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Development of Novel Low-Bandgap Conjugated Materials for Organic Solar Cells

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Abstract

Bulk-heterojunction (BHJ) organic solar cells based on conjugated *p*-type polymers and *n*-type fullerene derivatives have been intensively investigated in both academia and industry over the past decade due to their promising potential as one of future renewable energy sources. In this talk, I will present our recent efforts in the development of low-bandgap *p*-type materials with deep HOMO energy levels to achieve both high photocurrent (J_{sc}) and high open-circuit voltage (V_{oc}) and our stratagies in the control of the active layer morphology by using various processing additives to enhance photocurrent and fill factors. After the optimization of both the materials and the device fabrication process, a power conversion efficiency of 8.1 % has been realized on photovoltaic (PV) devices with an active area of 1.0 cm^2. In addition, we also worked on inverted organic solar cells by using annealing-free ZnO nanocrystals as an electron-selective layer. A certified power conversion efficiency as high as 7.1% has been achieved on the inverted devices with an active area of 1.0 cm^2. We investiged the organic solar cell stability as well. It was found that both the device structure and the organic semiconductor properties have determinative impacts on the ultimate device stability. We will demonstrate that with rational choice of the device structure and the active materials, the organic solar cell can be quite stable with little change in its power conversion efficiency after being stored under ambient condition for a month even without any encapsulation.