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Vertical Phase Separation in Bulk-Heterojunction Polymer Solar Cells YUEH-LIN LOO, HE WANG, JONGBOK KIM, Princeton University — With soft-contact lamination and delamination, we have elucidated whether and how vertical phase separation of active layers effects solar cell performance. We constructed conventional bulk-heterojunction solar cells comprising P3HT, PCPDTBT and 7,7′-(4,4-bis(2-ethylhexyl)-4H-silolo[3,2-b:4,5-b′]dithiophene-2,6-diyl)bis(6-fluoro-4-(5′-hexyl-[2,2′-bithiophen]-5-yl)benzo[c][1,2,5]thiadiazole), or T1, with fullerene derivatives. To exaggerate the influence of vertical phase separation, we laminated in each case a thin layer of electron donor on the bulk-heterojunction active layer prior to cathode deposition. While devices with PCPDTBT and T1 exhibit drastically reduced current compared to devices without the additional wetting layer, devices with P3HT exhibit only a marginal drop in its current compared to devices without a P3HT wetting layer. We ascribe this difference in the reduction of current to intrinsic differences in the ionization potential and tail state distribution of the electron donors. Relative to PCPDTBT and T1, P3HT has a HOMO energy level closer to vacuum and a substantially broader tail state distribution. Against the energy levels of fullerene, both these factors support electron-hole recombination, followed by electron injection from the cathode into the tail states of P3HT under device operation.

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