Role of Additive and Solvent Vapor Annealing on the Performance of Perovskite Solar Cells Fabricated in Ambient Air

Vincent Obiozo Eze, Okada Hiroyuki, Yoshiyuki Seike, Tatsuo Mori*

***E-mail: t2mori@aitech.ac.jp**

Introduction

Organic-inorganic halide perovskite solar cells have generated tremendous research interests among the solar cells researchers because of its solution-based fabrication routes and high efficiency. It is a well-known fact that $MAPbI_3$ perovskite is susceptible to decomposition in the presence of moist air. Therefore it is important to develop a simple approach to deposit uniform and homogenous perovskite on a planar substrate in ambient air for low-cost mass production. In this work, we investigated the influence controlling the nucleation and crystallization of $MAPbI_3$ perovskite layer through a combination of the addition of 1, 8-diiododooctane (DIO) additive in the perovskite precursor and solvent vapor annealing (SVA). The best performance device with additive+SVA exhibited a power conversion efficiency (PCE) of 10.23%, which is higher than without additive+SVA device (see Fig. 2 (a)).

Result and discussion

The morphological variations of perovskite films with additive+SVA and without additive+SVA were studied using SEM (Fig. 1a, b). Fig. 1b shows that the perovskite film fabricated without additive+SVA exhibited morphology with small grain sizes (~180 nm) and a significant amount of grain boundaries. Whereas the perovskite film with additive+SVA presents morphology with larger grain sizes (~460 nm) and fewer grain boundaries. The inset of Fig. 2 shows the solar cell structure used in this study. The crystal structures of with additive+SVA and without additive+SVA perovskite films were studied using XRD. As it can be seen, the intense peaks at 14.43° and 28.85°, which are assigned to (110) and (220) crystal planes of the $MAPbI_3$ perovskite structure for with additive+SVA are sharper and narrower than without additive+SVA peaks suggesting improved perovskite crystallinity.

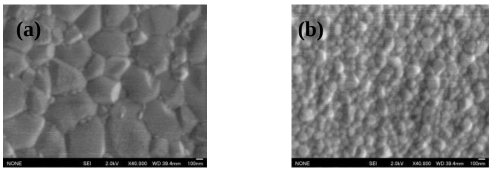

Fig. 1 SEM image of perovskite films; (a) with additive+SVA (scale bar is 100 nm), (b) without additive+SVA (scale bar is100 nm)

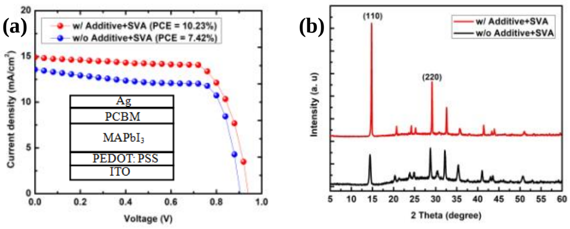

Fig. 2 (a) Reverse scan of *J-V* curves of PSCs with additive + SVA and without additive + SVA (The inset is the device structure). (b) XRD patterns of perovskite films with additive + SVA and without additive + SVA deposited on ITO/PEDOT: PSS substrates.

The larger grain size and enhanced crystallinity exhibited by with additive+SVA perovskite film are expected to improve both the photophysical properties and photovoltaic (PV) parameters of the PSCs. However, further investigation is ongoing to understand the synergistic effect of additive inclusion and SVA on the device performance.

Reference: (1) V.O.E et al., Jpn J. Appl. Phys. 55, 122301 (2016). (2) P.W. Liang, C.Y. Liao et al., Adv. Mater. 26 (2014) 3748-3754.