Efficient Planar Perovskite Solar Cells Using Solution-Processed Amorphous WOx/Fullerene C_{60} as Electron Extracting Layers

Vincent Obiozo Eze, Yoshiyuki Seike, Tatsuo Mori*

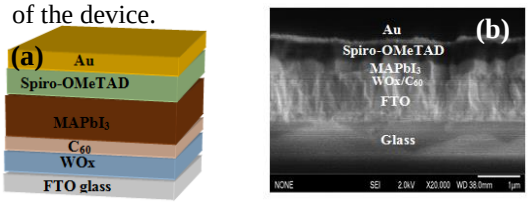
E-mail: t2mori@aitech.ac.jp

Introduction

Organic-inorganic lead halide perovskite solar cells (PSCs) have recently emerged at the forefront of photovoltaics research. Over the past six years, the power conversion efficiencies (PCEs) have rapidly increased from 3.8% to 22.1%. Amorphous tungsten oxide (WOx) has been successfully employed as electron extracting layer (EEL) in PSCs. However, the WOx device suffers from high charge recombination at the perovskite/WOx interface, resulting to low open circuit voltage (*Voc*) and fill factor (*FF*). Here, we report that WOx/fullerene C_{60} can work cooperatively to further enhance the performance of PSCs. When a WOx/C_{60} was used as EEL for the device, a PCE of 16.0% was achieved, while the pristine WOx achieved a PCE of 13.3% under reversed voltage scanning.

Results and discussion

Planar PSCs were fabricated with the structure fluorine-doped tin oxide (FTO)/WOx (50 nm)/with and without C_{60} /$MAPbI_3$ (200 nm)/Spiro-OMeTAD (~250 nm)/Au (80 nm) in ambient air. Figure 1 presents the solar cell configuration and the cross-sectional scanning electron microscope (SEM) of the device.



Figs. 1 (a) Schematic view, (b) Cross-sectional SEM images of the device.

The light and dark current density–voltage (*J–V*) curves of the best performance devices measured under simulated 1.5G solar irradiation at 100 mW/cm^2 is shown in Fig. 2.

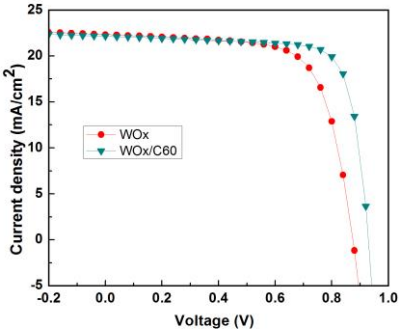


Fig. 2 *J–V* curves of PSCs with and without C60 modification.

The short-circuit current density (J_{sc}) of 22.74 mA/cm^2, a (V_{oc}) of 0.86 V, an *FF* of 0.68 and PCE of 13.3% were obtained from the pristine WOx device. While the optimized device with WOx/C_{60} as EEL showed a J_{sc} of 22.15 mA/cm^2, V_{oc} of 0.93 V, and *FF* of 0.78 leading to a PCE of 16.0%. We found that the efficiency enhancement in the WOx/C_{60} based device is mainly attributed to the improved *V*oc and *FF*, benefiting from the better electron transfer and less charge recombination.

Acknowledgements

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