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Synthesis, Characterization, and Application of Zinc Oxide Nano Particles

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ABSTRACT
The textile materials functionalized with nanostructures have proven to be useful for many applications, such as anti-microbial,ultraviolet (UV) light protection. The main reason of this research is to synthesize andcharacterize zinc oxide NPs for the applications of Anti-microbial bacterial activities. The Anti-microbial bacterial activities of Zinc oxide NPs synthesized against good bacteriostatic activity against Escherichia coli.

I. INTRODUCTION

Nanotechnology is one of the most vibrant and research activity in modern science.Nanotechnology can be used for the synthesis, characterization, exploration and application of nano sized (1-100nm) materials for the progress of science [1]. Nano materials measured to nano crystalline size (<100 nm) can show atom-like behaviors which result from higher surface energy due to their large surface area and wider band gap between valence and conduction band when they are divided to near atomic size [2].Nanoparticles show size and shape-dependent properties which are of interest for various applications ranging from bio-sensing, catalysts, optics, antimicrobial-activity, computer transistors, electrometers, chemical sensors, and wireless electronic logic and memory outlines.These particles also have many applications in different fields such as medical imaging, nano-composites, filters, drug delivery, and cancer-tumors[3]. The application of nano technology is rapidly increase in textile industry. Recently, several nano materials, such as zinc oxideare frequently used in textiles as coating or implanting agents [4].Zinc oxide is very significant material and wide range of applications in catalysis, solar-cells, as a gas sensor and in semiconductor devices[5].So, Zinc oxide is an inorganic compound with the formula ZnO. It naturally appears as a white powder. Zinc oxide is an amphoteric oxide. NPs have started being considered as nano antibiotics because of their antimicrobial activities. Nanoparticles have been combined into various industrial, health, food, feed, space, chemical, and cosmetics industry of consumers which calls for a green and environment-friendly approach to their synthesis [8]. These days, Zinc oxide NPs have become a promising candidate and gained more attention especially in nano-medicine and nano-semiconductors[9].Nano-structured materials based on ZnO-nanoparticles (having some advantages such as lower cost, white appearance, UV-blocking property and not harmful) can be used to impart outstanding UV-blocking property to the done textiles[10].In particular, the strong antimicrobial properties of nanoscale Zinc oxide NPs particles have been the focus of industrial applications in biocides coating in water treatment, paints and cosmetic products [11]. The possibility of Zinc oxide NPs nanoparticles has been a keen area of interest for biologist due to their distinguished antimicrobial and distinct activity which has opened new frontiers to biological sciences [12].The interactions between these unique materials and bacteria are mostly toxic, which have been exploited for anti-microbial applications such as in food industry. Interestingly, ZnO-NPs are reported by several studies as non-toxic to human cells, this aspect necessitated their usage as antibacterial agents, noxious to microorganisms, and hold good biocompatibility to human cells[13]. Zinc oxide nano-particle can be used as an antimicrobial agent to kill pathogenic microorganisms. Depending upon their particle size, shape, concentration and exposure time to the bacterial cell, they first damage the cell wall, penetrate, accumulate in the cell membrane and ultimately cause death by interfering with metabolic functions [14]. The advantage of using inorganic oxides such as zinc oxide as

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antimicrobial agents is that they contain mineral elements essential to humans and exhibit strong activity even when administered in small amounts. ZnO nano-particles exhibit strong antibacterial activities on a broad spectrum of bacteria[15]. The structuralproperties of the synthesized ZnO nano-particles have been confirmed by using UV–Vis, FT-IR (Fourier Transform Infrared Spectroscopy), XRD (X-Ray Diffraction).

Materials

- Zinc nitrate (99% purity)
- sodium hydroxide (pellet min. 99%)
- de-ionized water

Methods

Zinc nitrate (99% purity) and sodium hydroxide (pellet min. 99%) were used as the starting material and this material are available in lab. Take 2.28 gm of zinc nitrate was dissolved in 75 ml distilled water underconstant stirring. While at room temperature, 0.1M sodium hydroxidesolution was added drop by drop. After completion of reaction and the solution was allowed to settle for overnight and thesupernatant liquid was discarded. The white precipitate formedwas washed thoroughly with double distilled water to remove allthe ions and then centrifuged at 3000 rpm for 10 min. Theobtained precipitate was dried in a hot air oven at 80°C for 6 hours. During drying, complete conversion of Zn $(OH)_2$ into Zinc oxides NPs (ZNO NPs) took Place.

II. RESULTS AND DISCUSSION

The obtained Zinc oxide NPs were measured for its determined absorbance using UV-vis spectrophotometry. The optical property of Zinc oxide NPs wasdetermined via ultraviolet and visible absorption spectroscopy in the range between to 280 - 420nm.

UV Spectroscopic analysis

UV VIS ANALYSIS=

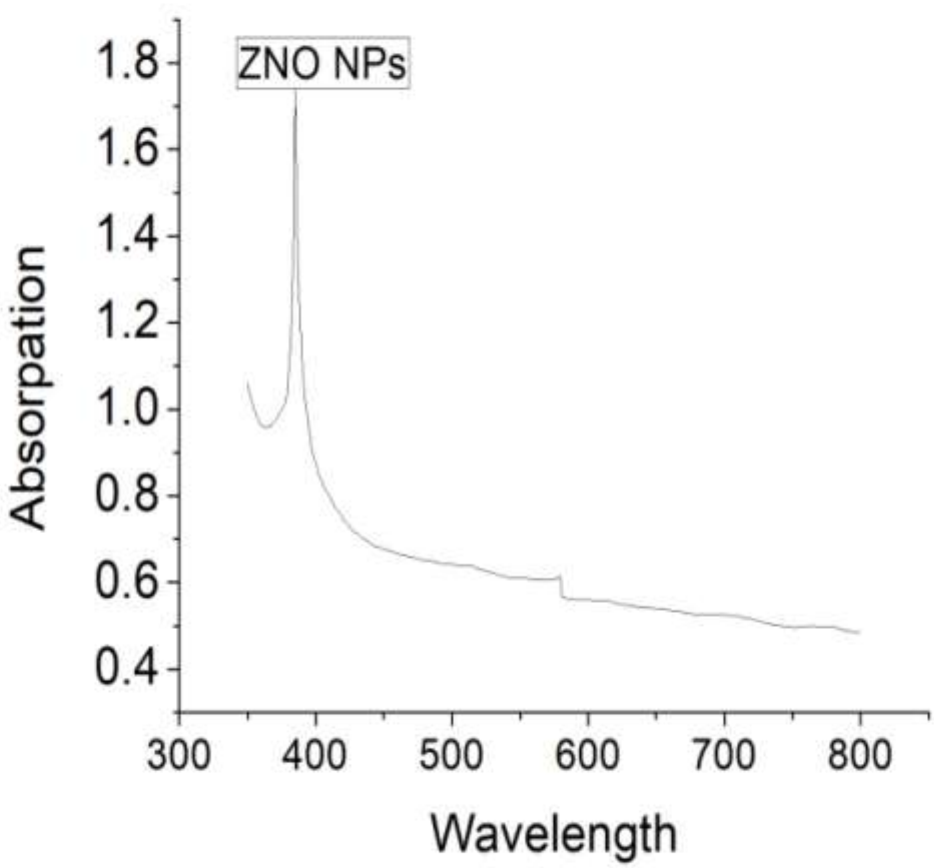

Figure-1 UV-Vis Spectra of Zinc Oxide nanoparticles

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UV–vis absorption spectra of Zinc oxide NPs is shown in Fig. OF UV–vis absorption spectra reveal that Zinc oxide NPs aredispersed. Zinc oxide nano particles show a broad absorption peak at 381 nm[16].

PARTICLE SIZE ANALYZER =

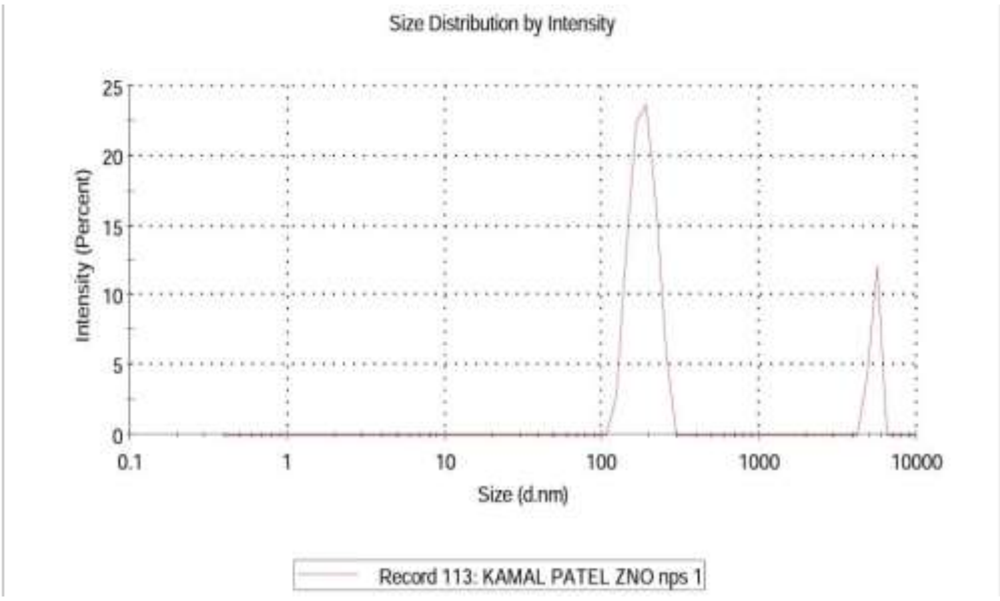

Figure-2 Particle size of the ZnO NP

The above graph showing the particle size of the sample Zinc oxide NP.
In graph, Zinc oxide NPs show size distribution by intensity at 183 nm [17].

FTIR-spectra of Zinc oxide NPs=

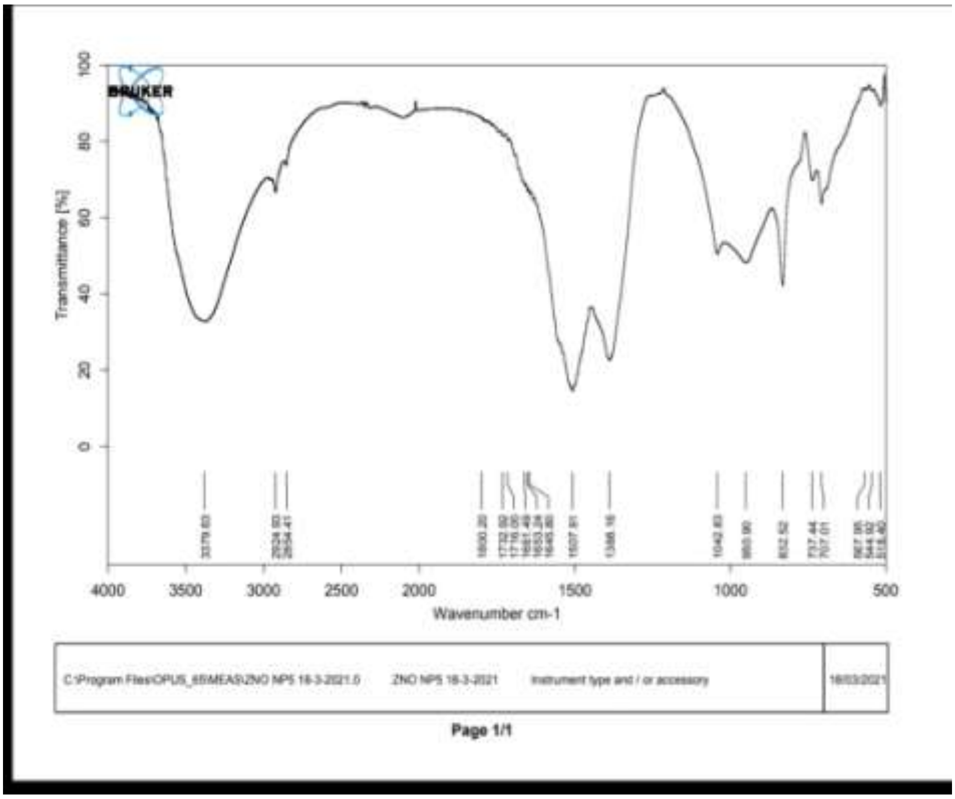

Figure-3 of FTIR-spectra analysis

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In view of confirming the nature of the functional groups on their surfaces as well as identifying theZinc oxide NPs formation, Fourier Transform Infrared (FTIR) spectroscopy was used precipitation method for Zinc oxide NPS.

Table 1. FTIR spectra with probable assignments.

Frequency (cm)−1= Probable Assignment
3379.63 cm−1 = O-H stretching vibrations
2924.33 cm−1 = The C-H stretch in alkanes
2854.41 cm−1 = O-H stretch in carboxylic acid
1507.91 cm−1 = C=C stretch in aromatic ring and C=O stretch in polyphenols
1461.45 cm−1 = C-N stretch of amide-I in protein
1042.83 cm−1 = C-O stretching in amino acid
544.92 cm−1 = hexagonal phase Zn-O

In view of the functional groups on their surfaces as well as identifying the Zinc oxide NPs formation, Fourier Transform Infrared (FTIR) spectroscopy was used. Peak at 3379.63 cm-1 corresponds to the O-H stretching. Peaks at 2924.33 cm−1 are attributed to the asymmetric stretching vibrations of C-H group (Aromatic) respectively.The absorption region at 1042.83 cm-1 - 1714 cm-1 is due to C=O, C=N, NH, C=C aromatic stretching vibrations. In generally, metal oxides are characterized by intrinsic absorption bands below 1000 cm-1 (the so-called fingerprint region) arising from inter-atomic vibrations. The FTIR spectrum of the biosynthesized Zinc oxide NPs showed an absorption peak exhibited in lower wavenumbers 544.92 cm-1 which is associated to the stretching mode of Zn-O and in higher wavenumbers which can be assigned to O-H group [18].

XRD spectra of Zinc oxide NPs

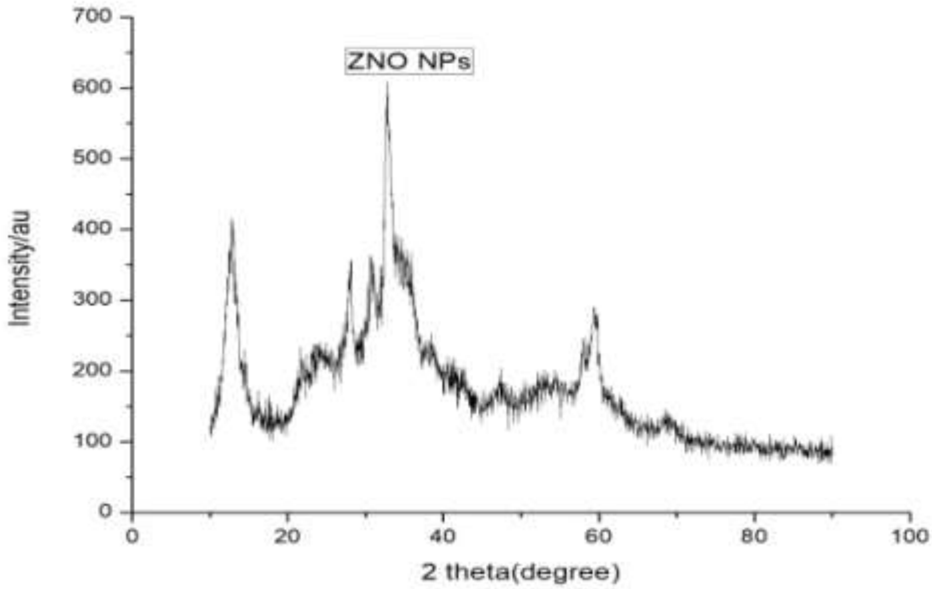

Figure-4 XRD spectra of Zinc oxide NPs

The XRD pattern of Zinc oxide NPssynthesized using Zinc nitrate hydrateand sodium hydroxide.Zinc oxide NPs wereconfirmed by XRD analysis.XRD spectra showed well definedpeaks at 2 theta values12.73°, 28.12°, 30.63°, 32.68°, 32.78°,59.41°,which has proved the formation of Zinc oxide NPs [19].

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Anti-microbial activity test on zinc oxide NPs

Zinc oxide NPs was coated onto cotton fabrics to evaluate the anti-microbial activity against good bacteriostatic activity.The cotton fabrics with 260 mm diameter were uniformly pressed on the agar solution and incubated for 24 hours at room temperature. After incubation, the anti-microbial bacterial effect of the fabrics was considered by evaluating that area of inhibition formed around the discs measured in millimeters (mm) and recorded**.**It was found that Zinc oxide NPs are using in cotton fabrics against Anti-microbial activity ongram negative **(**E. coli) bacteria.

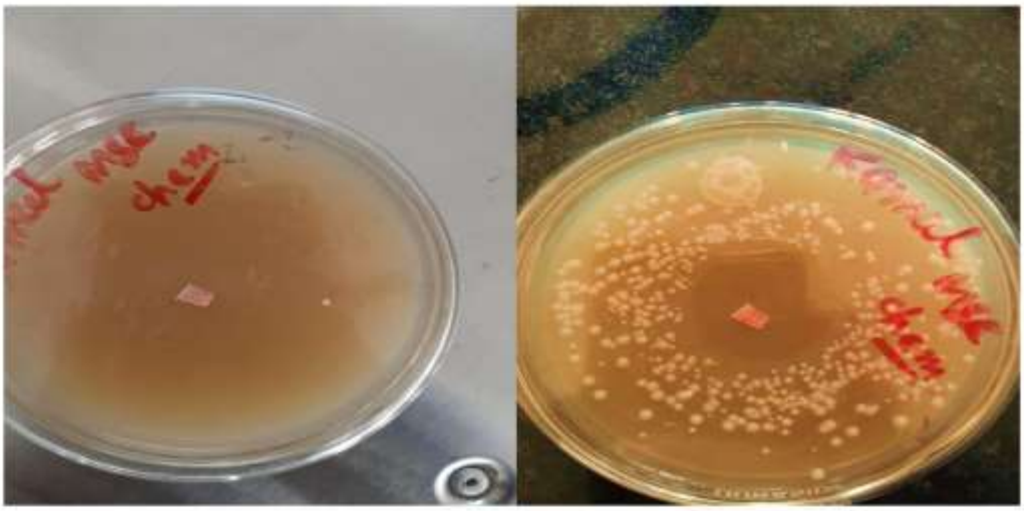

Figure-5Anti-microbial activity test

III. CONCLUSION

Zinc oxide NPs are made by precipitation method. The Zinc oxideNPs have been confirmed by using UV–Vis, FT-IR (Fourier Transform Infrared Spectroscopy), XRD (X-Ray Diffraction).Zinc oxide NPs revealed the anti-micro bacterial activity on E. coli bacteria and the 260mm (2.6 cm) zone in observed.This show that Zinc oxide NPs it has potential to anti-micro bacterial activity and taken can be used for precipitin of detergent with their nano particles.

FOR FUTURE PROSPECT

1.In preparation of UV-protection sun-screen.

2. In normal cosmeticcare product can be added to protecting for UV.

3. For micro bacterial Tuberculosis (TB) in a resistance and used as cell protecting agents.

4.This can be used against protecting micro bacteria in form sanitizer, soap, and detergent.

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