

# Synthesis and Analysis of ZnO Nanoparticles

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## ABSTRACT

The Nanoparticles are the small particles behaving as a whole unit with respect to its properties. The paper deals with an approach to synthesize of ZnO Nanoparticles. The ZnO Nanoparticles are having wide scope for the research due to its piezoelectric nature and superior mechanical properties. The synthesis of ZnO nanoparticles has been carried out in low reaction temperature by zinc nitrate hexahydrate  $[Zn(NO_3)_2 \cdot 6H_2O]$  was used as the zinc ion as a source and sodium hydroxide (NaOH) pellets were used as a reducing agent. The micro structural characterization of ZnO particles was carried out by XRD, SEM and particle size Analyzer.

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## 1. INTRODUCTION

ZnO Nanoparticles has prove to be very promising for the researchers due to its mechanical properties and piezoelectric nature more over the synthesis of ZnO Nanoparticles is not very difficult. The optical and electronic properties of ZnO crystals can be modulated by changing their size and morphology. The morphological behavior of zinc oxide nanoparticles with sulphate ions and nitrate ions had been studied. The difference in the morphology of ZnO nanoparticle films can be seen clearly by addition of different anions.[1]. ZnO Nanoparticles are the unique material that exhibits multiple properties semiconducting, piezoelectric, pyroelectric high photostability, biocompatibility and biodegradability etc.[3][9]. The quasi dimensional particles show novel physical properties due to their unique geometry and structure.[4] ZnO nanorods with hexagonal tip can be synthesized by water at 140°C in a simple reaction of Zn powder.[5]. ZnO Nanoparticles can be a alternative of GaN for the application such as light emitters, gas sensors, and surface acoustic wave devices [6]. The uncooked rice can be used as a source of ZnO Nanoparticles.[7]. The size analysis of ZnO Nanoparticles can be done by XRD. At higher temperature the nature of the ZnO particles is endothermic and the loss weight upto 10%. [10]. ZnO nanoparticles can readily prepared at room temperature from zinc nitrate hexahydrate and cyclohexylamine either in aqueous or ethanolic medium.[11]. The size of ZnO Nanoparticles depends on temperature and base concentration. As the temperature increases the size of ZnO Nanoparticles goes on increasing. [12][13]. ZnO nanoparticles can be synthesized from zinc chloride using sodium hydroxide as the precipitant.[14]. ZnO nanoparticles/nanorods can be synthesized by reaction of zinc metal with alcohol as the C-O bond of alcohols is readily cleaved by Zn metal. The ethylenediamine can be used as the director and the shape controlling agent.[15]

## 2. EXPERIMENTAL SETUP

Material required: Zinc nitrate hexahydrate of analytical reagent grade, sodium hydroxide pellets from qualigens, soluble starch, distilled water, magnetic stirrer, microwave oven, centrifuging equipment.

**Preparation of composition:** For soluble starch solution

0.5% (w/v) soluble starch solution has to be made in 500ml of distilled water

So, in 100 ml of distilled water = 0.5g of soluble starch

In 500ml of distilled water= 2.5g of soluble starch has to be mixed

For zinc nitrate

0.1 mole of zinc nitrate hexahydrate has to be made

Means, for 1000ml solution 29.748148g  $Zn(NO_3)_2 \cdot 6H_2O$  has to be taken

So, for 500 ml solution = 14.874g  $Zn(NO_3)_2 \cdot 6H_2O$  has to be taken

For sodium hydroxide solution

0.2 mole of sodium hydroxide has to be made

Means, for 1000ml solution 8g NaOH has to be taken

So, for 500ml solution 4g NaOH has to be taken  
Hence, for 100ml solution = 0.8g NaOH has to be taken

**Synthesis of ZnO Nanoparticles:** The method used was wet chemical method using zinc nitrate and sodium hydroxide solution precursor and soluble starch as stabilizing agent. 0.1 % ( w/v) soluble starch solution is made in 500ml of distilled water by using microwave oven. Zinc nitrate, 14.874g (0.1 mol), was added in the above solution. Then the solution was kept under constant rigorous stirring using magnetic stirrer to completely dissolve the zinc nitrate for 1 hour. After complete dissolution of zinc nitrate, 0.2 mol of sodium hydroxide solution was added under constant stirring, drop by drop touching the walls of the vessel. The reaction was allowed to proceed for 2 hour after complete addition of sodium hydroxide. After the completion of reaction, the solution was allowed to settle for overnight and the supernatant solution was then discarded carefully. The obtained nanoparticles were washed three times using distilled water. Washing was carried out to remove the byproducts and the excessive starch that were bound with the nanoparticles. After washing, the nanoparticles were dried at 80°C for overnight. During drying, conversion of  $\text{Zn}(\text{OH})_2$  into ZnO takes place.

### 3. OBSERVATIONS AND ANALYSIS

#### XRD RESULTS

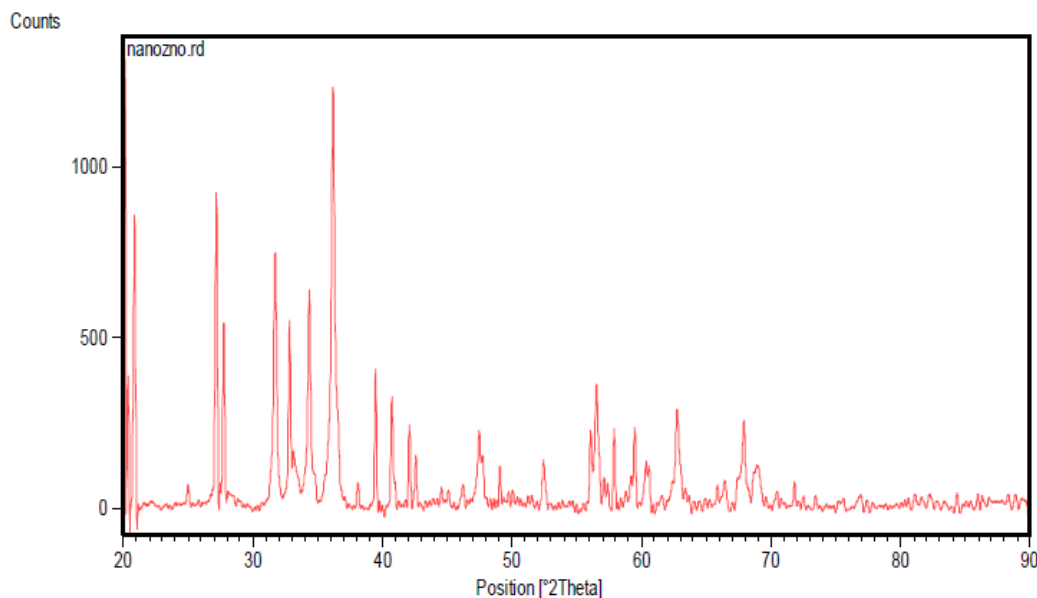


Fig. 1: XRD of ZnO Nanoparticles sample

#### SEM RESULTS

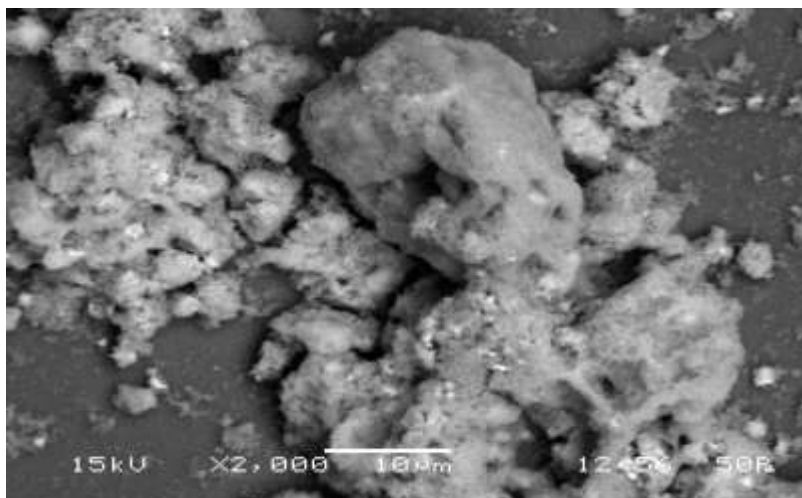


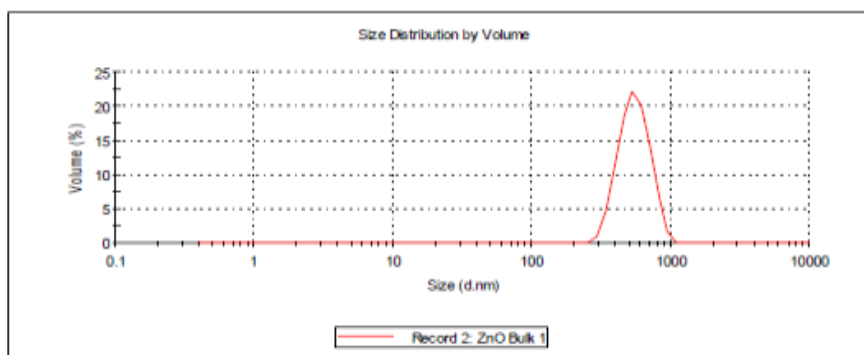
Fig. 2: SEM of ZnO Nanoparticles

## MICROSCOPIC VIEW



**Fig. 3: Microscopic view of ZnO Nanoparticles in dispersed form**

## Particle size analysis



**Fig. 4: Particle size of ZnO Nanoparticles**

The size of the particles formed were 559 nm studied by the particle size analyzer. The XRD of the sample reveals that the required phase have a little amount of impurities. The particle sizes which was done by particle analyzer was supported by the XRD Scherer's formula. SEM of the ZnO sample showing that agglomeration has been taken place. The particle size is irregular.

## CONCLUSIONS

The ZnO Nanoparticle obtained from zinc nitrate hex hydrate  $[Zn(NO_3)_2 \cdot 6H_2O]$  were in the form of powder. The reducing agent used was sodium hydroxide (NaOH) pellets. The XRD, SEM and particle size Analyzer were used for the characterization of the ZnO Nanoparticles. The results show that the size of Nanoparticles obtained is 559 nm. This method can be used for producing the smaller size ZnO Nanoparticles by controlling the temperature. The method is time consuming but the amount of Nanoparticles produced can be very high. The chemical reaction in this method doesn't have any hazardous byproducts. This method for synthesizing the ZnO Nanoparticles is very easy and economical.

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