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# Synthesis of ZnO Nanostructures Using Sol-Gel Method

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**Abstract**

Zinc oxide plays an important role in current industry due to its special characteristics such as anti-corrosion, anti-bacteria, has low electrons conductivity and excellent heat resistance. Therefore, the objective of this study is to synthesize zinc oxide nanostructures with the most practical ways by using sol-gel method and characterize the nanostructures. Sol-gel method is the simplest method and has the ability to control the particle size and morphology through systematic monitoring of reaction parameters. ZnO nanoparticles were synthesized via sol gel method using Zinc acetate dehydrate ($Zn(CH_3COO)_2.2H_2O$) as a precursor and ethanol ($CH_2COOH$) was used as solvent, Sodium hydroxide (NaOH) and distilled water were used as medium. ZnO nanoparticles were characterized by using XRD, EDX, FESEM, and nano-particles analyser. Result of EDX characterization shows that the ZnO nanoparticles has good purity with (Zinc content of- 55.38% and; Oxygen content of- 44.62%). XRD result spectrum displays mainly oxygen and zinc peaks, which indicate the crystallinity in nature as exhibited. FESEM micrographs shows that synthesized ZnO have a rod-like structure. The obtained ZnO nanoparticles are homogenous and consistent in size which corresponds to the XRD result that exhibit good crystallinity. ZnO nanoparticles were successfully synthesized by sol-gel method in nanosize range within 81.28nm to 84.98nm.


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## 1. Introduction

Synthesis of metal nanoparticles with specific properties is a newly established research area that attracts a great deal of attention. There are several methods that have been put forward for synthesis of these materials, namely chemical vapor condensation, arc discharge, hydrogen plasma-metal reaction, and laser pyrolysis in the vapor phase, microemulsion, hydrothermal, sol-gel, sonochemical, and microbial processes taking place in the liquid phase, and ball milling carried out in the solid phase[1,2]. The properties of metal nanoparticles depend largely on their synthesis procedures. The variety of metal oxide is great and their range of properties and possible applications appear to be enormous. Zinc Oxide is very suitable for sensor and transducer usage with its relatively bio-safe and biocompatible material. Besides, nanostructured metal oxide has been found to display appealing nano-morphological, functional, biocompatible, non- toxic and catalytic properties[3]. The market demand for the ZnO nanopowders is increasing and widely used in industries due to their ultraviolet filtering, catalytic, anti-corrosion and anti-bacterial properties. Recently, they have mainly been used in sunscreens as an ultraviolet-resistant additive. Other applications of zinc oxide nanopowder include electrophotography, photoprinting, capacitors, protective coatings, anti-microbial, and conductive thin-films in LCDs, solar cells, and blue laser diodes[4].

## 2. Experimental

Zinc Oxide nanostructure was synthesized by using sol-gel method. In order to prepare a sol, 2 g of Zinc Acetate Dihydrate and 8 g of Sodium Hydroxide were weighted using a weighting balance. Then, 10 ml and 15 ml of distilled water were measured by a measuring cylinder. After that, 2 g of zinc acetate dihydrate was dissolved with a 15 ml of distilled water and 8 g of sodium hydroxide was dissolved in a 10 ml of distilled water. The solutions were stirred with a constant stirring for about five minutes each. After well mixed, sodium hydroxide solution was poured to the solution containing zinc acetate with a constant stirring by magnetic stirrer for about five minutes. Then, a burette was filled with 100 ml of ethanol and tiltrate dropwise to the solution containing both sodium hydroxide solution and zinc acetate. After the reaction, white precipitate was formed.

### *2.1 Synthesis of Zinc Oxide Nanostructure*

Synthesizing Zinc Oxide nanostructure via sol gel technique in this research includes the use of several materials such as Zinc Acetate Dihydrate ($Zn(CH_3COO)_2.2H_2O$) ≥99% purity ( HmbG Chemicals), Sodium hydroxide (NaOH) ≥98% (Sigma Aldrich), Ethanol ($CH_2COOH$) HmbG Chemicals) and distilled water. Zinc Acetate Dihydrate was used as precursor and Ethanol was used as a reagent. Distilled water was used as a solvent medium.

## 3. Results and Discussion

### *3.1 Zinc Oxide Nanostructures*

Based on the experimental work that has been done, there are series of chemical reaction that takes place. The complete hydrolysis of zinc acetate with the aid of NaOH in an ethanolic solution should result in the formation of a ZnO colloid. The final product was obtained as a result of the equilibrium between the hydrolysis and condensation reaction. Due to the heating, Zinc Acetate within the solution undergoes hydrolysis forming acetate ions and zinc ions. The abundance of electrons in the oxygen atoms makes the hydroxyl groups (-OH) of alcohol molecules bond with the zinc ions[5]. The overall chemical reaction to form ZnO nano-powder when sodium hydroxide was used as solvent stated as follow in Eq. (1):

$$(Zn(CH_3COO)_2.2H_2O) + 2NaOH \longrightarrow ZnO + 2NaCH_3COO + H_2O \quad (1)$$