Effect of Temperature on Oxidation Growth of ZnO Nanoparticle

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Abstract: Zn nanoparticle, produced by renovated hybrid induction and laser heating, dispersed by ultrasonic wave in ethanol and deposited on flat fundus of Al_2O_3 ceramic, were used to prepared Granular ZnO films at different temperature (500℃, 600℃, 700℃) in air resistance. Field emission scanning electron microscopy (FESEM) investigation reveals that the morphology of ZnO nanoparticles in the Granular ZnO films was transformed from flake into granular by combined action of melt and oxidation of nanometer Zn.

Keywords: ZnO; Zn; Thermal Oxidation; nanoparticle; Crystal Growth;

1. Introduction

Properties of ZnO nanocrystals depend closely on not only their particles size, morphology, surface area and activity but also preparation technology. For this reason, many technologies and processes, such as magnetron sputtering [1], sol–gel method [2], gas-phase reaction [3], and hydrothermal synthesis [4], was employed to prepare ZnO nanocrystals.

In the present study, thermal oxidation, a simple technology, was employed to prepare ZnO nanoparticle by Zn nanoparticle which were produced by renovated hybrid induction and laser heating, dispersed on ethanol and freely deposited on flat fundus of Al_2O_3 ceramic. Effect of Heating Temperature on Oxidation growth of ZnO Nanoparticle was study by field emission scanning electron microscopy (FESEM).

2. Experimental Details

Zn nanoparticle, produced by renovated hybrid induction and laser heating from body Zn (Zn%>99.9%) in argon with the pressure on 15Pa[5], is irregular polygon and average size 30nm. To begin with, The Al_2O_3 substrates were rinsed three times in acetone with ultrasonic vibration for fifteen minutes and one times in ethanol. Then Zn nanoparticles were dispersed in ethanol by ultrasonic vibration for 10min in breaker and the Al_2O_3 substrates were put into the bottom of the beaker. Furthermore, Zn nanoparticles were freely settle for 24 hours so that Zn nanoparticles were precipitated on Al_2O_3 substrates, the Al_2O_3 substrates with Zn nanoparticles were dried in cool, dark and dry place. Finally, Zn nanoparticles were thermal oxidation growth for 2 hours in air resistances where temperature had reached 500℃, 600℃ and 700℃ respectively. Field emission scanning electron microscope (FESEM) images were recorded with a FEI-Sirion 200.

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3. Result and Discussion

In Fig. 1 we show the low and high magnification FESEM images of the ZnO nanoparticles obtained by thermal oxidation of Zn nanoparticles at 500℃, 600℃ and 700℃ in air resistances. Fig. 1 (A) (C) (E) show the shape of ZnO clusters and Fig. 1 (B) (D) (F) show the detail of ZnO nanoparticles.

The morphology of ZnO nanoparticles transforms when temperature of thermal oxide growth goes up. With a thickness about 30nm the same as the diameter of original Zn nanoparticles [5], it displays flake in Fig. 1(A) and (B) that the morphology of ZnO nanoparticles is thermal oxide growth at 500℃. The shot rod of ZnO nanoparticles appears with neck formation each other and the flake disappears at 700℃, as is shown in Fig. 1(E) and (F). Moreover, the diameter of ZnO rod is quite equal to the size of original Zn nanoparticles.

The growth mechanism of ZnO nanocrystals oxygenated by Zinc vapor process has been reported recently [6-9]. The tiny zinc droplets formed in zinc vapor firstly and then oxidized to ZnO, the oxidation process is controlled by the outward diffusion of Zn through the oxidation layer. However, Zn nanoparticles, simultaneously, was melted and oxidized to ZnO from outside to inner in our experiment. When ZnO layer has formed, the melting process is ongoing and isn't completed. The oxidation process of inner melting Zn is controlled by the outwar diffusion of Zn through the oxidation layer [9, 10]. The higher temperature, the faster diffusion velocity [8, 11],

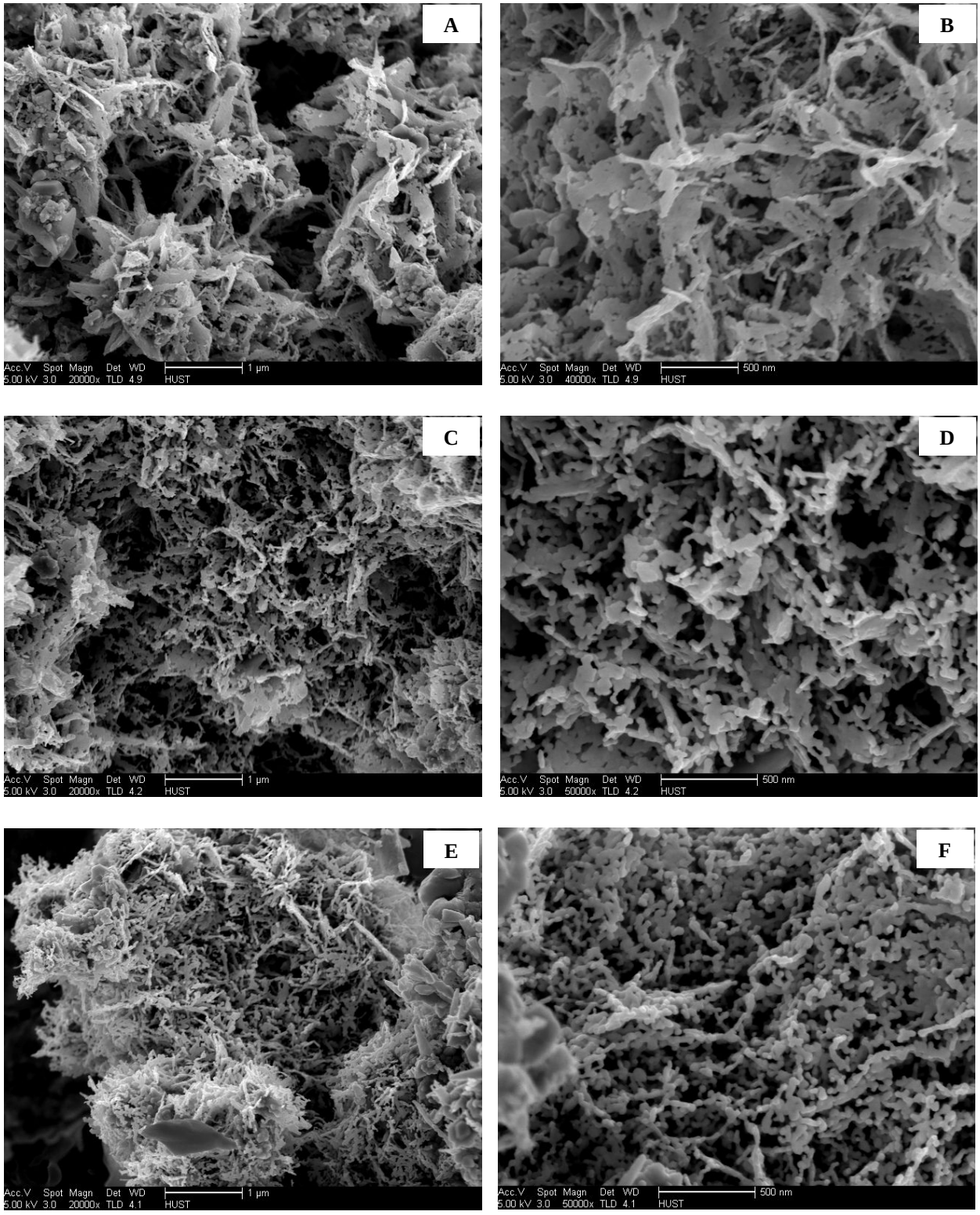

Fig. 1 FESEM images of the as-prepared ZnO at different heating temperature, (A) (B) 500℃, (C) (D) 600℃, (E) (F) 700℃,

the ZnO layer thicken and harden, e.g. 700℃, the morphology of ZnO is more the same as the morphology of initial Zn nanoparticles. On the contrary, e.g. 500℃, the ZnO layer bursts and the inner melting Zn leaks. Finally,

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flaky ZnO was formed by mutual amalgamation of nanoparticles. What has described as follow fig. 2

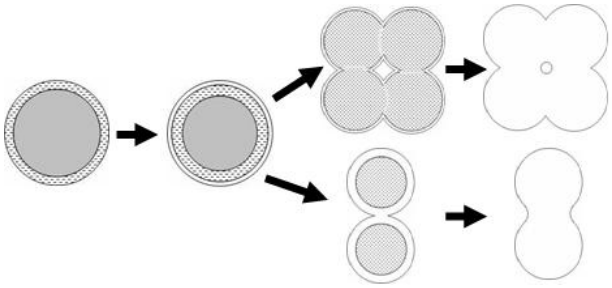

Fig. 2 Oxidation of Zn nanoparticle

4. Conclusions

A simple procedure to produce nanoparticles or films of ZnO with different morphology was provided by thermal oxidation growth, with zinc nanoparticles dispersed by ethanol, deposited on flat fundus of Al_2O_3 ceramic, in different temperature (500℃, 600℃, 700℃). This is in accordance with the finding that the morphology of ZnO nanoparticles was transformed from flake into granular by combined action of melt and oxidation of nanometer Zn.

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