New routes for the fabrication of Organic Photovoltaic Cells

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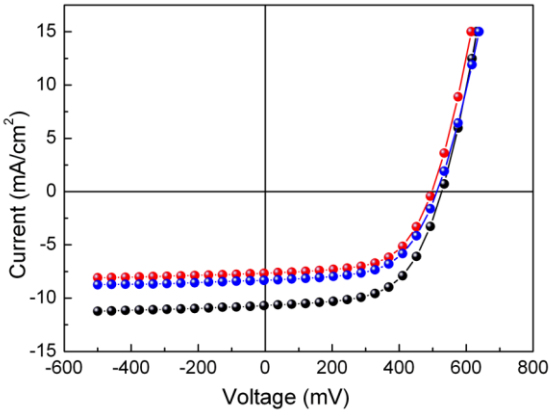
Organic solar cells have been the subject of research for the realization of portable, flexible and transparent modules as renewable energy sources. Here we propose alternative routes to fabricate such type of devices using simple and cost effective fabrication methods based on, the replacement of electron blocking layers by sputtered NiO, the substitution of the ITO electrode by a sputtered thin metal film, and on the fabrication of

Metal electrode relative to ITO		
Electrode type	Cu(9)-Ni(1)	Cu(7)-Ni(1)
Transmission relative to ITO	59%	66%
J_{sc}/J_{sc}(ITO)	73.5%	77.2%
Field Int. in relative to ITO	75%	80%

the organic photovoltaic cells using a dip coating procedure instead of a spin coating one

Table 1 Performance of Cu-Ni electrode based cells compared to ITO based cells

We fabricated and tested the performance of P3HT:PCBM bulk hetero-junction solar cells when the PEDOT:PSS, the most commonly used hole transporting layer, is replaced by a thin layer of sputtered NiO, and when the transparent indium tin oxide (ITO) electrode is replaced by a sputtered ultra-thin Cu-Ni bilayer. We show, here, that when NiO is used as the hole transporting layer, the characteristic photovoltaic parameters of such cell are similar or better to those of the device fabricated with PEDOT:PSS. We also studied the lifetime of NiO based cells in comparison to the PEDOT:PSS based ones. We observed that an ambient air processing of the organic materials was not detrimental to the ulterior performance of the NiO based cell, which degraded in ambient air conditions with a time constant larger than 300 hours. On the contrary, the PEDOT:PSS cell degraded very rapidly and the loss in efficiency was shown to be 29 times



faster when compared to the NiO cell.

Figure 1. I-V curves for P3HT/PCBM cells fabricated using ITO (black), Cu(7 nm)-Ni(1 nm) (blue), and Cu(9 nm)-Ni(1 nm) (red).

In such NiO based cells we also used a Cu-Ni semi-transparent electrode to replace the ITO. Despite the fact that the metal electrode exhibits a transparency that is 65% of the ITO electrode, the short circuit current for the metallic anode based cell is 77% of the ITO based one (see Table 1), which exhibited a power conversion efficiency of 3.3% (see Figure 1). Such discrepancy between the transparency and short circuit current percentage indicates that photon absorption may be enhanced by the optical microcavity formed between the Cu-Ni and Al electrodes.

We also fabricated organic solar cells with a bilayer architecture, in which poly(p-phenylene vinylene) (PPV) was used as the electron donor while Rhodamine 6G as the electron acceptor. We showed that photo-conversion efficiency for such dip coated fabricated cells is 1.4 times higher than that obtained from cells fabricated using the traditional spin coating procedure. Comparing the performance of several cells produced by dip coating on the same substrate we observed a high degree of uniformity, as opposed to the performance of the spin coated cells which exhibited a large dispersion. In addition, when the dip coating is applied the same coating solutions may be used many times to fabricate cells in a continuous mode. We discuss the use of orthogonal solvents to demonstrate that the technique can also be applied for the fabrication of other polymeric cells such as, for instance, P3HT/PCBM cells. In summary, the proposed method for organic solar cell fabrication is an alternative to obtain photovoltaic devices with a better performance than the spin coated cells. Such technique opens the possibility to implement an alternative route to other procedures that have already been considered for a cost effective large scale production of high efficiency OSCs such as the spray coating or the ink jet printing.