected for NIR enhancement, including 1,3-bis[4-(dimethylamino)phenyl]-2,4-dihydroxycyclobutenediylium dihydroxide (squarylium dye – Aldrich) and aluminium 1,8,15,22-tetrakis(phenylthio)-29*H*,31*H*-phthalocyanine chloride (ATPPC dye – Aldrich) have demonstrated suitable energy level alignment with devices comprising poly(3-hexylthiophene-2,5-diyl) (P3HT) and [6,6]-phenyl-C_{61}-butyric acid methyl ester (PCBM[60]). Fabrication of bulk blended as well as multi-layer structures has been performed and measured using spectral response. The devices incorporating the ATPPC dye extended the NIR response with a 5% enhancement in external quantum efficiency compared to the baseline structures. Thus, the prospect of enhancing the NIR response in polymer solar cells has been demonstrated and approaches to increase the overall power conversion efficiency of these devices will be discussed.