Low temperature processed ZnO nanorods for perovskite solar cells

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Perovskite solar cells based on organic-inorganic perovskite materials have attracted considerable attention due to its remarkable photovoltaic performance and ease of fabrication process. In this type of solar cell, an n-type metal oxide film is usually required that acts as an electron transporting layer (ETL) and to prevent the direct contact between the oxide electrode and perovskite layer. TiO_2 is the commonly used ETL among the metal oxide layers; however, it has a lower electron transport mobility and requires higher sintering temperature compared to ZnO [1].

In this work, we demonstrate the formation of ZnO nanorods by wet oxidation in water at low temperature and its application as ETL for solar cells. This method could pave the way to future flexible optoelectronic devices based on organic substrates with low thermal stability. Herein, vacuum-deposited Zn thin film on indium tin oxide (ITO) substrates are immersed in 90ºC water for 8h. Perovskite solar cells with a configuration of ITO/ZnO/$CH_3NH_3PbI_3$/P3HT/Ag are then fabricated based on the resulting ZnO nanostructures. In addition, perovskite films are prepared using one-step and sequential two-step routes to investigate the effect of fabrication technique on photovoltaic performance of the solar cells.

Figures 1(a) shows that hexagonal flat-topped and pointed ZnO nanorods are grown after 8h of wet oxidation in water. These nanorods with a mean diameter of 140 nm have a relatively tilted structure, as shown in Figure 1(b). Finally, the sequential two-step route for the deposition of perovskite film on top of ZnO nanorods exhibited a higher PCE compared with the one-step route. This result is in agreement with the reported literature wherein solar cells prepared by two-step coating were superior to one-step method because of better nanostructured metal oxide coverage [2].

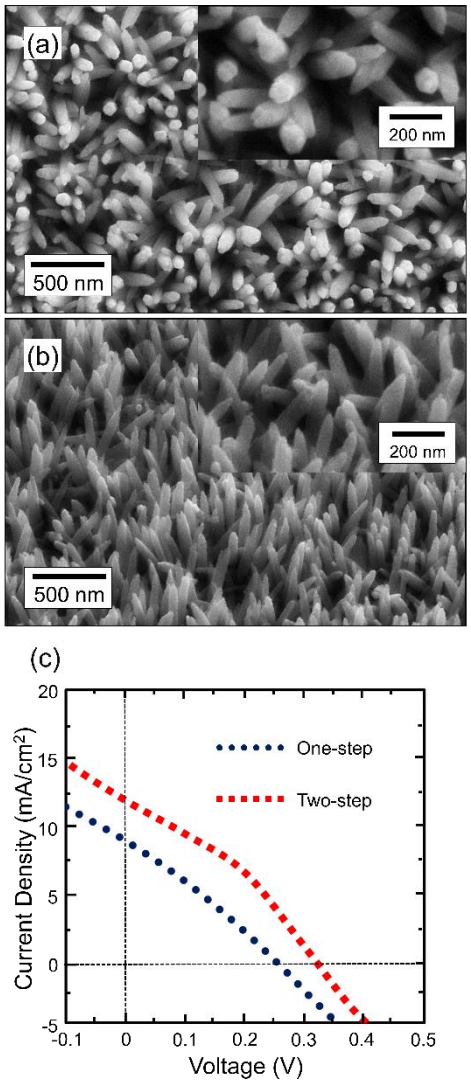

Fig. 1. SEM images of ZnO nanorods formed after wet oxidation of 8h at tilting angles of 0 (a) and at 45 ° (b). (c) J-V characteristics of ZnO-based perovskite solar cells.

References:

[1]Kumar et al., Chem. Commn., 2013, 49, 1108

[2] Im, J,-H; Kim, H-S.; Park, N.-G. APL Mater. 2014, 2, 081510.