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Controllable Morphologies of ZnO Nanoparticles in Sub- and Super-critical Water

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1. Introduction

As one of the most important semiconductors, zinc oxide (ZnO) has been studied intensively. Recently, morphology control of ZnO nanoparticles has attracted much attention, since different morphologies of the particles may alternate the chemical, electrical, and optical properties of the nanoparticles. However, the morphological control of ZnO nanoparticles remains challenging to material scientists. Synthesis of ZnO nanoparticles in sub- and super-critical water (sub-CW and SCW, respectively) is well known as a very good method, because it is an environmentally friendly and very simple process for synthesis of nanoparticles. In the present research, we are going to control the morphologies of ZnO nanoparticles in sub-CW and SCW in a flow-type reactor.

2. Experimental

A schematic diagram of the flow-type reactor is shown in Figure 1. The precursor was introduced and mixed with high temperature water. The precursor solution was suddenly heated up to appropriate temperature and goes into the reactor. Then, the reaction was quenched by an external cooling water jacket. Zinc acetate dihydrate and Zinc nitrate hexahydrate with ammonia solution or potassium hydroxide were applied for preparing the precursors.

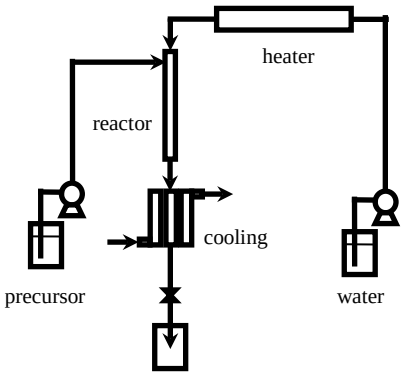

Figure 1. A schematic diagram of a flow-type reactor.

3. Results and discussion

XRD patterns of the nanoparticles of rod-like, flower-like, and plate-like ZnO nanoparticles were shown in Figure 2a, 2b, and 2c, respectively. The sharp peaks of the powders imply their good crystallinity and the diffraction peaks in the XRD spectra indicate that all the nanoparticles are hexagonal structure ZnO under all the conditions (JCPDS 36-1451). The typical SEM and TEM images of ZnO nanoparticle, which are shown in Figure 3a, 3b, and 3c, indicated that all the particles are uniformed rod-like, flower-like, and plate-like nanoparticles.

The temperature and pH value effects on the morphologies of ZnO nanoparticles were investigated and plausible mechanisms of the growth of ZnO nanoparticles were proposed.

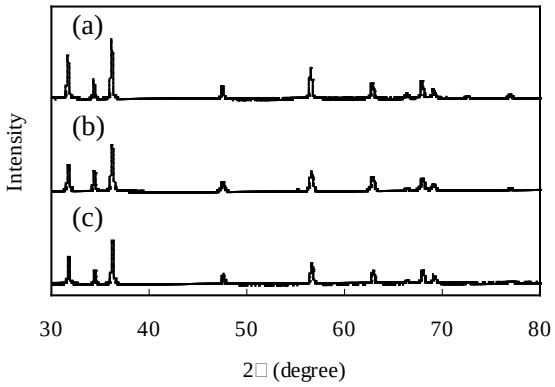

Figure 2. XRD patterns of ZnO nanoparticles: (a) rod-like, (b) flower-like, and (c) plate-like ZnO nanoparticles.

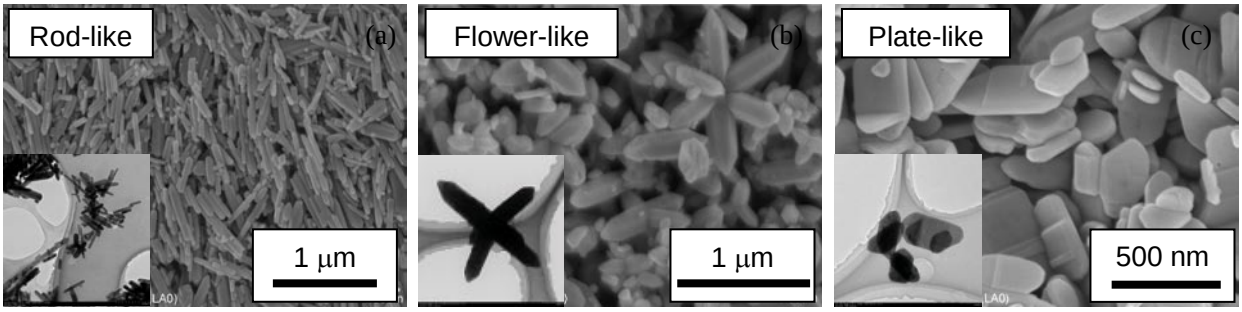

Figure 3. SEM and TEM images of the synthesized ZnO nanoparticles in sub-CW or SCW in a flow-type reactor. (a) Rod-like ZnO nanoparticles, (b) flower-like ZnO nanoparticles, and (c) plate-like ZnO nanoparticles.

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