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Fabrication of inverted polymer based organic solar cells on stainless steel substrate

D. G. K. K. Namawardana, G. Wanigasekara, W. T. M. A. P. K. Wanninayake, K. M. D. C. Jayathilaka, R. P. Wijesundera* and W. Siripala

Department of Physics and Electronics, Faculty of Science, University of Kelaniya, Sri Lanka
palitha@kln.ac.lk*

In the past years, polymer based organic solar cells (OSCs) have become a widely researched topic as a potential candidate for producing clean and renewable energy due to their lightweight, high mechanical flexibility, and large-area processability. As an alternative for the conventional device structure, in this study, OSC devices with an inverted structure were fabricated and characterized under the top illumination. Regioregular poly (3-hexylthiophene) (P3HT) and phenyl-C61-butyric acid methyl ester (PCBM) were used as the electron donor and electron acceptor material respectively for the device fabrication with structure of SS/P3HT:PCBM/PEDOT:PSS/Au. On pre-cleaned stainless steel (SS) substrates, bulk heterojunction polymer blend was spin coated from chlorobenzene solution (20 mg/mL) with a 1:1 weight ratio of P3HT: PCBM and then it was thermally annealed. As a hole-transport-layer (HTL), a thin film of poly (3,4-ethylenedioxythiophene) polystyrene sulfonate (PEDOT:PSS) doped with ethylene glycol (10 wt.%) was blade coated on the active layer and the stack was annealed at 120ºC for 10 minutes. As the top contact of the device, gold (Au) was sputter coated. Performances of the fabricated OSC devices were optimized by varying several discrete parameters including the spin rate of the active layer formation, annealing temperature and the annealing time of the active layer. The optimum conditions for the device fabrication with the best performance were at the spin rate of 3000 rev./min for the active layer formation whereas optimum annealing temperature and annealing time were 160ºC and 60 minutes, respectively. The best device produced had an open-circuit voltage (V_{oc}) of 238 mV and a short-circuit current density (J_{sc}) of 4.36 $mAcm^{-2}$. A maximum power conversion efficiency (PCE) of 0.02% with a fill factor (FF) of 23.16% was obtained under 1 sun illumination (AM 1.5G, 1000 Wm^{-2}). The spectral response measurements of the fabricated cell indicate that it absorbs photons with energy higher than 1.77 eV to generate electron-hole pairs. It is planned to fabricate a thin film of Zinc Oxide (ZnO) as a potential electron transport layer (ETL) on SS substrate to improve the FF and PCE of the device.

Keywords: Inverted structure, Organic solar cells, P3HT:PCBM, Stainless steel substrate, Top illumination

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