

Towards hybrid small-molecular/polymeric and organic/inorganic solar cells

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Organic solar cells (OSC) can be fabricated by multiple approaches, each of them having its advantages and drawbacks. In this poster, we primarily focus on the following two types of photovoltaic cells:

1. Heterojunctions (HJ) comprising polymeric and small molecular materials
2. Organic/inorganic hybrid cells

In our previous works on other organic systems, namely polymer-polymer heterojunctions, we achieved the external quantum efficiency (IPCE) of 37% and energy conversion efficiency 1.7% by using the blends of two polyphenylenevinylene (PPV) polymers as active layer.^[1] This is among the highest OSC performance ever reported for this system.^{[1],[2]} However, the fill factors remain still moderate.

Here, we present devices comprising a novel small molecular material as electron acceptor and a PPV donor polymer. The highest fill factor up to 57% was achieved by vacuum depositing the small molecular layer on top of the PPV polymer layer. This very high fill factor is comparable to the same vacuum processed cells with C60 as electron acceptor.^[3] Based on an interlayer technique,^[4] the same bilayer structure can be successfully all solution processed. The latter case revealed fill factors of around 43%. The fill factor dropped further to only 26%, when the device active layer is solution deposited as a blend film of the molecule and the polymer. By comparing layered and blend devices we are able to distinguish processes of exciton dissociation from carrier collection.

Hybrid solar cells merge inorganic and polymer semiconductors and have the advantage of potentially very high electron mobilities over purely organic semiconductors. Metal oxides serve as inorganic transparent semiconductors therein, among which TiO_x is a very promising electron acceptor material. It allows the reproducible fabrication of ultra thin porous and nanotextured films by means of low-cost and large-area processing. The following wet-chemical routes are presented in this work: (1) Sol-gel chemistry and (2) nano-particle synthesis.

Bulk morphology and surface characteristics of the TiO_x-films are important, as they define the exciton diffusion and carrier transport performance of the inorganic/polymeric hybrid-cells made therefrom. Besides preliminary solar cell characteristics, we show the topography dependence of TiO_x on the manufacturing techniques applied.

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