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STUDY OF THE INFLUENCE OF PROCESS PARAMETERS ON THE MORPHOLOGY OF ZNO NANOSTRUCTURES

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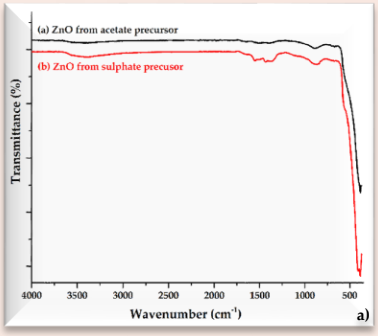
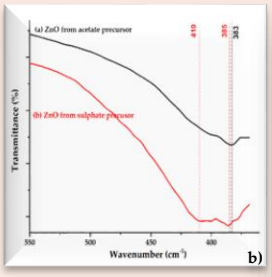
ABSTRACT

Zinc oxide nanostructures are considered materials with real potential in different scientific fields. In the case of these nanostructures, it was found that the morphology of ZnO plays an essential role in the development of further applications, but it is necessary a rigorous control of the main factors that influence the size, shape, agglomeration tendency, uniformity, and orientation of the nanostructures. In the present paper, our efforts are oriented to synthesize different types of ZnO nanostructures by chemical method, and optimization was achieved with varying parameters, such as the concentration of precursors, types of solvents, pH, time or temperature, as well as the parameters required for thermal treatment. To obtain the characteristic structural and morphological information, ZnO nanostructures were investigated using Fourier transform infrared spectrometry (FTIR), scanning electron microscopy (SEM), and X-ray diffraction (XRD). SEM analysis confirms that the morphology and size of the ZnO nanostructures depend on the process parameters. The XRD results reveal that the synthesized samples have a wurtzite crystalline structure, and FTIR spectra show the presence of Zn-O bonding. The wetting capacity of continuous ZnO surfaces with different morphologies was studied by measuring the contact angle, indicating that the wetting and percolation capacity, depend by the orientation of the synthesized nanostructures.

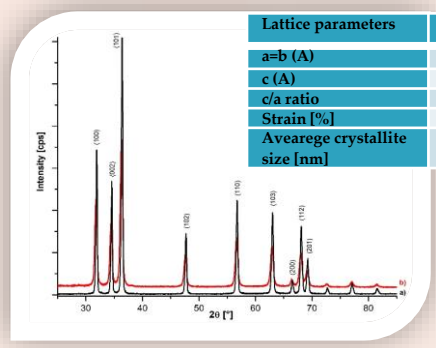
RESULTS





FTIR spectra for ZnO samples obtained from a) Zinc Acetate; Zinc sulphate; b) detail of Zn-O bands

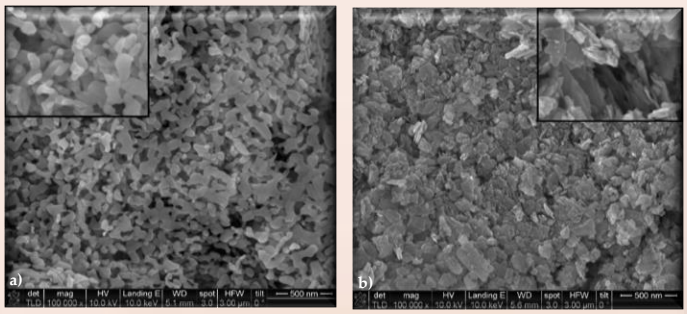
The absorption band centered at about 385 cm^{-1} can be attributed to the vibrational mode of the Zn-O bond in the wurtzite structure of ZnO, for the sample synthesized from the acetate precursor.
In the case of the obtained oxide from the sulfate precursor, the existence of the second peak at 410 nm, associated with the Zn-O bond, indicates the coexistence of an oxide with different morphologies.



Lattice parameters	$Zn(CH_3COO)_2$	$ZnSO_4$
a=b (A)	3.2512	3.2482
c (A)	5.2084	5.2028
c/a ratio	1.6019	1.6017
Strain [%]	0.11	0.02
Avearege crystallite size [nm]	16.2	31.6

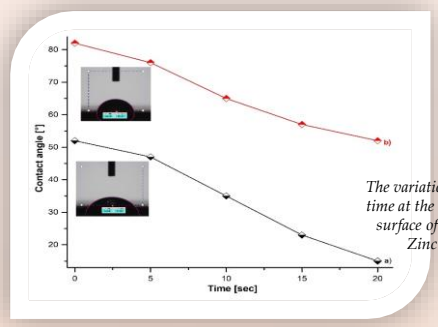
XRD diffraction patterns for ZnO samples obtained from a) Zinc Acetate; b) Zinc Sulphate

The diffraction peaks correspond to the wurtzite phase of ZnO, which belongs to the space group P63mc, according to the ICDD, card no. 36-1451.
The sharp and narrow diffraction peaks revealed the high crystallinity of the ZnO nanostructures. No peaks characteristic of other phases of ZnO or corresponding to any impurity were detected, which confirmed the high purity of the synthesized samples.



SEM images for ZnO samples obtained from a) Zinc Acetate; b) Zinc Sulphate

The ZnO obtained from acetate has spherical formations, with a slight tendency to agglomerate, and with sizes varying between 25-70 nm.
The sample obtained from zinc sulfate shows irregular morphologies with different shapes, spherical nanoparticles with a tendency to aggregate, but also types of sheets/plates of various sizes.



The variation of contact angle depending on time at the contact of the water droplet with surface of ZnO samples obtained from a) Zinc Acetate; b) Zinc Sulphate

The contact angle for the ZnO samples indicates high hydrophilicity with a value of 52° (in the case of using zinc acetate) and 82° (in the case of using zinc sulphate). The decrease in the hydrophilic character of the ZnO obtained from sulphate can be associated with the existence of sheets/plates.

CONCLUSIONS

- ZnO nanostructures with two types of zinc precursors have been synthesized by the sonochemical method.
- The FTIR spectra of ZnO nanostructures showed the characteristic absorption of Zn–O bond, regardless of the type of precursor used in their synthesis.
- The FESEM morphology of the analyzed samples indicates the formation of some spherical particles in the case of using acetate and the coexistence of different morphologies for sulfate oxide, with a tendency to agglomerate and keep the dimensions in the nanometric range.
- The XRD results show that the synthesized powders possess crystalline, wurtzite hexagonal phases of ZnO for both samples, and the crystallite size is strongly influenced by morphology, and respectively by the type of precursor used.
- ZnO nanostructures exhibit hydrophilic wetting character and good percolation properties, better for ZnO synthesized from in acetate precursor than sulphate.
- Based on the obtained results, ZnO could be considered a functional material with applicability in multidisciplinary fields.

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