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SINGLE STEP SYNTHESIS OF ZnO NANOPARTICLES

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ABSTRACT

The ZnO nano particles have various applications including solar cell applications. This paper reports a beaker chemistry method that is short and convenient to demonstrate in laboratories. The method is useful for the teachers. Quick dissolution of zinc acetate in isopropanol at 60^0 and mixing with sodium hydroxide quickly results into formation of widely distributed ZnO nanoparticles. Nano formation is confirmed with UV-visible spectrophotometry. Peak at 332 nm ensured nano particle formation.

Keywords: *Zinc Acetate, Isopropanol, Sodium Hydroxide, ZnO Nanoparticles, UV Spectrophotometer.*

I. INTRODUCTION

Nanotechnology is widely considered to have potential to bring benefits in areas as diverse development, water decontamination, information and communication technologies and production of stronger and higher durable material and though lighter material either by scaling up from single group of atoms or by refining or by size reduction of bulk materials. While the development of nano particles is a modern multidisciplinary science involving fields like physics, chemistry biology and engineering [1]. Ordinary materials when reduced to the nano scale often exhibit novel and unpredictable characteristics such as extra-ordinary length, chemical reactivity, electrical conductivity super magnetic behavior and other such characteristics that the same material do not posses at micro-or marcoscale. In recent years zinc oxide has promoted itself as an interesting metal oxide material because of its unique chemical and physical properties such as high chemical and mechanical stability, broad range of radiation absorption, high catalyst activity electro-chemical coupling nature, nontoxic nature user friendly and so as well [2]. The biggest advantages of ZnO nanoparticles are low price, good gas sensing agent, photo catalytic activity and antibacterial activity possibility to prepare structures with interesting optical properties. It frequently used in several technologies and it is worthy to investigate high quality self textured ZnO films synthesized on different kinds of substrate [3].

II. APPLICATIONS OF ZINC OXIDE NANOPARTICLES

A) Agricultural Application :

Nanotechnology has a dominant position in transforming agriculture and food production. Nanotechnology has a great potential to modify conventional agricultural practices. . Nanosensors development can help in determining the required amount of farm inputs such as fertilizers and pesticides Zinc oxide NPs have potential to boost the yield and growth of food crops. Peanut seeds were treated with different concentrations of zinc oxide nanoparticles [4].

Zinc oxide nanoscale treatment (25 nm mean particle size) at 1000 ppm concentration was used which promoted seed germination, seedling vigor, and plant growth and these zinc oxide nanoparticles also proved to be effective in increasing stem and root growth in peanuts The colloidal solution of zinc oxide nanoparticles is used as fertilizer. This type of nanofertilizer plays an important role in agriculture [5]. Nanofertilizer is a plant nutrient which is more than a fertilizer because it not only supplies nutrients for the plant but also revives the soil to an organic state without the harmful factors of chemical fertilizer. One of the advantages of nanofertilizers is that they can be used in very small amounts. An adult tree requires only 40–50 kg of fertilizer while an amount of 150 kg would be required for ordinary fertilizers. Nanopowders can be successfully used as fertilizers and pesticides as well [4].

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B) BioMedical Applications :

As biomolecules are very sensitive to the solution pH and temperature, there is a generalneed to synthesize metal oxide semiconducting nanoparticles for possible applicationsin biological sensing, biological labeling, drug and gene delivery, and nanomedicines. In particular, due to their easy fabrication, environmentally friendly nature, and-toxic synthesis route, ZnO nanoparticles can provide a better option for various biologicalapplications [6]. However, water solubility and biocompatibility of ZnO nanoparticle are the main requisites for biological applications. Furthermore, in terms of application, the buffertris(hydroxymethyl)aminomethane represented a standard nontoxic buffer that is inert toa wide variety of chemicals and biomolecules and can be satisfactorily used for a variety biological reactions. In addition, this buffer has an important role for the sphericity [6,7].

C) Solar Cells, Photocatalytic, Photoluminescence, and Sensor

Application of ZnO Nanoparticles

Regarding ZnO nanoparticle application in solar cells, Suliman reported the Synthesis of ZnO nanoparticles with average diameter of 30 nm by using zinc chloride as a precursor and NaOH as a base in a PVP solution of water at 160_C for 8 h via The hydrothermal method [5]. The as-synthesized structures were characterized by TEM, SEM and XRD analyses. Absorption spectrum was measured using a UV-vis spectrophotometer [8].

To make a ZnO film over transparent conducting glass (TCO), ZnO nanoparticles were dissolved in ethanol and then applied over the TCO surface using the doctor blade technique, which resulted in a 6 _m thick film of ZnO nanoparticles over the TCO, and finally it was annealed for 30 min at 450_C. To make dye-sensitized ZnO thin films, the film was soaked in 0. 5 mM ethanol solution of ruthenium complex, cis bis(isothiocyanato)–bis(2,2'-bipyridyl-4,4'-dicarboxylato)–ruthenium (II) (N3 dye). The TCO acted as a counter electrode on which 340 nm thick layer of Pt was deposited by sputtering. Electrolyte was made by 0. 03 M I2/0. 3 M LiI in propylene carbonate (PC) which was attracted into the interelectrode space by capillary forces, and then the resulting films of 0. 4 cm2 were illuminated through the conducting glass support with an Oriel [9, 10].

To make a photoelectron films, ZnO aggregates were deposited by drop-cast method on a fluorine doped tin oxide (FTO) glass substrate, and thickness of films depended on the number of drops. Finally, the ZnO films were heated at 350_C in air for 1 h to remove residual [8].

Cosmetic Application of ZnO Nanoparticles :

In addition to the above applications, i. e. , gas sensors, chemical and biosensors, light emitting diodes, photo-detectors, and photo catalytic application, ZnO nanoparticles also Exhibit tremendous UV-blocking properties. Generally, sunlight consists of three types of UV radiation, i. e. , UV-A (320–400 nm), UV-B (290–320 nm), and UV-C (250–290 nm)[11, 12].

UV-A radiation is the main concern as it contributes 95% of the total sunlight radiation.

UV-B radiation contributes 5 %, and UV-C radiation has no prominent effect, as it is absorbed by ozone at the surface of the Earth [6]. Moreover, UV-A radiation is considered more dangerous than UV-B, because it is100 times more intense than UV-B and can penetrate deeper into the dermis area of the skin. In the view of the abovementioned UV radiation values, it is important to block such types of harmful radiation, as exposure causes skin cancer in humans. Generally, to protect the skin, materials having UV-blocking properties are added to cosmetic formulations [7, 12]. For the protection of skin from UV-A radiation, ZnO nanoparticles provided an effective UV-blocking material compared to TiO2. Generally, ZnO nanoparticles effectively absorb UV-A radiation rather than scatter it, but TiO2 usually scatters these wavelengths. Although ZnO absorption for UV-A radiation is good compared to TiO2, photo catalytic activity hinders its possible application in cosmetic formulations. In addition, due to the high photocatalytic activity of ZnO, reactive oxygen species are generated, which can oxidize ingredients involved in the cosmetic formulation [11].

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III. MATERIALS AND METHODS

Zinc Acetate =Zn(CH_3CO_2). $2H_2O$ (0. 10g per batch), Isopropanol =(CH_3)CHOH (165 ml per batch). 0.05M NaOH solution viz. dissolve 0.20 NaOH in 100ml of Isopropanol with heating (Quickly weigh out about 2 pellets of hygroscopic NaOH and immediately transfer to waiting solvent) Ice bath [3].

1L beaker for hot water bath and icebox, thermometer to measure 65^0C, stir bar ans stirring hot plates, 50 and 250 ml of Erlenmeyer flasks, 25 ml graduated cylinder, 0. 01g balance, UV spectophometr 730nm. [3]

Safety Precautions: Isopropanol vapors irritate the respiratory tract and eyes. Wear eye protection and use in a fume hood to avoid skin contact. Chemical gloves recommended.

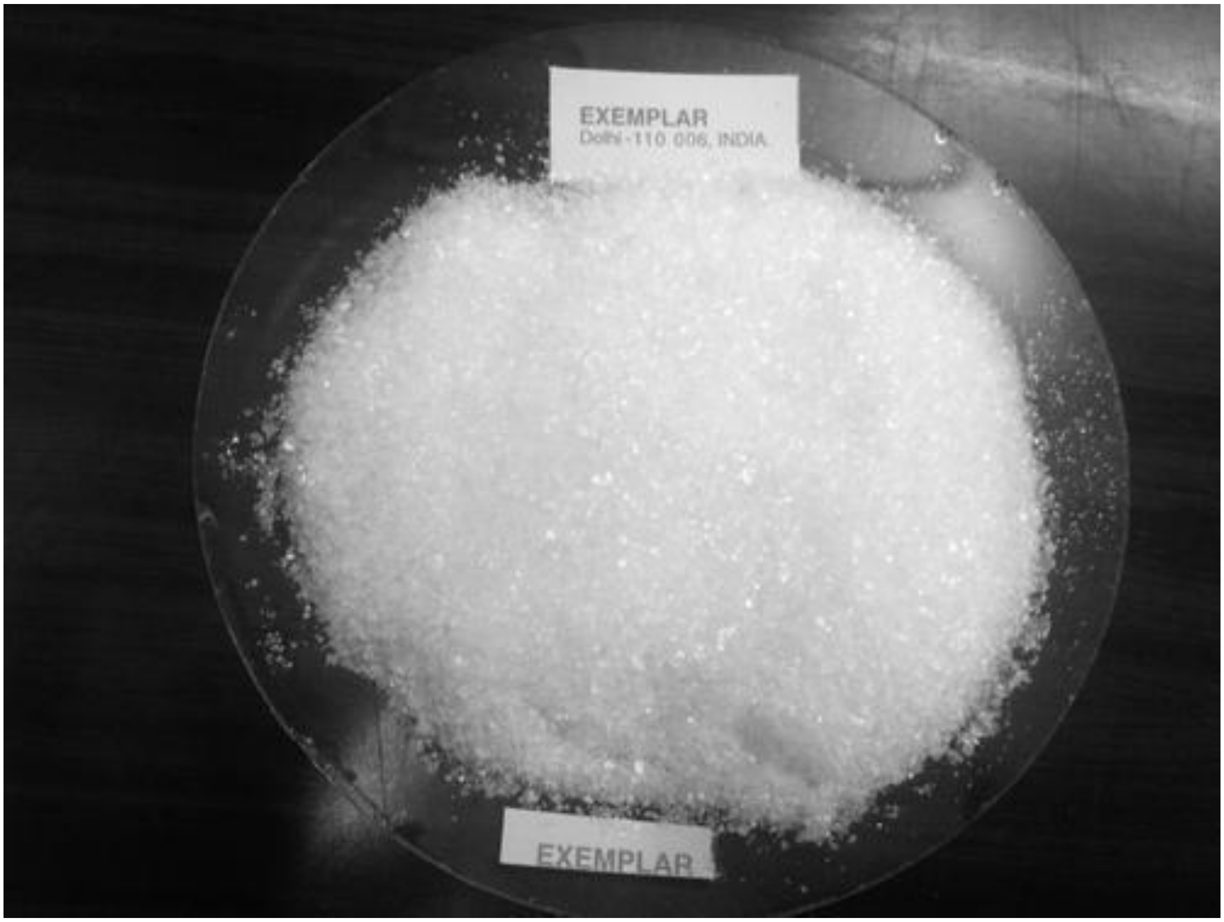

Figure -1: Zinc acetate, the starting material

Zinc as Starting Material:
In material science zinc oxide is consider as a semiconductor in group 2-6, with broad energy band of 3. 37eV and high band energy od 60meV. Because of its distinct properties it is widely used in many fields. Nanometric zinc oxide can occur in varied structures,such as one dimensional(1D), two dimensional (2D), and three dimensional(3D) structures. One dimensional structures make up the largest group including needles,helixes, nanorods ribbons, belts wires and combs. Three dimensional structures depict as snowflakes dandelion flowers as well. Zinc oxide plays an important role in current industry due to its special characteristics such as anit-corrosion, anti bacterial, has low electros conductivity and excellent heat resistance. Therefore, the objective of this study is to synthesisze zinc oxide

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nanostructures with most practical ways using sol-gel method and characterize the method. Sol-gel method is the simplest method and has the ability to control the particle size and morphology through systematic monitoring and reaction parameters [3].

Figure -2: Isopropanol, the starting material

Experiment

<u>Step 1</u>: Dissolve 0. 10g of zinc acetate $Zn(CH_3CO_2)_2$. H_2O in 25 ml of Isopropanol with mild heating at 25^0C using a constant heating mantel and fume hood. The time required to complete dissolutionof Zinc Acetate is 15 min. [3]

Step 2 : Meanwhile, prepare an ice bath by adding water to ice. Place 125ml isopropanol in a flask and chill the flask in an ice bath. Also begin heating a large beaker of water to 65^0C.

Figure -3: Heating mantle

Figure -4: Reaction mixture maintained at 4^0C

Step 3: When the zinc acetate solid has all dissolved, add that solution to the 125ml of chilled isopropanol. Also obtain 15ml of 0. 05m NaOH in isopropanol and chill the solution (use NaOH from the stock and mentioned above).

Step 4 : Slowly transfer the chiled NaOH solution to chilled and rapidly stirring zinc acetate solution using a Pasteur pipette.

Step 5:Place the chilled mixture flask in the 65^0C water bath and start taking samoles immediately. Record the UV spectra of Each Sample (Note : Use Isopropanol as blank solution for UV reading).

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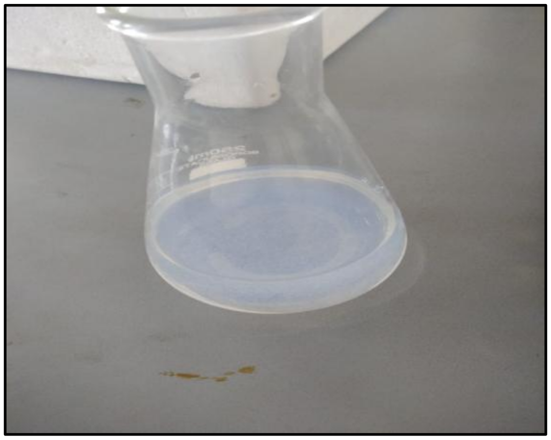

Figure -5: Zinc acetate + NaOH in isopropanol

Figure -6: UV-Visible spectrophotometer, Jasco V-730

IV. RESULTS AND DISCUSSIONS

Table 1: Absorption of wavelength by Zinc Nanoparticles recorded by UV spectrophotometer

Wavelength	Absorption
332. 6	1. 56467
316	1. 43094
222	2. 74803
213. 6	1. 55974
213. 4	1. 71618
213	1. 43315
212. 8	1. 55687
212. 4	1. 1706
211. 6	1. 20404
211. 2	1. 60932
210. 8	1. 05012
210. 4	1. 35017
210. 2	0. 98498

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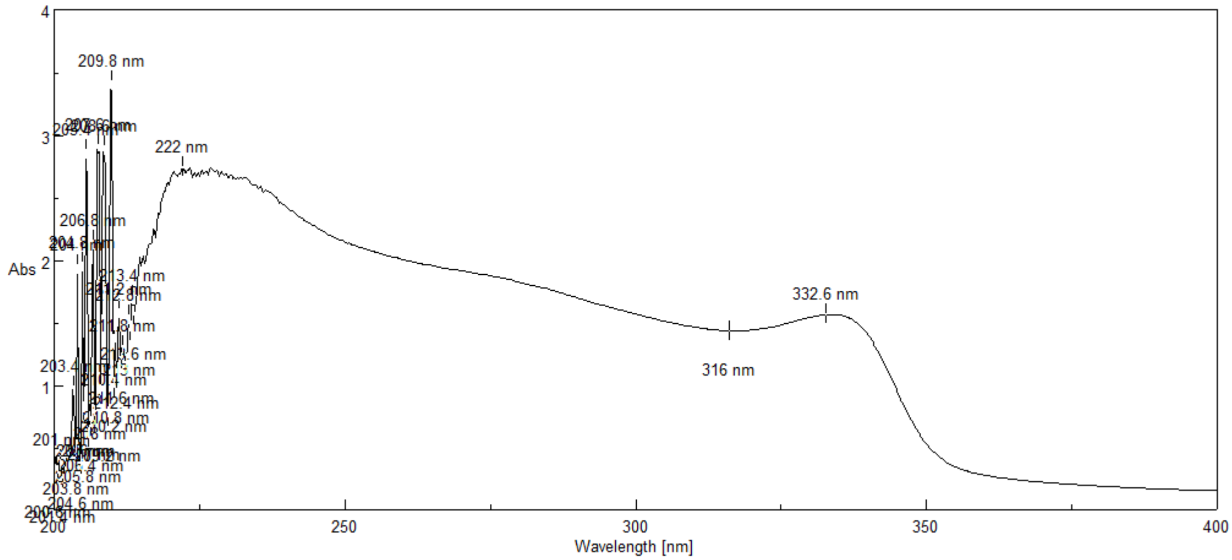

Figure -6: Graph of UV Spectophotometre

V. CONCLUSION

ZnO nanoparticles were synthesized using various routes. The sol–gel method proved a Successful synthetic route in terms of its cost, ease of handling, reliability, repeatability, and environmental friendliness. Moreover, with detailed review, it is confirmed that the various applications of ZnO nanoparticles depend upon the control of both physical and chemical properties such as size, size dispersity, shape, surface state, crystal structure, organization onto a support, and dispensability. In addition, these factors mainly depend upon the synthetic method. Therefore, shape, size, and dispersivity can be controlled by tuning different parameters during the synthesis process, e.g. the precursor type and concentration, types of capping molecule, types of solvent, reaction time, and reaction temperature. At a conceptual level, we need a better understanding of the relationship between size, shape, and structure of zinc oxide nanoparticles, and how one can tune its capability for electronic and chemical interaction with biological molecules and its sensing (biological and chemical) properties.

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