Electronic Supplementary Material (ESI) for Energy & Environmental Science

High-Performance Semi-transparent Polymer Solar Cells Possessing Tandem Structures

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Supporting Information

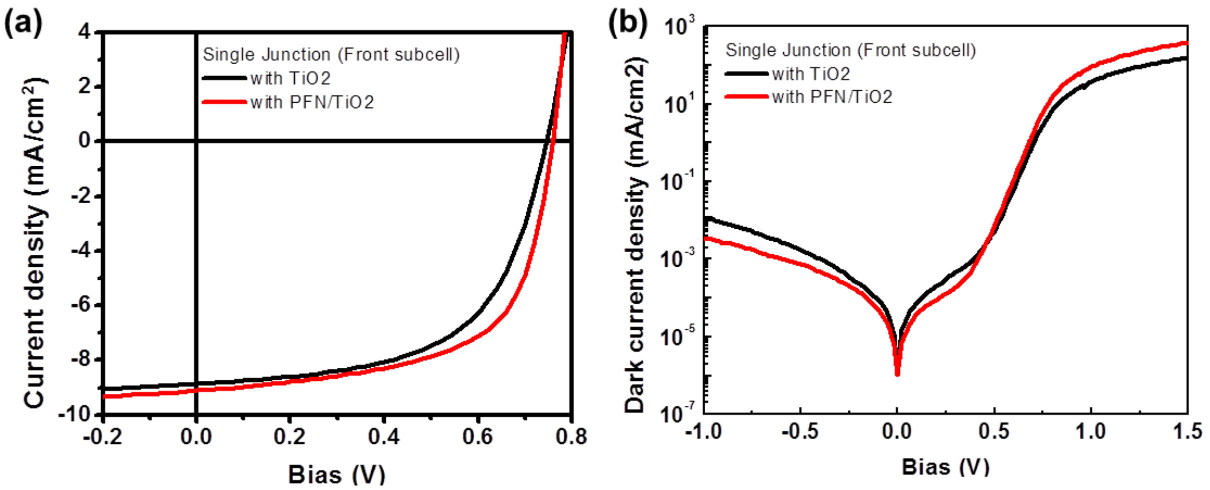

Fig.S1 *J–V* curves of the single junction transparent PSCs, measured under (a) incident light coming from the ITO/glass substrate and (b) dark condition with either TiO_2 or PFN/TiO_2 double layer as electron injection layer

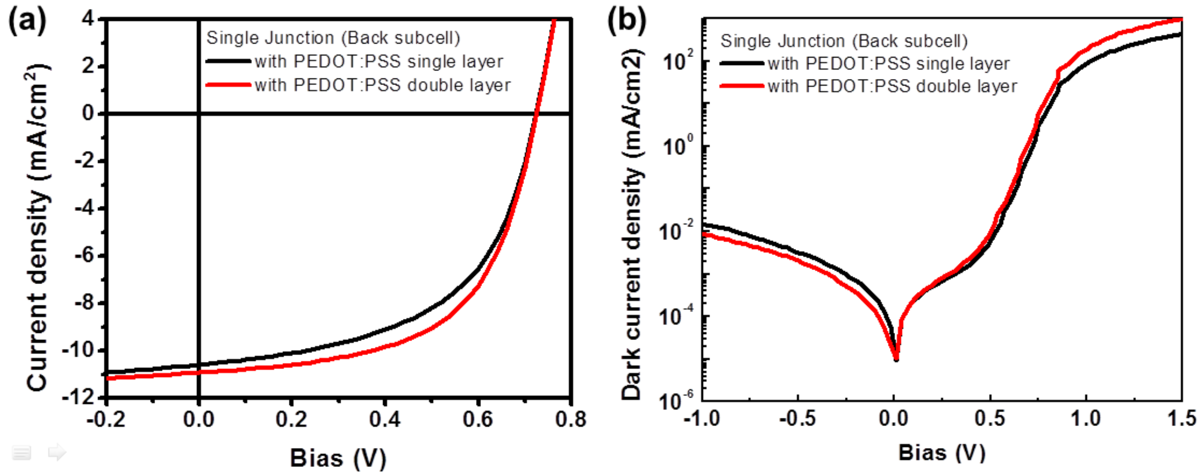

Fig.S2 *J–V* curves of the single junction transparent PSCs, measured under (a) incident light coming from the ITO/glass substrate and (b) dark condition with either PEDOT:PSS single layer (PH1000) or double layer (PH1000/AI 4083) as hole injection layer

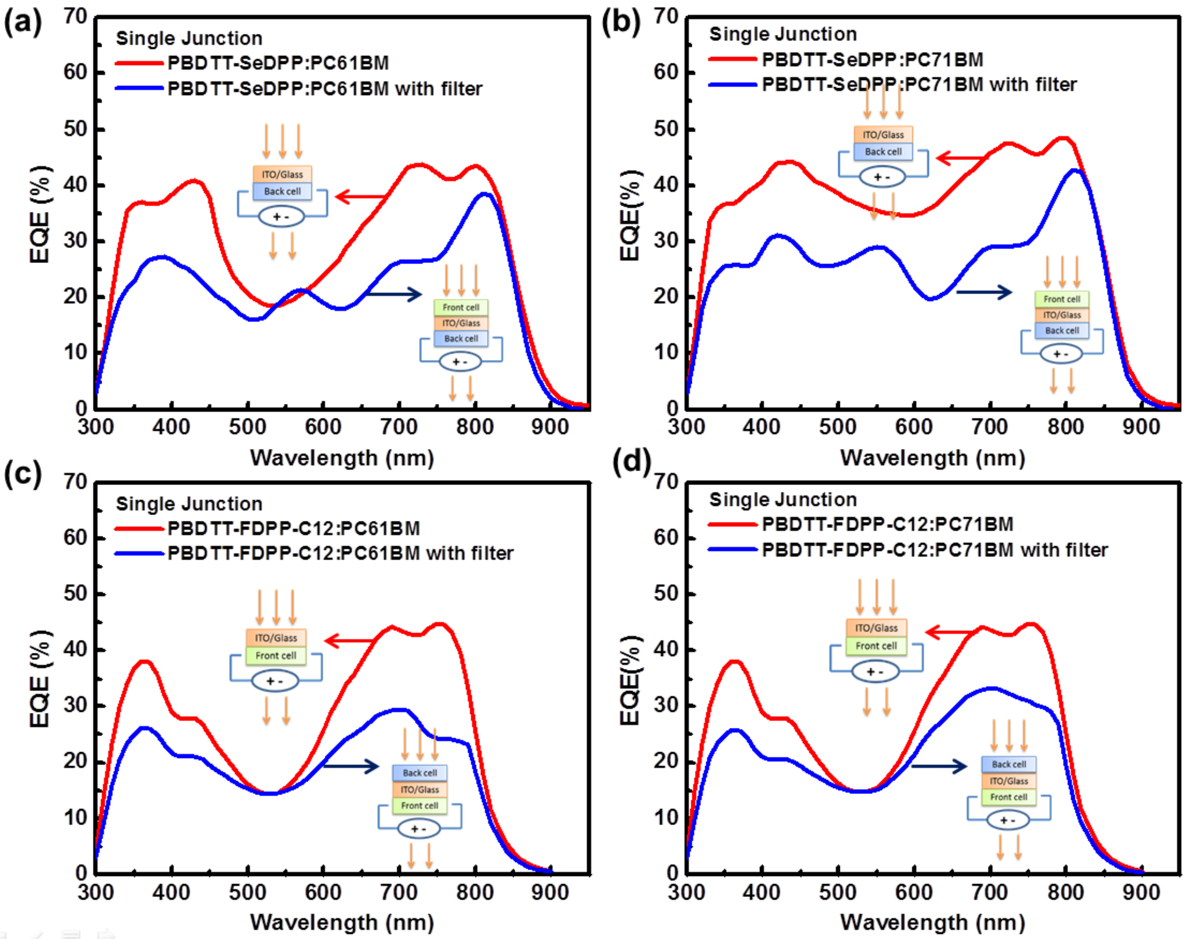

Fig. S3 EQE spectra of single-junction devices mimicking (a, b) the back subcells in the (a) transparent and (b) semi-transparent tandem PSCs under bottom illumination and (c, d) the front subcells in the (c) transparent and (d) semi-transparent tandem PSCs under top illumination.

Because of their overlapping absorption spectra, the two subcells in the tandem device responded to photo-signals at the same time, making it very difficult to distinguish their individual EQE signals. Here, we measured EQE spectra of single-junction devices with optical filters to simulate the conditions encountered by the subcells in the tandem devices. The front subcells in the tandem devices received no optical interference from the back subcells; therefore, their performances were similar to those of the corresponding single-junctions devices. The back subcells, however, displayed lower EQE signals because the front subcell had harvested a fraction of the incident light. We simulated the EQE spectra of the back subcells by measuring the single-junction devices with a layer of front-subcell material—serving as an optical filter—coated on the back of the ITO/glass.[36] For the transparent tandem PSC, we compared the EQE spectra of the back subcell absorber (PBDTT-SeDPP:PC_{61}BM) in the single-junction device in the presence and absence of a coating of PBDTT-FDPP-C12:PC_{61}BM as an optical filter. From Fig. S1a, the values of J_{sc} calculated from the EQE curves were 10.2 mA/cm^2 without the filter and 7.0 mA/cm^2 with the filter. From Fig. S1b, we used a single-junction device incorporating PBDTT-SeDPP:PC_{71}BM to simulate the EQE spectra of the back subcell in the semi-transparent tandem cell when using PBDTT-FDPP-C12:PC_{61}BM as filter; the calculated value of J_{sc} from this EQE curve was 8.1 mA/cm^2. In Fig. S1c, the single-junction device incorporating PBDTT-FDPP-C12:PC_{61}BM was filtered by a coating of PBDTT-SeDPP:PC_{61}BM to mimic the front subcell in the transparent tandem device under top illumination; the calculated value of J_{sc} was 6.2 mA/cm^2 for this transparent tandem cell. In Fig. S1d, the single-junction device incorporating PBDTT-FDPP-C12:PC_{61}BM was filtered by a coating of PBDTT-SeDPP:PC_{71}BM to mimic the front subcell in the semi-transparent tandem cell under top illumination; the calculated value of J_{sc} was 6.5 mA/cm^2 for this semi-transparent tandem cell.

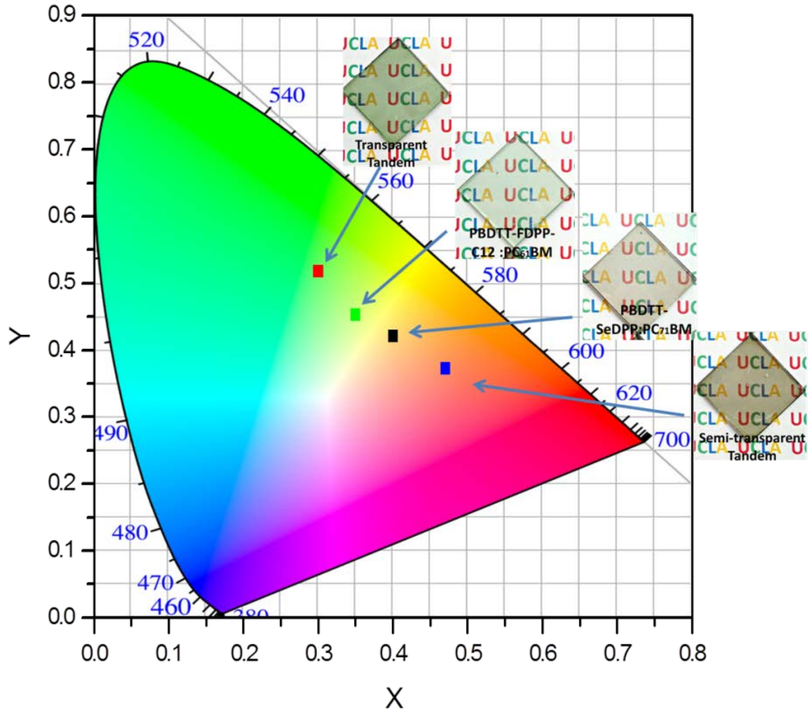

Fig. S4 The CIE 1931 color space representing the color coordinates of different transparent and semi-transparent solar cells when illuminated with standard AM 1.5G solar spectrum