Synthesis of ZnO nanobrush for application in dye-sensitized solar cells

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Dye-sensitized solar cell (DSC) based on nanostructured ZnO has been explored extensively. In this work, we report the synthesis of brush-like ZnO nanostructures called ZnO NB for use in DSCs via a two-step chemical bath deposition (CBD) process. Firstly, ZnO nanowires (NWs) was grown by immersing the seeded FTO substrate in aqueous solutions containing 0.02 M zinc nitrate hexahydrate, 0.02 M hexamethylenetetramine (HMTA), and 12 mM polyethylenimine (PEI). These ZnO NWs were then used as the trunks for the growth of branches via the second CBD process of different concentrations. Advantages of ZnO NB based DSCs are two folds: (i) the NW array serves as a direct electrical pathway that can enhance the collection of exciton; and (ii) the branches of NB further provide a larger surface area for absorption of dye. As shown in Fig. 1, the ZnO NB consists of upstanding NWs and outstretched branches grown all over each nanowire. We have achieved a high conversion efficiency of up to 3.4% on the cells based on ZnO NB (Fig. 2), which is much higher than that of the cells based on bare ZnO NWs. Effects of NW density, NW length, and branch length on the performance of DSCs were investigated.

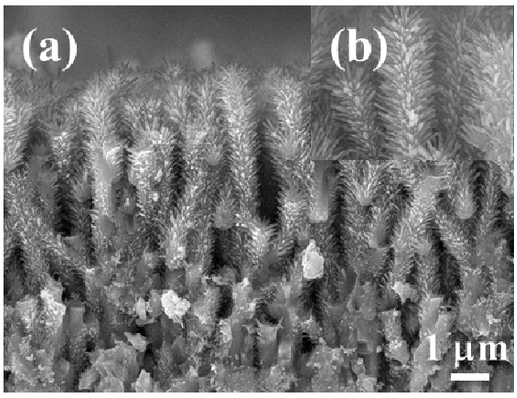

Fig. 1. (a) Cross-sectional SEM image of ZnO NB; (b) magnified SEM image at the tip of ZnO NB.

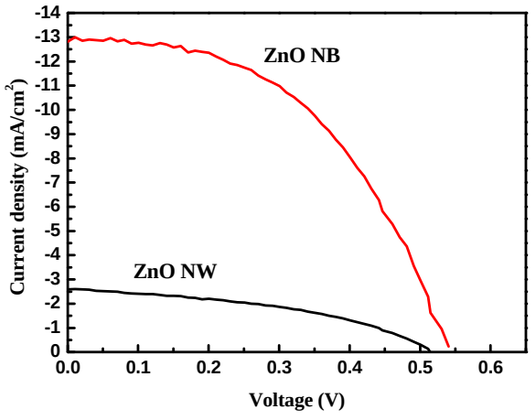

Fig. 2. I-V curves of DSSCs based on ZnO NB (black) and ZnO NWs (red).