Functionalized CVD-graphene as transparent conductive electrodes for scalable organic solar cells

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Abstract

Transparent conductive electrodes based on Indium-Tin-Oxide (ITO) are unable to withstand external mechanical deformations, thus restricting the potential in many future flexible and wearable electronic applications [1]. The replacement of ITO is one of the research topics in Organic Photovoltaics (OPV) [2-3]. Chemical vapor deposited (CVD) graphene represents a promising candidate as transparent conductive electrode in OPV due to the appealing electrical and optical properties. However, a few efforts have been carried out to decrease sheet resistance while maintaining high transparency. Moreover, wettability of the graphene surface remains a critical issue for the fully compatibility with the typical solution processing of OPV. In this work, a proper functionalization of CVD graphene has been applied by chemical doping or by plasma oxidation to obtain an effective electrode on glass in terms of wettability, transmittance and sheet resistance [4]. In particular, the p-doping of the multilayer graphene by $SoCl_2$ treatment allows to achieve 25Ω/□ and the O_2-plasma oxidation decreases the contact angle from 90° to 58°. Organic Solar Cells (PSCs) have been fabricated onto the modified graphene, leading to efficiency of about 4%, compared to the poor performance of pristine graphene (1%). OPV devices have been also fabricated on graphene/glass substrates addressing the fabrication towards a real scale-up of the technology. Spray coating in air as scalable technique, commercial materials and industry compatible solvents have been used [5]. A remarkable power conversion efficiency of 3.1% has been achieved, not far from the reference device based on the ITO. Then, the first application of graphene as electrode in a module has been performed. Through the implementation of laser and shadow masking as patterning methods, a mini-module with three series-connected cells has been presented. Notably, the active area of such device ($1.6cm^2$) demonstrates the high quality of CVD graphene over large area.

References

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Figures

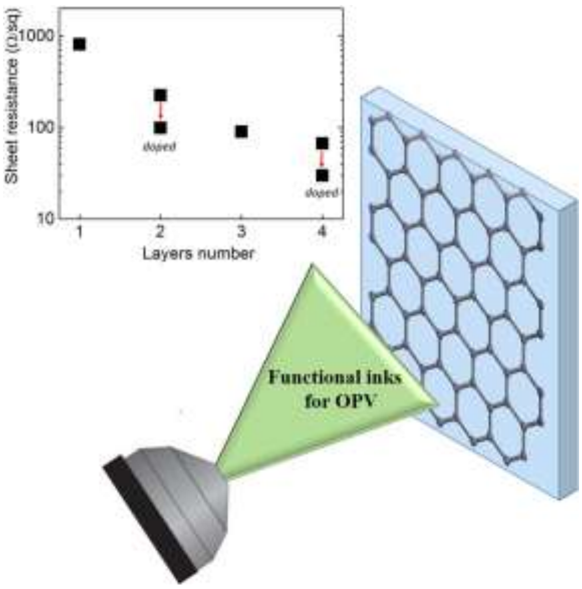

Figure 1: Sheet resistance values of graphene electrode for increasing graphene layer number and $SOCl_2$ doping steps.

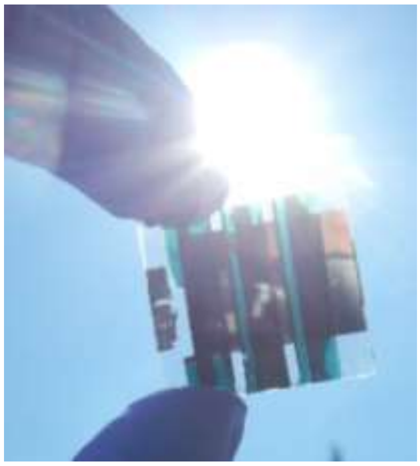

Figure 2: First application of CVD-graphene in OPV modules