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# ANTI BACTERIAL EFFECT OF ZnO-Au NANOCOMPOSITES

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## ABSTRACT

The synthesis of ZnO-Au nanocomposites prepared by dissolving 1:1 concentration of Zinc Nitrate and Chloroauric acid in the presence of Sodium Hydroxide. The formation of ZnO-Au nanocomposities can be observed by a change in color from a colorless solution to yellowish white precipitate. Characterization studies of this stable ZnO-Au nanocomposities were carried out. AFM, UV absorption, SEM and XRD characterization of the synthesized nanocomposites showed an even distribution of gold nanoparticles. The ZnO-Au nanocomposite can be effectively used for controlling antimicrobial activity in human physiological systems.

**KEYWORDS:** Nanocomposites, Nanoparticles.

## INTRODUCTION

Nanostructured materials differ from bulk materials with respect to their novel properties. Zinc Oxide (ZnO) nanoparticles are a semiconductor material, which forms different nanostructures at varying temperatures, hence can be extensively used in a wide range of industrial applications [2]. Major applications of significance include surface acoustic wave devices, ultra violet nanolaser, gas sensors, biosensors, luminescent, cosmetics, field emission, nanogenerators and pharmaceutical industry applications [1]. Nanometer sized Gold (Au) nanoparticles supported on substrates such as oxides, carbides or hydroxides have proven to possess noticeable active reaction rates [12]. Au doped ZnO nanocomposites are studied for their excellent coating properties that can be used as metal protective coating properties, owing to their superior glass, durability, tint strength, particle uniformity and brightness [6].

The synthesis of nanoparticles with controlled morphology, crystalline structure has been a challenge [3]. At the industrial level, the most commonly employed method is the coprecipitation method [10]. Inorder to completely precipitate all interfering ions and to produce fine nanoparticles, coprecipitation method is chosen as the synthesis procedure in this study.

Colloidal silver has been known to have unique antimicrobial activity that may be useful in the construction of antibacterial materials to aid in the fight against bacteria-related infections. These Ag nanopowders were doped with ZnO nanoparticles. Study was done in E.coli [7]. The Ag-doped ZnO nanopowders were proven to have antibacterial capabilities that render them potentially useful as antibacterial agents for a variety of applications [2].

An antimicrobial is a substance that kills or inhibits the growth of microorganisms such as bacteria, fungi, or protozoan's[8].Antimicrobial nanotechnology is a recent addition to the fight against disease causing organisms, replacing heavy metals and toxins [4]. ZnO-Au nanocomposites may someday be a viable alternative.

## CO-PRECIPITATION METHOD

The co-precipitation method is one of the most appropriate ways of synthesizing a nano powder. Co- precipitation is the name given by analytical chemists to a phenomenon whereby the fractional precipitation of a specified ion in a solution results in the precipitation not only of the target ion but also of other ions existing side by side in the solution[5]. The additional precipitation of unwanted ions is, of course, an impediment to the analytical process. In the field of fine particle production, however, the method whereby all the batched ions in a solution are fully precipitated is known as co-precipitation. Some of the most commonly substances used in coprecipitation operations are hydroxides, carbonates, sulfates and oxalates [8].

## MATERIALS AND METHODS

Commercially available (Merck) Zn $(NO_3)_2.H_20$, NaOH and $HAuCl_4.3H_20$, were used as starting materials. Deionized water was used to prepare the aqueous solutions.

**Solution I**: 0.99M $Zn(NO_3)_2.H_20$ was dissolved in 50ml of deionized water.

**Solution II:** 0.01M $HAuCl_4.3H_20$ was dissolved in 10ml of deionized water.

**Solution III:** 1M NaOH was dissolved in 100ml of deionized water.

Solution I and Solution II were mixed thoroughly to form Solution IV. Solution III was heated at $60^0$ C under constant stirring. The experiment was carried out at room temperature ($26^0$ C). Solution IV was added drop wise in Solution III under constant stirring. The beaker was sealed at this condition for half an hour, to form yellowish white ZnO-Au precipitate. The precipitate was filtered and washed with deionized water and ethanol. Then it was dried at $80^0$ C. Thus gold doped ZnO nanocomposites were synthesized by co-precipitation method.

## ANTI BACTERIAL STUDIES

The antibacterial activity was evaluated against two gram positive and two gram negative bacterial cultures, being *Salmonella typhimurium*, *enterococci* and *Staphylococcus aureus* ,*Klebsiella pneumoniae* respectively(clinically isolated micro organisms from The Microbiological Laboratory,Coimbatore).Two replicas of the respective micro organisms were prepared by spreading $10^6$ CFU / ml of revived culture inoculums on the nutrient agar plates. A well of 7 mm diameter was made. 20µlitres concentrations of the synthesized ZnO-Au nanoparticles were deposited in the wells. In one well tetracycline was deposited as control. Zones of Inhibition (ZOI) were measured after 24 hours of incubation at 35 degrees using the standard dilution micro method.

## CHARACTERIZATION

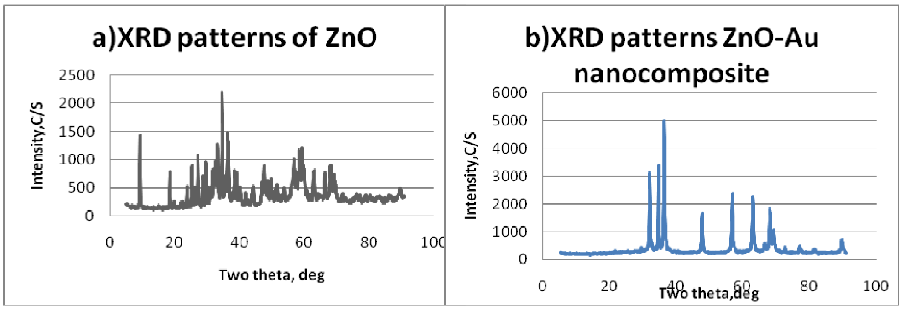
Atomic absorption spectroscopy was used to for finding the particle size and AFM was used to calculate inter atomic distance, absorption, diffraction of the crystal and for studying the surface morphology of the synthesized sample. The X-ray diffraction analysis was carried out on a Siemens powder diffractometer model. The morphological characterization was done by scanning electron microscope (SEM).

## RESULTS AND DISCUSSIONS

ZnO-Au nanocomposities was synthesized and the precipitate appears as yellowish white color. Characterization of the synthesized nanocomposite was done by using AFM, UV absorption Spectroscopy, XRD and SEM.

The X-ray diffraction analysis was carried out for all synthesized samples, but only diffractograms for pure ZnO and ZnO-Au with highest gold loading are shown in Fig. 1. The refinement with Powder Cell software shows the presence of ZnO in studied samples. The diffraction peaks of gold in the studied range should be sought at 2ϴ of $9.30017^0$, $33.1316^0$, $34.6416^0$, $34.7073^0$, $34.7729^0$, $36.4142^0$, $58.6044^0$ and $59.3265^0$ corresponding to the crystal planes. Broad peaks are observed, due to the high dispersion of gold and the small particle size. As a result, most of them are overlapped by ZnO diffraction peaks. As expected, the gold peaks were not observed in the XRD patterns of other ZnO-Au nanocomposites, due to the low content of gold.

**Fig.1. X-ray diffraction patterns of pure (a) ZnO and (b) ZnO-Au.**




SEM images were taken at 10µm, 4µm, 2µm.The SEM images depicted in Fig. 2 show that crystal morphology is observed for ZnO-Au nanocomposites with the highest gold loading. Characterization of ZnO nanoparticle was done by using Atomic Force Microscopy and the Particle size was 37.62nm.The UV absorption spectroscopy revealed an absorption spectra of 545.45 nm.

**Fig.2.SEM image of ZnO-Au nanocomposite.**

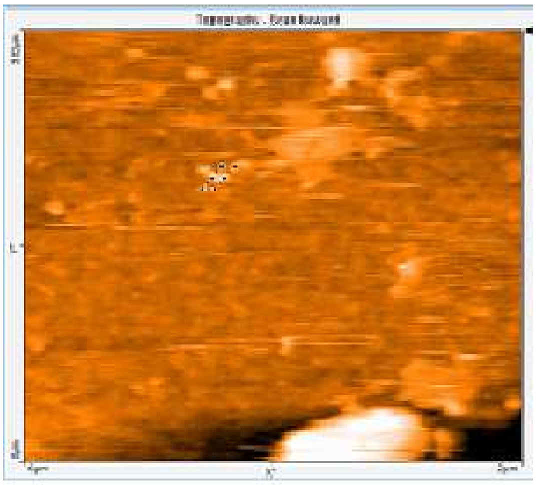


**Fig.3. AFM of ZnO-NPs.**

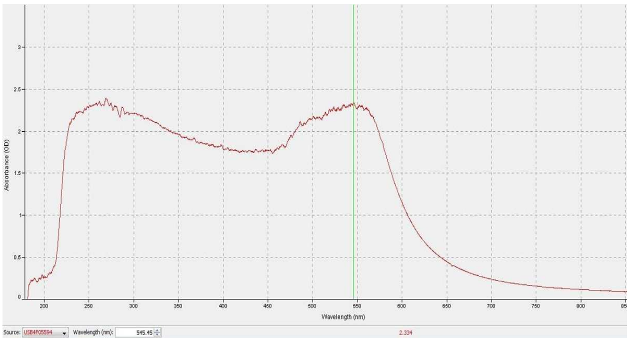


**Fig.4. UV absorption Spectroscopy for Au nanoparticles**

## ANTI-BACTERIAL STUDIES

The antibacterial effects against two Gram positive and two Gram negative bacterium were studied by determining the zone of inhibition (ZOI). Zone of Inhibition (mm) were found to be 26 mm for Salmonella typhi, 22 mm for *Klebsella pneumonia*, 16 mm for *Enterococci* sps and 34 mm for *Staphylococcus aureus* respectively. Thus, the inhibitory effects of the synthesized ZnO-Au nanocomposites are revealed.

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**Fig.5. ZOI of *Staphylococcus aureus***

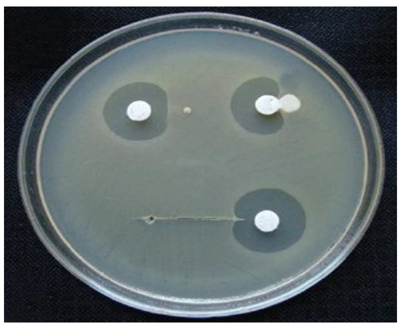

**Fig.6. ZOI of *Enterococci sps***

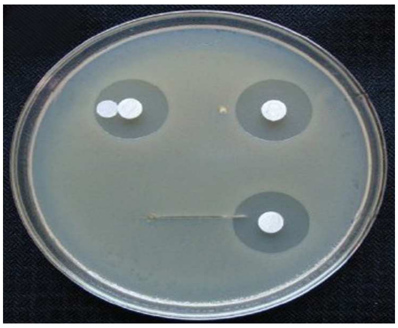

**Fig.7. ZOI of S. aureus**

**Fig.8.ZOI of Klebsella pneumonia**

## CONCLUSIONS

Thus ZnO-Au nanocomposites were prepared by Co-precipitation method and yellowish white precipitate indicate the formation of ZnO-Au nanocomposites. Characterization were done by using AFM, UV absorbsion Spectroscopy, SEM and XRD to determine the particle size, absorbsion, morphological studies and crystalline structure.

The synthesized ZnO-Au nanocomposites by co-precipitation method, have great promise as antimicrobial agents, which can find versatile applications in the fields such as medical devices and antimicrobial systems.

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