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# INFLUENCE OF THE SYNTHESIS METHOD ON THE MORPHOLOGY OF ZnO

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*Synthesis methods are known to affect the characteristics of nanostructures. This work explored the effect of two types of synthesis methods on the morphology of ZnO, namely, sol-gel and combustion. Both the samples were annealed using identical conditions, at 500 °C for 3 hours. ZnO nanostructures were examined under Scanning Electron Microscopy (SEM) and Transmision Electron Microscopy (TEM) for morphological studies. Results showed that the morphology of ZnO was not the same with the different synthesis methods used. ZnO nanorods were obtained by the sol-gel method and ZnO spherical shapes were obtained by the combustion methods.*

**Keywords:** Zinc oxide, Nanorods, Combustion, Sol-gel

## INTRODUCTION

ZnO with special characteristics of direct wide band gap of 3.37 eV with free exciton binding energy (60 meV) [2-12] make it an interesting material to investigate. These characteristics attribute ZnO as one of the promising materials for many applications such as solar cells [1], varistors [2], semiconductors [3], light-emitting diodes, field effect transistors, gas sensors, ultrasonic transducers [4], and other applications. Since this material has a potential in industries, the investigation of the synthesis method to obtain ZnO in a bulk is important to meet such demand in industries.

## EXPERIMENTAL

Zinc oxide (ZnO) was synthesized by using a sol-gel and combustion method. Zinc acetate of 99.9% purity was used as starting materials for the sol-gel method. The starting materials were dissolved in suitable solvent until a homogeneous solution was formed. Tartaric acid was added until a pH of 5 was obtained. The solution was then dried at a low temperature of around 100 °C. For the combustion method, zinc nitrate of >99% purity was used as starting materials with triethanolamine as the combustant. The starting materials and combustant were dissolved in deionized water. The solution was heated at 200 °C until combustion occurs and precursors obtained. The precursors from both methods were then annealed at 500 °C for 3 h. The annealed samples were then sent for X-Ray Diffraction (XRD) using the PANalytical X'pert Pro MPD with Bragg-Brentano optical configuration and Cu Kα radiation. This is to study the purity and the phase formation of the samples. The morphologies of the product were studied using a Field Emission Scanning Electron Microscope (FESEM), JEOL JSM-7600F with secondary electron irradiation (SEI) SEM mode and Transmission Electron Microscope (TEM), JEOL JEM-2100F in a bright field imaging mode.

## RESULT AND DISCUSSION

The precursors of ZnO obtained is white in colour. After annealing process the powder are grayish for ZnO synthesized by the sol-gel method and black powder for the ZnO synthesized by combustion method. Fig.1 shows the XRD results of ZnO obtained by both methods annealed at 500 °C for 3h. It shows pure ZnO obtained for both synthesis methods. The patterns are matched to the ICDD reference pattern with ICDD number of 01-089-7102. The ZnO obtained is in the hexagonal crystal system with a space group P63mc. From the XRD results, it can also be seen that the ZnO obtained from the combustion method is more crystalline than obtained by the sol-gel method as seen from the intensity of the XRD peak of the ZnO obtained by the combustion method (Fig.1 (a)) is higher than sol-gel method (Fig.1 (b)). This may be due to the higher energy that has been provided during firing process to the materials during combustion method which caused it more crystalline.

The morphology of the ZnO obtained from both methods are shown in Fig.2 which is investigated by SEM and Fig.3 by TEM. SEM results clearly show different morphologies are obtained from both synthesis methods. ZnO nanorods are obtained by the sol-gel method and ZnO nano-spherical particles are obtained by the combustion method. This shows the synthesis method influenced the morphologies of the ZnO nanostructures.

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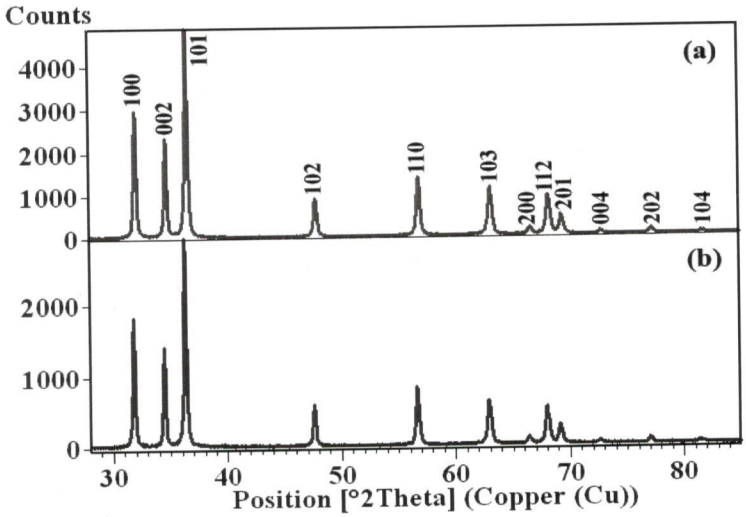


**Fig. 1. XRD results of ZnO obtained via the a) combustion synthesis method b) sol-gel synthesis method annealed at 500 °C for 3h.**

The average aspect ratio of the ZnO nanorods is about 4.36 and the average crystallite size of the ZnO nanospherical particles is about 79.3 nm. However, TEM results as shown in Fig.3, does not indicate much difference in shape. For the ZnO synthesis by the sol-gel method, it shows a mixture of spherical particles and some short rods or elongated particle while for the ZnO synthesized by the combustion method, it shows spherical particles are obtained.

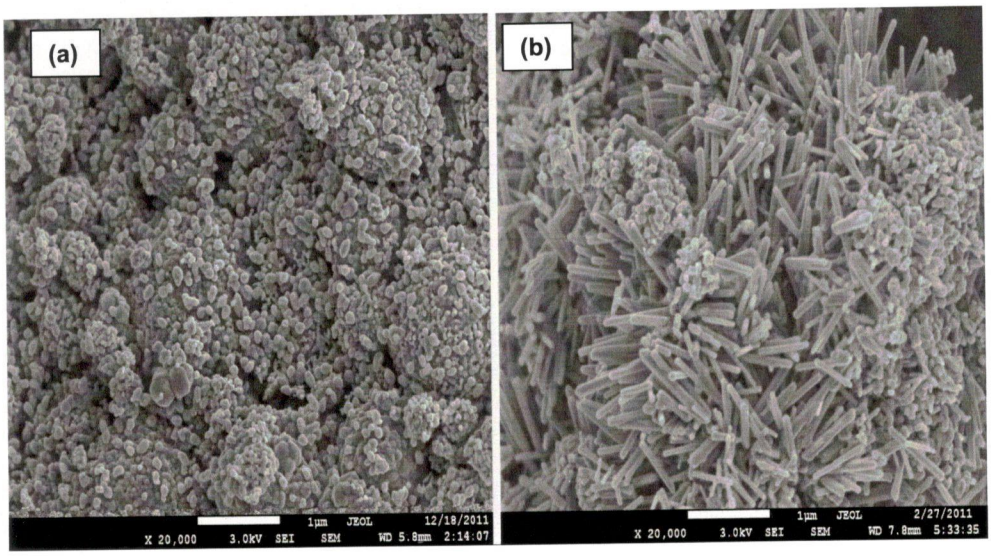


**Fig. 2. SEM results of ZnO annealed at 500 °C for 3 h synthesized by (a) Combustion method (b) Sol-gel method**

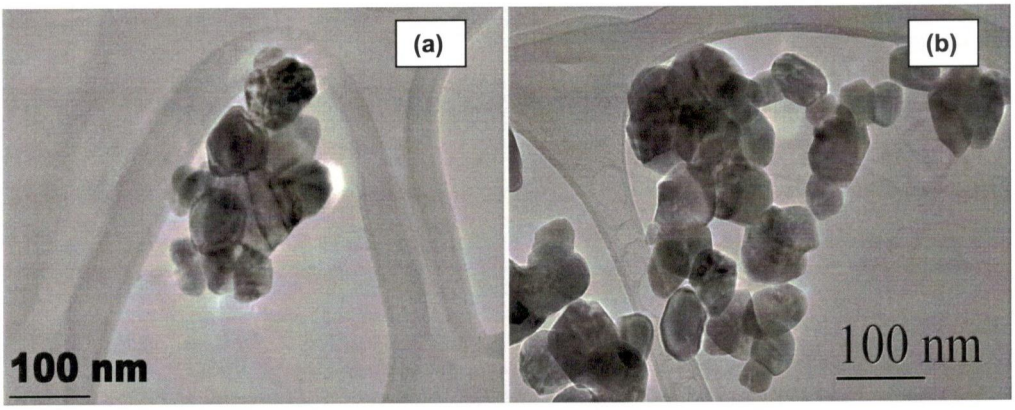


**Fig. 3. TEM results of ZnO annealed at 500 °C for 3 h synthesized by (a) Combustion method (b) Sol-gel method**

## CONCLUSION

Pure ZnO nanostructures can be obtained by sol-gel and combustion synthesis methods. The synthesis method also influenced the morphology of ZnO nanostructures. ZnO nanorods were obtained by the sol-gel synthesis method while ZnO nano-spherical particles obtained when the ZnO synthesized by the combustion method.

## ACKNOWLEDGEMENT

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