Accepted Manuscript

Organic solar cells with near 100% efficiency retention after initial burn-in loss and photo-degradation

Mushfika Baishakhi Upama, Naveen Elumalai, Md Arafat Mahmud, Heng Sun, Dian Wang, Kah Howe Chan, Matthew Wright, Cheng Xu, Ashraf Uddin

PII: S0040-6090(17)30393-0
DOI: doi: 10.1016/j.tsf.2017.05.031
Reference: TSF 35987

To appear in: *Thin Solid Films*

Received date: 18 July 2016
Revised date: 28 April 2017
Accepted date: 22 May 2017

Organic Solar Cells with Near 100% Efficiency Retention after Initial Burn-In Loss and Photo-Degradation

Mushfika Baishakhi Upama, Naveen Elumalai*, Md Arafat Mahmud, Heng Sun, Dian Wang, Kah Howe Chan, Matthew Wright, Cheng Xu, Ashraf Uddin*

School of Photovoltaic and Renewable Energy Engineering, University of New South Wales, Sydney, NSW-2052, Australia

*Corresponding authors: Naveen Elumalai (n.elumalai@unsw.edu.au) & Ashraf Uddin (a.uddin@unsw.edu.au)

ABSTRACT

In this article, we attempt to demonstrate a way of tackling one of the biggest challenges in the path of commercialization of organic solar cells, the initial photo-degradation of the cells known as “burn-in”. The “burn-in” phenomenon is most prominent during the first few hours of device operation under illumination and responsible for losing 25% or more fraction of the initial efficiency. To address this major issue, we have studied photo degradation of inverted organic solar cells with plain Zinc Oxide (ZnO) and Aluminum doped ZnO (AZO) as an electron transport layer over a short time period of 5 hours during which the degradation is most severe. The study has been done on two different device structures containing both crystalline and amorphous polymers (Poly(3-hexylthiophene-2,5-diyl) and Poly({4,8-bis[(2-ethylhexyl)oxy]benzo[1,2-b:4,5-b′]dithiophene-2,6-diyl}{3-fluoro-2-[(2 ethylhexyl)carbonyl]thieno[3,4-b]thiophenediyl}), respectively). Application of an AZO layer as the electron transport layer resolves the issue of photo-degradation in both cases, regardless of the polymer used in the active layer. AZO layer is found to provide less charge accumulation and better charge extraction at cathode/active layer interface. Mott-Schottky analysis shows modification of cathode interfacial layer work function and enhancement of open-circuit voltage due to the introduction of doped ZnO as electron transport layer. The exaltation persists even after the ageing of the devices. The devices with AZO layer retain their initial efficiency (almost 100%) even after photo-degradation while the device with pristine ZnO layer loses upto 60% of the initial efficiency.

KEYWORDS: Burn-in, PTB7, AZO, ZnO, Work function, Impedance Spectroscopy, Stability, Organic Solar Cell