

Influence of the solvent in the morphology of ZnO

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Abstract – ZnO with different morphologies was obtained by microwave hydrothermal method, with variation of the solvent and synthesis time. Flower-like morphologies were formed when water was present in the media. For pure water, nanoparticles agglomerated to form the flowers. For water/ethanol media, flowers were formed by the agglomeration of sticks. The use of pure ethanol led to a meaningful variation in the morphology, indicating that a “crystallization – dissolution – recrystallization – self-assembly mechanism was present in the system, with the formation of spherical agglomerates after 30 min.

Nanomaterials with one dimension (1D) and three dimensions (3D) are intensively studied by the scientific community, due to their technological importance, as they bring an important opportunity of investigating the influence of morphology in the optical, electrical, magnetic and structural properties [1,2], besides the possible applications as nanodevices [3-6]. In this sense, different methodologies have been developed in order to control the morphology and the particle sizes. An important one is the hydrothermal method with microwave heating.

In this work, ZnO with different morphologies was obtained using a domestic microwave hydrothermal method, in different solvents (water, ethanol and water/ethanol), with different synthesis times (5, 15, 30 and 45 min), using NH₄OH as alkaline agent. Samples were characterized by X-ray diffraction (DRX), Raman spectroscopy and field emission gun scanning electron microscopy (FEGSEM).

FEGSEM images showed the formation of ZnO with different morphologies as a function of the synthesis media. In aqueous media, with small synthesis times, nanoparticles, sticks and plates were observed. The increase in synthesis time to 30 min led to flower-like morphologies, with spherical particles agglomerated in the center of the flower while petals, with sizes varying between 140 and 240 nm, were formed by nanosticks. In ethanolic media, a high variation in the morphology was observed according to synthesis time. In this case, a growth process by “crystallization – dissolution – recrystallization – self-assembly was observed [6] and spherical agglomerates were formed after 30 minutes. When two solvents, water and ethanol, were mixed in the ratio 1:1, sticks grew from the same nucleation site, forming agglomerates which led to flower-like morphologies. An important point was that alkalization with NH₄OH only favored flower-like morphologies when water was present in the media, as synthesis in ethanolic media led to an increase in the pressure, avoiding the formation of flower-like morphologies.

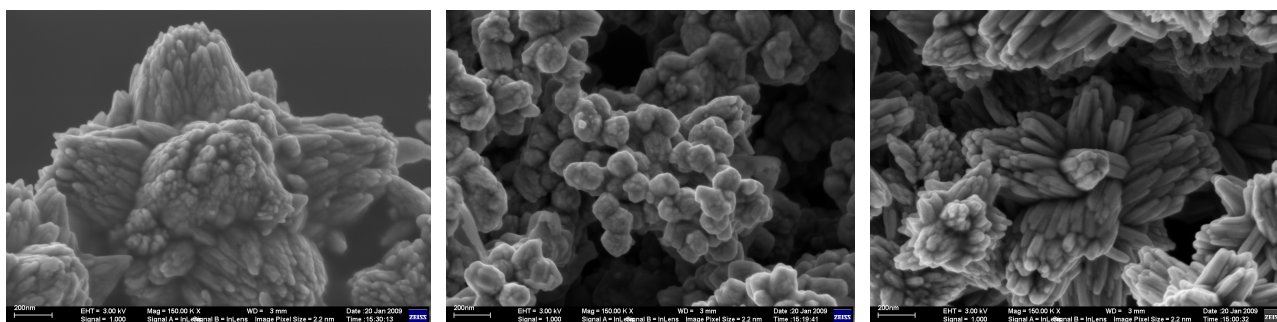


Figure 1: FEGSEM Images of ZnO synthesized in different media for 30 min (a) aqueous (b) ethanolic and (c) aqueous/ethanolic (1:1)

References

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