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Solution processed organic photodetector utilizing an interdiffused polymer/fullerene bilayer

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Low dark current (off-current) and high photo current are both essential for a solution processed organic photodetector (OPD) to achieve high photo-responsivity. Currently, most OPDs utilize a bulk heterojunction (BHJ) photo-active layer that is prepared by the one-step deposition of a polymer:fullerene blend solution. However, the BHJ structure is the main cause of the high dark current in solution processed OPDs. It is revealed that the detectivity and spectral responsivity of the OPD can be improved by utilizing a photo-active layer consisting of an interdiffused polymer/fullerene bilayer (ID-BL). This ID-BL is prepared by the sequential solution deposition (SqD) of poly(3-hexylthiophene) (P3HT) and [6,6] phenyl C61 butyric acid methyl ester (PCBM) solutions. The ID-BL OPD is found to prevent undesirable electron injection from the hole collecting electrode to the ID-BL photo-active layer resulting in a reduced dark current in the ID-BL OPD. Based on dark current and external quantum efficiency (EQE) analysis, the detectivity of the ID-BL OPD is determined to be 7.60×10^{11} Jones at 620 nm. This value is 3.4 times higher than that of BHJ OPDs. Furthermore, compared to BHJ OPDs, the ID-BL OPD exhibited a more consistent spectral response in the range of 400 – 660 nm.

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