INVESTIGATION OF Cu_2O AS PHOTOCATHODE FOR P-TYPE DYE-SENSITIZED SOLAR CELLS

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Abstract

In p-type dye-sensitized solar cells (p-DSSCs), NiO is the most commonly used p-type semiconductor [1]. Considering the drawbacks of NiO, alternative p-type semiconductors with better optical transparency, lower VB edge position and higher hole mobility are desired for p-DSSCs [2]. The cuprous oxide (Cu_2O) is a natively p-type semiconductor with a direct band gap of about 1.9–2.2 eV [3]. Non-toxic nature, the stability, natural abundance, low cost production, good electrical properties and a good absorption coefficient for visible light prompted to investigate the cuprous oxide as a material suitable for the realization of low cost and large scale p-DSSCs [4]. the nanoparticles have been intensively studied as photocathodes materials for DSSCs because of their larger specific surface areas to absorb more dye molecules. At the same time, the small-sized particles have shown that the inefficient ability to scatter the solar radiation which reduces the light-harvesting efficiency. Based on these premises, we propose to investigate the effect of micrometer-size structures on the photovoltaic performance of p-DSSCs based on cuprous oxide.

In this work, 3D hierarchical structure built of the micrometer dendritic rods and the porous truncated octahedrons have been successfully synthesized via a facile one-step hydrothermal methods using copper (II) acetate and ethyl cellulose as reactants. The DSSC based on the porous structure exhibits approximately 15% increase in J_{SC} and V_{OC} than 3D hierarchical structure.

XRD patterns of the Cu_2O_1 and Cu_2O_2 compound, obtained from hydrothermal method are shown in figure 1. All the diffraction peaks could be indexed as Cu_2O (cuprite) with cubic structure (space group: *Pn-3m*; JCPDS Nr. 01-074-1230), only a small amount of CuO is detected as impurity in Cu_2O_2 sample. The formation of CuO phase is determined by the time reaction which in the case of Cu_2O_2 is still small to establish completely Cu^{+1} oxidation state.

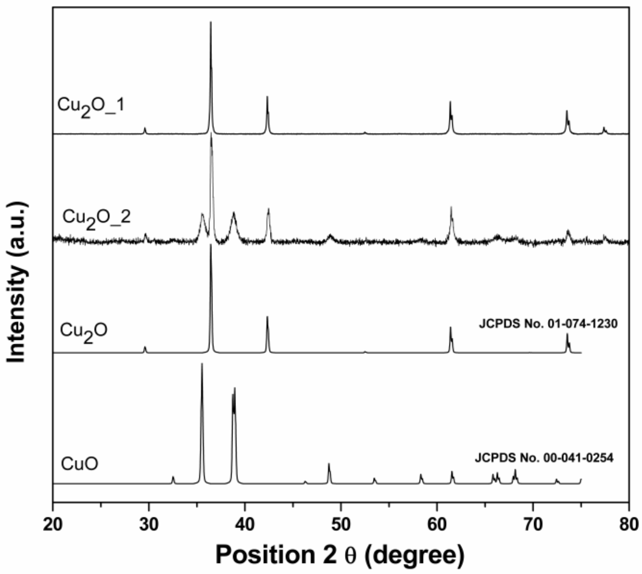
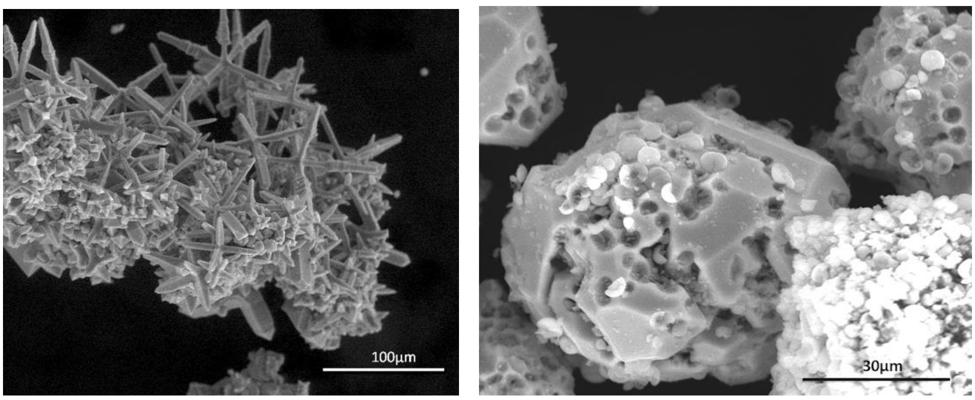


Figure 1. Room temperature X-ray diffraction patterns of Cu2O_1 and Cu2O_2 samples.
The SEM image (figure 2a) of Cu_2O_1 powder shows the 3D hierarchical structure

The SEM image (figure 2a) of Cu_2O_1 powder shows the 3D hierarchical structure consisting of micrometer dendritic rods. In case of Cu_2O_2 sample, the SEM image (figure 2b) shows that the grains are in the shape of the porous truncated octahedron, partially covered by the microspheres.



a **b**

Figure 2. SEM images of Cu_2O_1 (a) and Cu_2O_2 (b) samples.

Indeed, I-V characteristics of DSSC (Fig. 3) show that the photovoltaic performance has improved in case of the porous structure, showing approximately 15% increase in J_{SC} and V_{OC}.

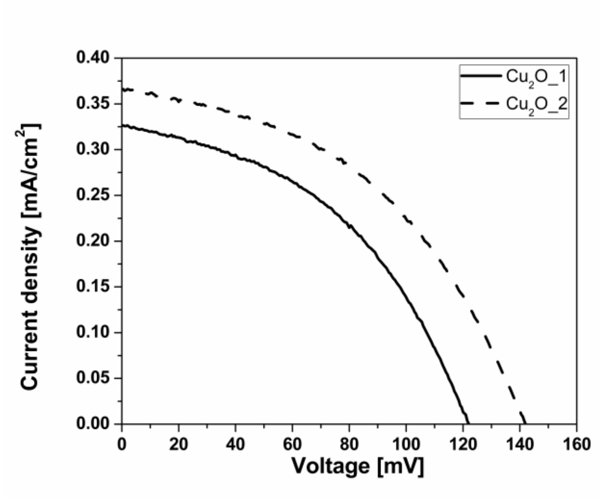


Figure 3. J-V curve of p-type DSSCs based on Cu_2O_1 and Cu_2O_2 samples.

Acknowledgements

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