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Organic photovoltaics - towards high performance low bandgap polyfluorene/fullerene bulk hetero-junction devices

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We use alternating copolymers of polyfluorene (APFOs) in polymer/fullerene blends as used in plastic solar cells. APFO-3/PCBM devices typically give power conversion efficiencies up to 3.4 % (AM1.5, 100 mW/cm²). The APFO's are stable, have high mobility and may be fashioned for liquid crystalline phases, as well as for broad optical absorption. By chemical design it is possible to move the optical absorption edge out to 1000 nm, and also to extract this absorption in photocurrent generation out to 1000 nm. As polymer bandgap is reduced, LUMO and HOMO orbitals shift. This requires the use of modified fullerene acceptors, with shifted orbitals, necessary to give the conditions for photoinduced charge transfer with the low bandgap polymers. The APFO polymers therefore give the necessary variability to catch a larger fraction of the solar spectrum. We have developed full optical and electrical model, predicting device performance for multilayer cells and for tandem cells, and using as input empirical determination of optical and electronic transport properties. We find the hole mobility to be a limiting parameter for device function.