

Study of 0D, 1D and 3D Zinc Oxide Morphologies by SEM and TEM

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Zinc oxide (ZnO) is widely used semiconductor oxide. The size and morphology control are important to give specific properties to nanostructured materials. ZnO is interesting due to its optical and electrical properties, this material is useful for solar cells, gas sensing, photocatalytic and UV filter applications. In this study we will present three morphologies nanoparticles (0D), flakes (1D) and rods (3D). The ZnO at bulk level presents a good absorbance in the UV region, but by taking it to the nanometer scale this property is improve [1].

The synthesis of ZnO nanoparticles (0D) was obtained by the precipitation method (PM) through a reflux system. It is prepared a solution (S1) of zinc acetate dihydrate (1.316 g) in ethanol (80 ml). Then was made a second solution (S2) of sodium borohydride (0.6 g) in ethanol (40 ml) adding it carefully to S1. After finish adding the S2, it was added H₂O₂ (7 ml with 3 % purity). The final solution (S3) was diluted adding 500 ml boiling water and filtered by gravity. Finally, the resulting paste was dried by 5 hours at 80 °C. The ZnO flakes (1D) and ZnO rods (3D) was synthesized by hydrothermal method (HM) which is one of the most used techniques. It was made a zinc acetate dihydrate (1.09 g) solution in water (15 ml) for both morphologies and it was maintained at vigorous stirring, then was added potassium hydroxide; 0.85 g and 4.2 g for flakes and rods, respectively. After both the salts dissolves, ethanol (15 ml) is added by dripping. The final solution was transferred to a teflon vial and was introduce inside autoclave flask. Then it was made heat treatment inside a conventional oven at 160 °C for 24 hours. Finally, the product obtained was washed and centrifugation with deionized water. Morphology and growth mechanisms were studied by SEM and TEM image techniques.

The morphology of ZnO nanoparticles with 0D are show in the figures 1a, 1d and 1g which are images acquired by SEM and TEM, the size of then are 8±2 nm with round shape, they are agglomerate. Particle with 1D are show in the figures 1b, 1e and 1h, the size of them are diameter of 270±60 nm with thickness average of 47±7 nm, the image at high magnification (Fig. 1 h) show it crystallinity a d-space are 2.6 Å which belongs to (100) direction. The 3D particles images are show in the figures 1c, 1f and 1i, they show elongated hexagonal prism rods with six faces pyramidal ending tip. The size measurement from the images are in length has as average of 8.3±2 μm and 0.77±0.15 μm diameter. Many methods have been used to obtained different morphologies [2,3,4]. In our case we focus in PM and HM techniques for synthesis repeatedly.

References:

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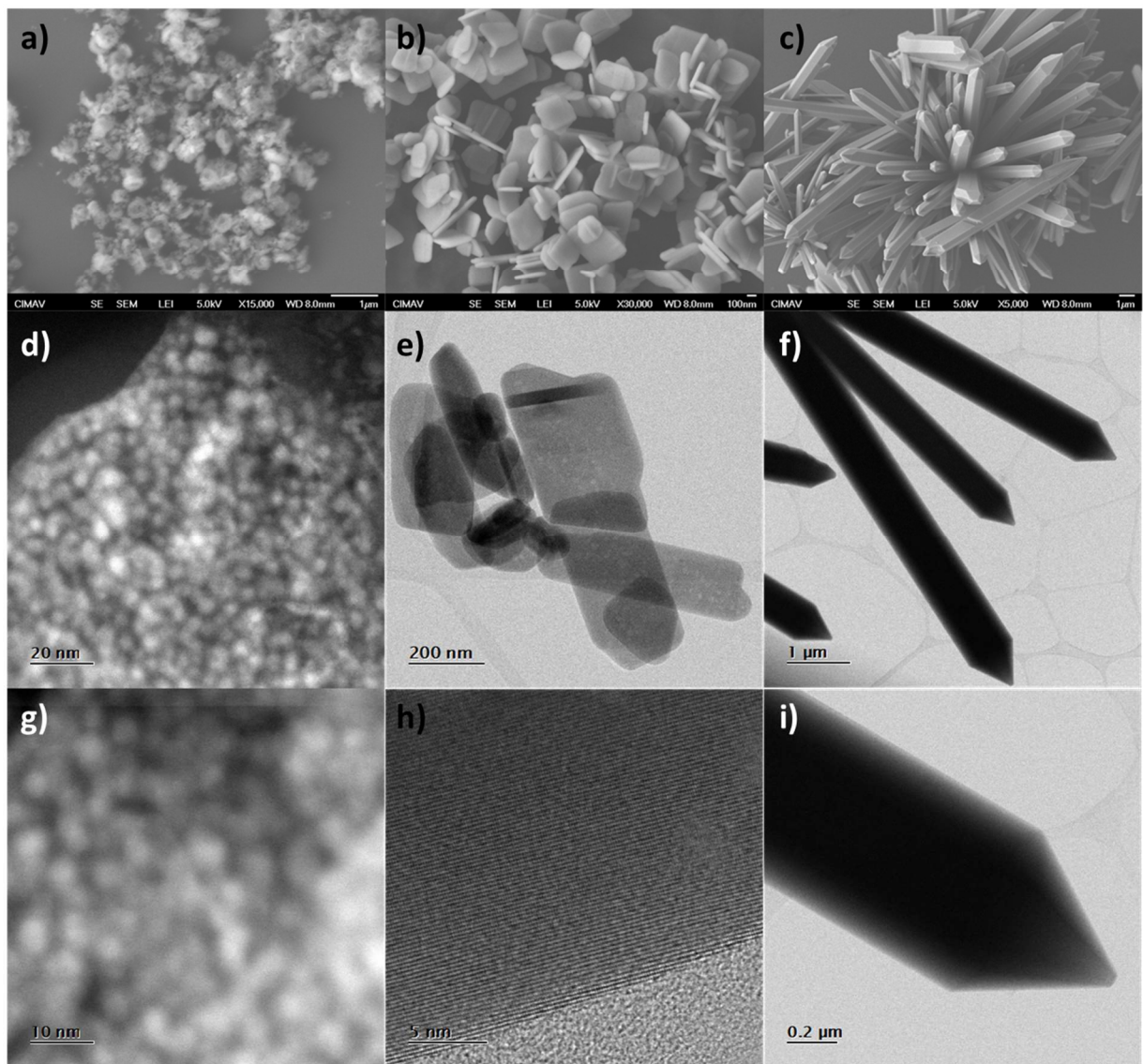


Figure 1. ZnO synthesized by PM a), d) and g). Then by HM b), e), h), c), f) and i).