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SYNTHESIS AND CHARACTERIZATION OF ZINC OXIDE NANOPARTICLES BY USING UV/VIS SPECTROMETRY, SCANNING ELECTRON MICRSCOPY AND ITS ANTIMICROBIAL ACTIVITY AGAINST BACILLUS SPP., PSEUDOMONAS SPP ESCHERICHIA COLI

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ABSTRACT

An eco-friendly and green synthesis of zinc oxide Nanoparticles using co-precipitation method was investigated. UV/Vis-Spectra showed the maximum absorbance of 380 nm in the zinc oxide nanoparticles formation. The sharp peaks indicated the crystallinity and purity of zinc oxide nanoparticles. We have successfully synthesized ZnO Nanoparticles. Co-precipitation methods are a new approach for synthesizing Nanoparticles and are of low cost and material availability. In this study zinc oxide nanoparticles were prepared via hydrothermal growth using zinc acetate dihydrate and sodium hydroxide, as it is commercially available and cheap. The SEM images and FTIR were also studied in the project to give the perfectness in structure of Zinc Oxide Particles. We have investigated their microbiological activity and in future we are working on their use in Ayurveda.

INTRODUCTION

Metal oxides nanostructures play crucial role in many areas of chemistry, physics and materials science. In this work, the co-precipitation method was employed to prepare Zinc Oxide Nanoparticles. The materials obtained were thermally treated at various temperatures. ZnO is an important metal oxides that could be easily grown, environmental friendly and of interest to many applications. Low-temperature aqueous chemical growth method has been shown to be a high performance growth technique for ZnO nanostructures, due to its

excellent advantages such as low cost, low temperature, non-toxic operation and environmental friendliness.

Certain chemicals can interfere directly with the proliferation of microorganisms at concentrations that can be tolerated by the host. The antimicrobial activity of zinc oxide Nanoparticles is well known. Hence we make use of this property to inhibit growth of *E.coli*, *Bacillus spp., Pseudomonas spp.* using disc diffusion method. These two bacterial strains were selected as they are highly contagious; thence we can evaluate the potential antimicrobial activity of zinc oxide Nanoparticles.

The main aim of this is to study an assay method for Synthesis and characterization of Zinc Oxide Nanoparticles and characterization using UV/Vis-Spectrophotometer, FT-IR, SEM and microbiological activity.

EXPERIMENTAL SET-UP

Preparation of 1 M of Zinc Acetate

21.9 grams of Zinc Acetate was dissolved in small amount of distilled water then diluted to 100 mL to make a concentration of 1 M.

Preparation of 1 M of Sodium hydroxide

4 grams of Sodium hydroxide was dissolved in small amount of distilled water then diluted to 100 mL to make a concentration of 1 M.

Synthesis of Zinc Oxide Nanoparticles using plant extracts

Zinc acetate dihydrate $Zn(CH_3COO)_2.2H_2O$ and sodium hydroxide NaOH were each dissolved separately in distilled water to form the liquid media of the desired concentrations of 1 M each. The Zinc acetate dihydrate was slowly added drop-wise to NaOH solutions under vigorous stirring at room temperature. This results in forming transparent white solutions. The formed solution was stirred on magnetic stirred for 1 hour. The resulted solution was kept in an oven at 90°C for 2 hours. These solutions were reacted to produce zinc oxide precipitates. Following the precipitation, the solution was centrifuged at 4000 rpm for 30 minutes. The supernatant was then removed, and the precipitation which contains Nano ZnO was obtained. Finally, Nano ZnO was grinded with mortar to be shaped into powder.

INSTRUMENTATION

UV-1800 SHIMADZU SPECTROPHOTOMETER

The Growth Mechanism of the Zinc Oxide Nanopowder

The growth process of ZnO Nanopowder can be controlled through the following listed chemical reactions:

$Zn(CH_3COO)_2.2H_2O + 2NaOH \rightarrow Zn(OH)_2 + 2CH_3COONa + 2H_2O$…….. (1)

$Zn(OH)_2$ (gel) + $2H_2O = Zn^{2+} + 2OH^- + 2H_2O = [Zn(OH)_4]^2$……. (2)

$[Zn(OH)_4]^{2-} \leftrightarrow ZnO_2^{-2} + 2H_2O$……..… (3)

$ZnO_2^{-2} + 2H_2O \leftrightarrow ZnO + 2OH^-$…….. (4)

The formation mechanism of the ZnO nanostructures is a complex process and mostly considered to include two main steps: the generation of a ZnO nuclei, and subsequent ZnO crystal growth, the $Zn(OH)_4^{2-}$ complexes serve as basic growth units for the preparation of ZnO nanostructures. The zinc acetate may convert into $Zn(OH)_2$ colloids firstly under alkali solution, as shown in reaction 1. During the process, part of the $Zn(OH)_2$ colloids dissolves into Zn^{2+} and OH^- according to reaction no 2. When the concentration of Zn^{2+} and OH^- reaches the super saturation degree of ZnO, ZnO nuclei will form according to reaction no 4.

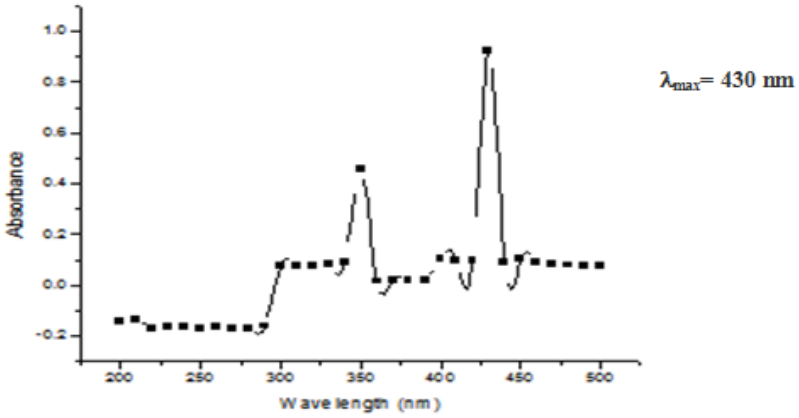
RESULTS AND DISCUSSION

UV/Visible Analysis of the reaction

The reduction of Zinc ions was characterized by measuring the UV–visible spectrum of the reaction medium at 2 hours after diluting a small amount of the sample into distilled water. UV–visible spectral analysis was done by using UV/Vis spectrophotometer (UV-1800 SHIMADZU SPECTROPHOTOMETER).

Table 1: Determination of λ_{max} for Zinc ions solution.

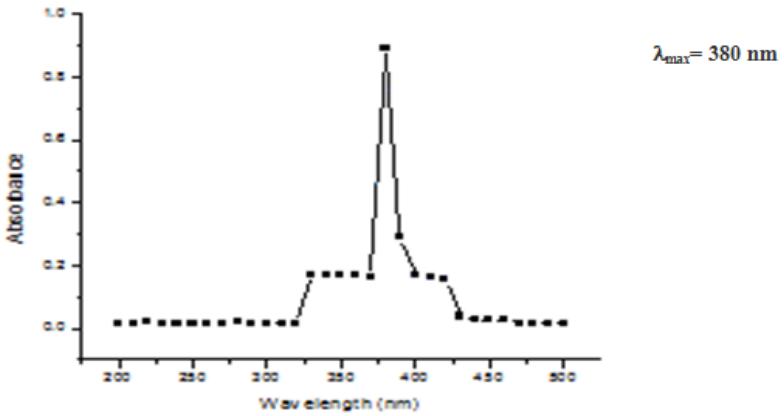
Wavelength /nm	Absorbance
200	-0.1456
210	-0.1345
220	-0.1734
230	-0.1635
240	-0.1623
250	-0.1696
260	-0.1665
270	-0.1724
280	-0.1693
290	-0.1612
300	0.0768
310	0.0789
320	0.0791
330	0.0838
340	0.0923
350	0.4567
360	0.0155
370	0.0198
380	0.0166
390	0.0162
400	0.1023
410	0.0982
420	0.0988
430	**0.9234**
440	0.0921
450	0.1034
460	0.0926
470	0.0817
480	0.0802
490	0.0792
500	0.0790



Graph 1: Calibration curve of absorbance vs. wavelength for Zinc acetate solution by UV/VIS Spectrophotometry technique.

Table 2: Determination of λ_{max} for Zinc Oxide Nanoparticles solution.

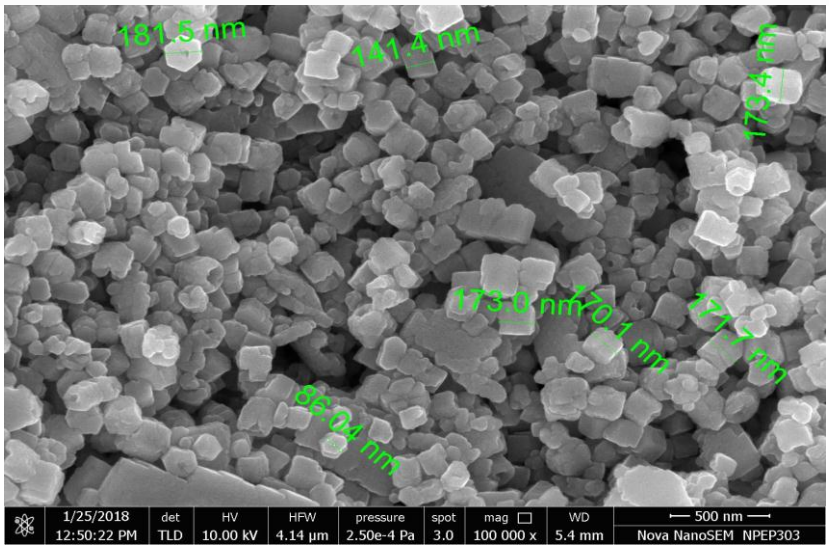
Wavelength /nm	Absorbance
200	0.0131
210	0.0147
220	0.0192
230	0.0169
240	0.0162
250	0.0154
260	0.0153
270	0.0155
280	0.0198
290	0.0166
300	0.0162
310	0.0166
320	0.0172
330	0.1696
340	0.1665
350	0.1724
360	0.1693
370	0.1612
380	**0.8910**
390	0.2928
400	0.1693
410	0.1627
420	0.1547
430	0.0380
440	0.0298
450	0.0266
460	0.0262
470	0.0166
480	0.0172
490	0.0169
500	0.0161



Graph 2: Calibration curve of absorbance vs. wavelength for Zinc Oxide Nanoparticles solution by UV/VIS Spectrophotometry technique.

SEM of Silver Nanoparticles

Scanning electron microscopy (SEM) provides size of the Nanoparticles which confirms the size of Zinc OxideNanoparticles. The average size of an individual particle is estimated to be 156.7 nm.



ANTIMICROBIOLOGICAL ACTICITY

Bacillus spp. ***E.coli*** ***Pseudomonas spp.***

Antibacterial Effect of different Compound on different organism i.e. *E.coli, Bacillus spp., Pseudomonas spp.* effective on nutrient agar plates

The most effective extracted compound that inhibited growth of E. coli, Bacillus, Pseudomonas spp. D-1, D-2, inhibited Alcoholic infusion extract D-1, D-2 more effective against Bacillus.

CONCLUSIONS AND FUTURE SCOPE

We have successfully synthesized ZnO Nanoparticles. Co-precipitation method is a new approach for synthesizing Nanoparticles and is of low cost and material availability.

Zinc Oxide NPs have extensive interest because of their super magnetic properties and they also have potential applications in many fields, include magnetic storage devices, analysis, sensor, magnetic resonance imaging (MRI) for medical diagnosis and therapeutics, and used for better-absorbed Zinc nutrient supplement.

We have did microbiological activity of Zinc oxide Nanoparticles and further in future use them in Ayurveda.

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