Electronic Supplementary Material (ESI) for Energy Advances.

Supplementary

Photocatalytic activity and pH-induced morphological changes of ZnO/CuO nanocomposite prepared by chemical bath precipitation

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Figure S1. Digital images of the sample powders.

In sample ZC10, the OH^- and $Zn(OH)_4^{2-}$ ions attach to the positive polar (0001) plane of ZnO which is rich in Zn^{2+} ions and causes the preferably growth along the c-axis direction. On the other hand, the $Zn(NH_3)_4^{2+}$ complex is produced through the reaction of ammonia and Zn^{2+} ions on the surface of the positive plane. This reduces the surface energy of the (0001) plane and hinders the predominant growth of ZnO nanorods. Therefore, the process proceeds in the middle of the rod and the six petals grow through the six facets of the hexagonal wurtzite crystal to form flower-like ZnO nanostructure [1]. Moreover, CuO has flower-like morphology. Correspondingly, the excess OH^- ions provided by HMTA and hydroxyl ions obtained from ammonia, are the main reason for the formation of flower-like morphology [2]. Moreover, Liu et al. [3] studied the effect of ammonia in the growth of the flower-like CuO and reported that the higher amount of ammonia may accelerate the growth rate of the CuO flower-like structure.

Lee et al. [4] reported that ZnO nanoflowers were formed at low pH of 9 and changed into hexagonal pillar shapes by increasing the pH to 11. Correspondingly, in the presence of ammonia, the $Zn(OH)_2$ molecules were produced through the following reaction:

$$Zn(NH)_3 + NH_4OH \rightarrow Zn(OH)_2 + 4N \quad (1)$$

These molecules aggregate to each other to form $[Zn(OH) - O - Zn(OH)]$ through the following reaction:

$$Zn(OH)_2 + Zn(OH)_2 \rightarrow [Zn(OH) - O - Zn(OH)]n + H_2O \quad (2)$$

Afterwards, the $[Zn(OH) - o - Zn(OH)]$ seeds agglomerate at an angle of 60° and turn into hexagonal nanoplates. Eventually, $[Zn - O - Zn]n$ seeds coordinate according to the following reaction:

$$[Zn(OH)-O-Zn(OH)]n+[Zn(OH)-O-Zn(OH)]n\rightarrow[Zn-O-Zn]n+nH_2O \quad (3)$$

These assembly grow along the [001] plane and transfer to ZnO hexagonal pillar shapes [5], which are illustrated by FESEM images (Figure 1f). Moreover, due to the increased concentration of OH^-, the petal sizes of the flower-like ZnO increased [6].

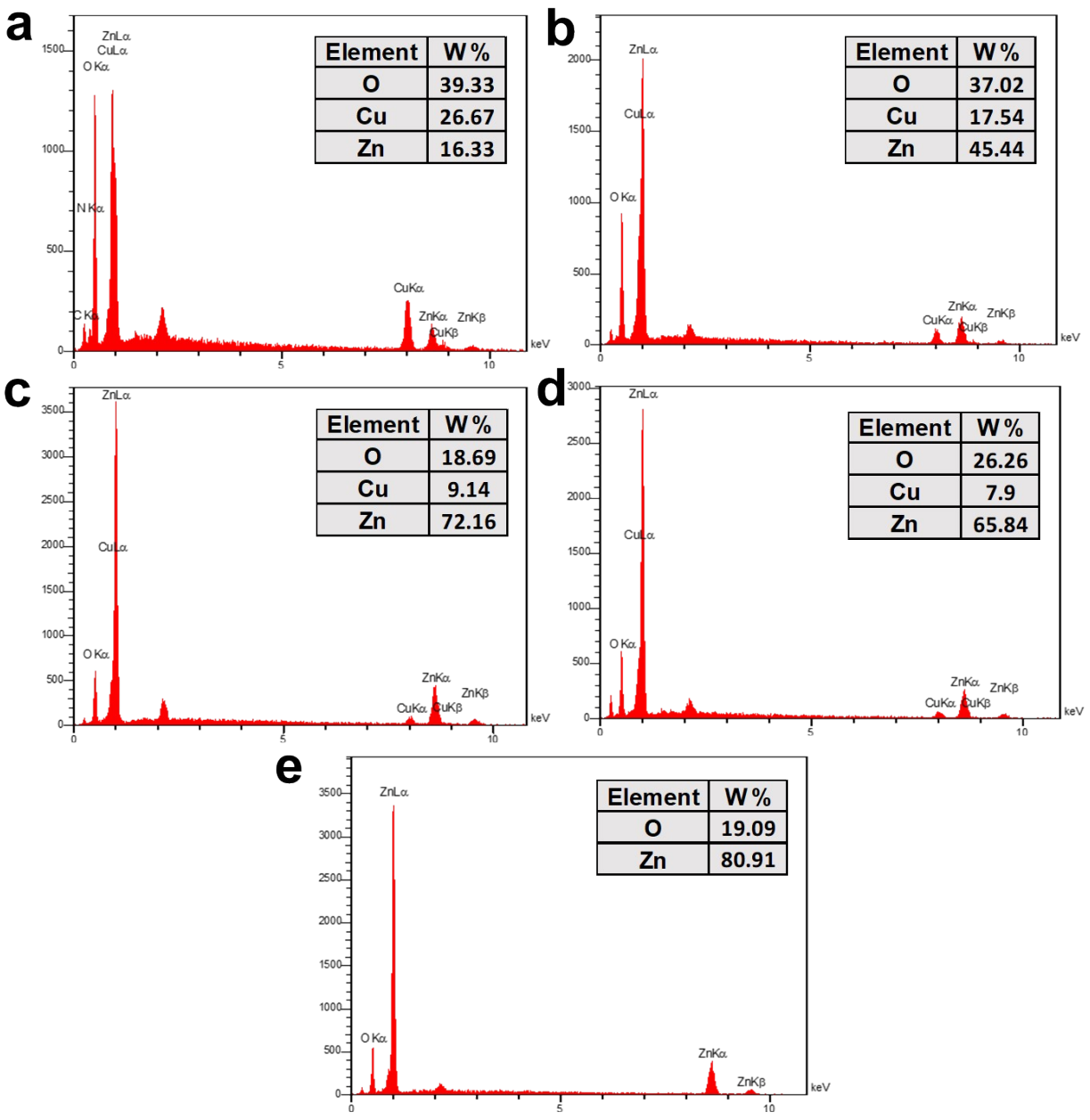

Figure S2. EDS analysis of samples (a) ZC1.5, (b) ZC3.5, (c) ZC6.8, (d) ZC10, (e) ZC11 illustrating the quantitative content of O, Cu, and Zn elements.

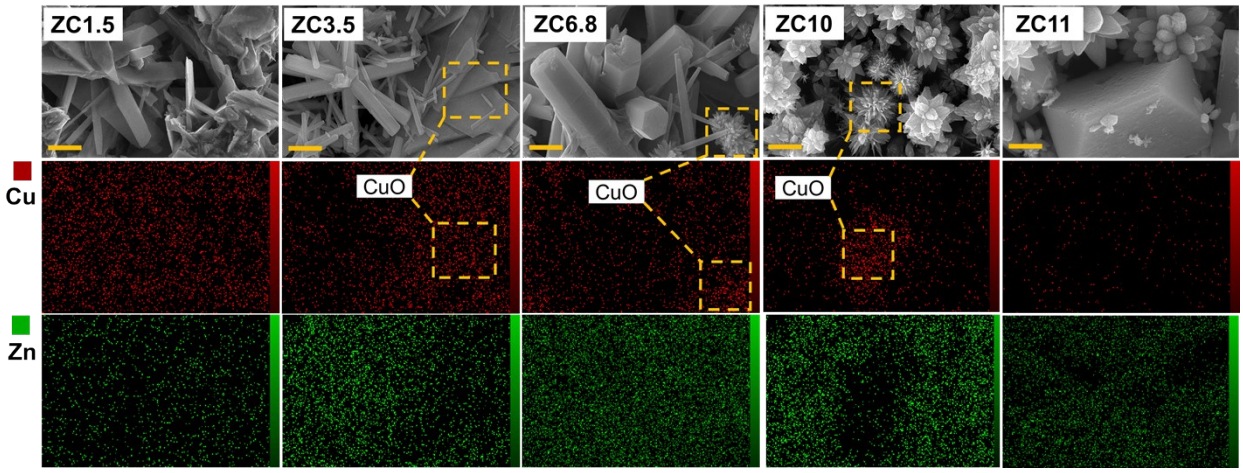

Figure S3. FESEM images and the corresponding distribution of Cu and Zn elements carried out with EDS mapping of the samples (the scale bar shows 1 μm)

References

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