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Designing high efficiency organic photovoltaics by controlling the ordering at the donor-acceptor interface ADITYA MOHITE, WANYI NIE, GAUTAM GUPTA, BRIAN CRONE, CHENYU KUO, HSINHAN TSAI, DARRYL SMITH, Los Alamos National Lab, PAUL RUDEN, FEILONG LIU, University of Minnesota, HSING-LIN WANG, SERGEI TRETIAK, Los Alamos National Lab — The overall power conversion efficiency in an organic solar cell depends on the balance between the rates of exciton dissociation, recombination and separation at the donor acceptor interface. Inability to design, control and engineer these interfaces remains a key bottleneck in their widespread use for the next generation organic electronic devices. Here, we show that we can control the ordering at the P3HT/C60 interface in bilayer device geometry by inserting a monolayer of oligothiophenes, which leads to a complete suppression in the exciplex (or charge transfer state) recombination. We observe that the photocurrent increases by 500%, which in turn results in an increase in the overall power conversion efficiency by an order of magnitude. Moreover, we find that the oligothiophene with an odd number of rings (ter and penta oligothiophene) exhibit a much higher increase in the photocurrent in comparison to the oligothiophene with an even number of rings (tetra oligothiphene). STM measurements reveal that the oligothiophene with odd and even number of rings differ in their ordering respectively, that has a big effect on the overall device performance. We also find that this ordering is highly dependent on the side functional groups in the oligothiophenes. The mechanism of photocurrent generation will be discussed and a simple transport model will be used to explain the change in the charge transfer and recombination rates and predict current-voltage curves.

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