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A FACILE GREEN SYNTHESIS OF ZnO NANORODS USING LEAF EXTRACT OF FICUS HISPIDA L.

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Abstract- **During the past decade, green nanotechnology has received attracted attention due to minimize the use of toxic chemicals for preparation of nanomaterials. Among all green protocols, the plant mediated synthesis of ZnO nano rods offers numerous advantages such as eco-friendliness and biocompatibility for pharmaceutical, biotechnological and biological applications. In this paper, for the first time, we report an eco-friendly, cost-effective and simple method for the synthesis of ZnO nanorods using aqueous leaf extract of *Ficus Hispida* L. As synthesized ZnO nanorods were characterized using various analytical techniques such as UV-Visible (UV-Vis) spectroscopy , Fourier transform-infra red (FTIR) spectroscopy, powder X-ray diffraction (XRD), field emission scanning electron microscopy (FE-SEM), and transmission electron microscopy (TEM). The FTIR and UV-Visible spectroscopic technique confirms the formation of ZnO nanorods. The powder XRD patterns confirmed the formation of phase pure ZnO nanorods with wurtzite structure.**

Keywords— **Zinc Oxide Nanorods, Green Synthesis, *Ficus Hispida* L. Leaves,**

I. INTRODUCTION

Toxic and carcinogenic chemicals such as dyes, pesticides effluents from paper, textile and agro-industries, when contaminated with water causes water pollution. Water pollution not only effect the ecosystem but also severe hazard to human health[1-2].However, waste-water containing dyes is very difficult to treat, since the dyes are recalcitrant organic molecules, resistant to aerobic digestion and are stable to light, heat and oxidizing agents. Adsorption, membrane filtration are the traditional water treatment methods are unsuccessful for complete removal of dyes and also produce secondary pollutants. For large scale treatment of polluted water, a new emerging, cost-effective method is photocatalysis . Nano semiconductor photocatalysts are used in the photocatalysis method[3]. Among nano semiconductor photocatalysts, ZnO nano particles (ZnO nanorods) have more advantages due to their attractive properties such as cost-effective, nontoxic, ecofriendliness, natural abundance,high photocatalytic activity,high photosensitivity, wide band gap energy of 3.3 eV, high exciton binding energy of 60 meV, UV blocking ability and high stability. ZnO nano rods used as solar cells [4-5], gas sensors [6], photodiodes [7], photodetectors [8], light emitting diodes [9], ZnO nano rods also exhibit antibacterial activity against food related bacteria such as B.subtilis, E.coli, Hence ZnO nano rods have remarkable applications in the fields of agriculture , food. ZnO nano are synthesized by electrophoresis , Sol-gel method, chemical vapour deposition, physical vapour deposition, microwave assisted thermal decomposition[10-14]. These conventional methods used for synthesis of ZnO Nano rods are expensive and hazardous to environment due to involvement of various hazardous chemicals responsible for many health problems. Hence there is need to develop ecofriendly, cost-effective , easy available, biocompatible, high stable, one pot green method. The green synthesis method growing as a main branch of nano science and nanotechnology. In the green synthesis method the use of plant extracts, microbes, fungi used for synthesis of ZnO Nano rods. Plant mediated green synthesis of ZnO nanorods has attracted and more attention of researchers recently due to cost effective and non toxic. Many reports are available for synthesis of ZnO nanorods using plant extracts such as Jacaranda mimosifolia, Aloe vera, Euphorbia prolifera, rambutan(Nephelium lappaceum L.) peel, Carissa edulis extract, Anchusa italic, Solanum nigrum, Tribulus terrestris, Terminalia chebula, Carica papaya[15-24] .

We synthesize first ZnO Nano rods using aqueous leaf extract of *Ficus Hispida* L. *Ficus Hispida* L. belongs to Moraceae family. the leaves of *Ficus Hispida* L. particular interest from a medicinal point of view as cardioprotective, hepatotoxicity , anti-inflammatory, antidiarrheal, and anti-ulcer drug[25-30]. Leaf extract of *Ficus Hispida* L. carbohydrates, alkaloids, sterols, amino acids,flavonoid, coumarin,proteins,phenols,saponins. Phytochemical present in leaf extract of *Ficus Hispida* L. can act as reducing and capping agent for formation of ZnO nano rods.

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Ficus Hispida L. plant

II. EXPERIMENTAL

A. **Materials**

Zinc acetate (Zn $(CH_3COO)_2$ and Sodium hydroxide (NaOH) were obtained from Merck, India and used without further purification. The leaves of *Ficus Hispida* L. were collected from local forest of Chintapalli, Andhra Pradesh, India Botanical aspect of leaf materials were identified and authenticated by plant taxonomist Dr. S. B. Padal, Associate professor, Andhra University, Visakhapatnam, A.P, India. Throughout the synthesis process Milli-Q water was used.

B. Preparation of plant extract

Ficus Hispida L. fresh leaves were washed several times with running tap water and followed by Milli-Q water ,then the leaves were shade dried for 20 days. The dried leaves were made powdered using blender. The extract was prepared by dissolving 5 grams of leaves powder of *Ficus Hispida* L. in 100 ml Milli-Q water and the solution was boiled for 20 min at 60 ^{0}C. Then the aqueous leaves extract was filtered through the Whatman NO.1 filter paper and the filtrate was stored at 4 ^{0}C .

C. **Synthesis of ZnO nanorods**

0.5g of $Zn(CH_3COO)_2$, 10 mL of 5 % aqueous leaves extract of *Ficus Hispida* L. and 80 mL milli-Q water were added in 250 mL Erlenmeyer flask . Then stirred the reaction mixture on water bath for 60 minutes at 70 ^{0}C. The reaction mixture was added 10 mL of 1M NaOH in drop wise then that mixture turned in to a white coloured precipitate(ZnO nanorods), which was followed by filtered and washed with milli-Q water twice and once with ethanol. Then finally the obtained ZnO nanorods was dried under vacuum at room temperature.

D. **Characterization**

The absorption spectra of ZnO nanorods were measured by 2450 – SHIMADZU UV-Visible spectrophotometer. Functional groups presented in *Ficus Hispida* L. leaf extract act as reducing and capping agents for the formation of ZnO nanorods identified by using SHIMADZU-IR PRESTIGE-2 FTIR instrument. The crystalline structures of ZnO nanorods were determined using powder X-ray diffractometer (PANalytical X'pert pro diffractometer). The crystallographic structure and morphologies of ZnO nanorods were characterized by Field emission scanning electron microscopy (JEOL JSM-7600F FEG-SEM). Morphology and size of ZnO nanorods were determined by using (FEI Technai 20 U Twin).

III. RESULT AND DISCUSSION

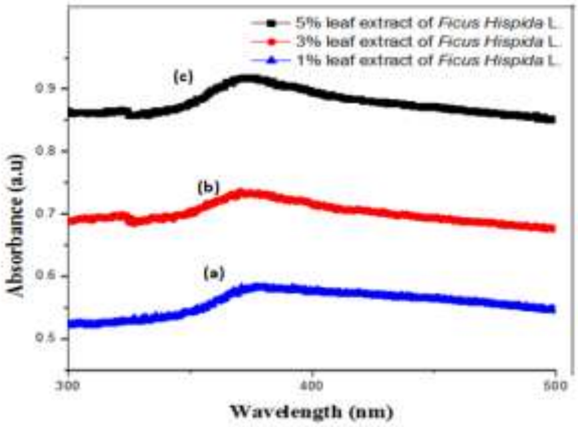


Fig. 1(a-c) UV-Vis absorption spectra of ZnO nano rods synthesized by using 1%,3%,5% aqueous leaf extract of *Ficus Hispida* L. respectively.

Fig.1 indicates the UV-Vis absorption spectra of ZnO nanorods synthesized using 1%, 3% and 5% aqueous leaves extract of *Ficus Hispida* L. The characteristic absorption peak of ZnO nanorods was observed at 375 nm.

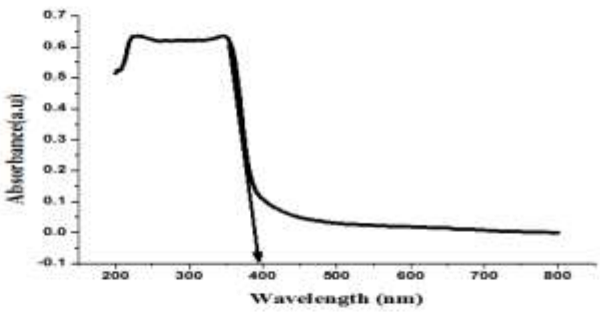


Fig.2 UV- diffusible reflectance spectra of ZnO nano rods.

Fig.2 indicates the synthesized ZnO nanorods having 3.15 eV band gap. Fig. 3(a) indicates FTIR spectrum of aqueous leaves extract of *Ficus Hispida* L. and synthesized ZnO nanorods. FTIR spectrum of the aqueous leaves extract of *Ficus Hispida*

L. exhibited characteristic stretching frequencies at 3433, 2926, 1436, 1315, and 1054 cm^{-1}, which are ascribed to the presence of O-H group of phenolic compound, and C-H group of alkanes respectively.

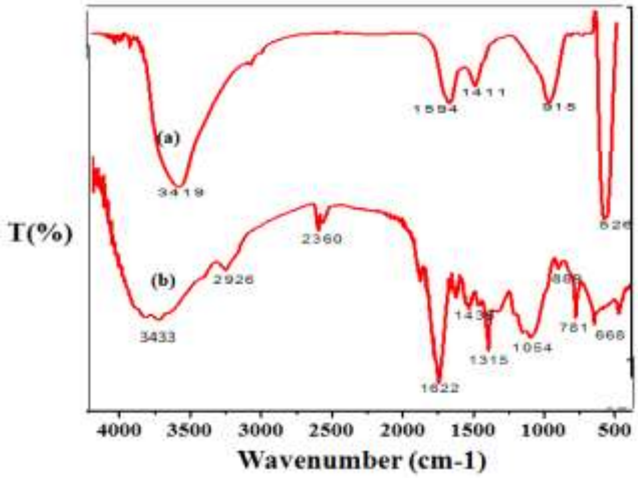


Fig.3(a) FTIR spectrum of *Ficus Hispida* L leaf powder and (b) FTIR spectrum of synthesized ZnO nano rods

Based on FTIR spectrum of aqueous leaf extract of *Ficus Hispida* L. indicated the presence of alkaloids, phenols and carbohydrates which were mainly responsible for the preparation of the ZnO nanorods .The Fig. 3(b) shows, the characteristic bands for ZnO nanorods shifted compared to aqueous leaf extract of *Ficus Hispida* L. The bands due to O-H group of phenol, was shifted from 3433 to 3419 cm^{-1} and It is also observed that the bands associated to C=C group of aromatic compounds (1436 to 1411 cm^{-1}) and C-O stretching of phenolic group (1054 to 907 cm^{-1}) were shifted compared to aqueous leaf extract of *Ficus Hispida* L. The additional band was observed at 526 cm^{-1} ascribed to Zn-O stretching vibration of ZnO nanorods. This indicates that the phytoconstituents present in aqueous leaf extract of *Ficus Hispida* L. were act as reducing and capping agent for ZnO nanorods.

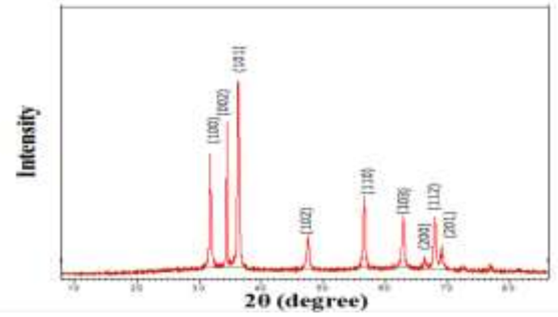
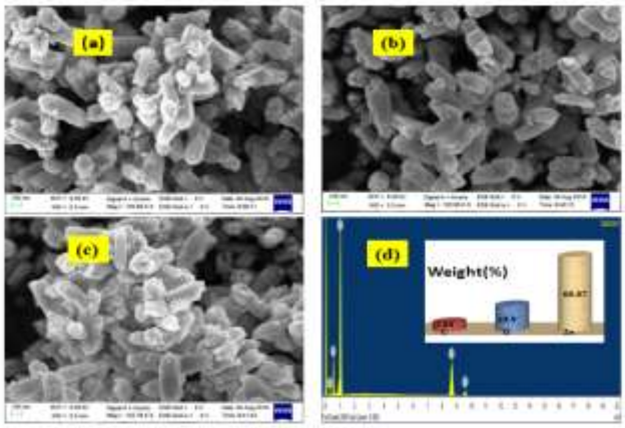


Fig .4 Powder XRD patterns of synthesized ZnO nano rods

Fig.4. shows the powder XRD pattern of ZnO nano rods using aqueous leaves extract of *Ficus Hispida* L. The Bragg reflection peaks of ZnO nano rods were observed at 2θ values of 31.76^0, 34.42^0, 36.27^0, 47.51^0, 56.59^0, 62.90^0, 66.39^0, 67.98^0 and 69.16^0 which could be indexed as (100),(002),(101), (102), (110), (103), (200), (112), and (201) planes of wurtzite phase of pure ZnO nano rods (JCPDS, File No. 36-1451). The average crystallite sizes of the ZnO nano rods were determined by the Scherrer equation (Eq. 2)

$$D = k\lambda / \beta\cos\theta \qquad \text{(Eq.2)}$$

Where D is particle diameter size, β is the full width at half maxima (FWHM), k is a constant equals 1, λ is wavelength of X-ray source (0.1541 nm), and θ is the diffraction angle corresponding to the lattice plane. According to Scherrer equation with the width of (101) plane, the average crystallite size of ZnO nano rods is found to be 35.68 nm.



5(a-c) FE SEM images of ZnOnano rods synthesized using aqueous leaf extract of *Ficus Hispida* L. and (d) EDS spectrum of ZnO nano rods.

Fig 5(a-c) shows FESEM images and EDS of ZnO nanorods. FESEM images of ZnO nanorods were found as nano rod shape. Fig 5(d) shows The EDS spectrum indicates the presence of Zinc (Zn), Carbon (C) and Oxygen (O) confirm the formation of ZnO nanorods. Fig 6(a-b) shows TEM images of ZnO nano rods. The morphology of the ZnO nano rods was found to be nano rods with average particle size 50 nm. Fig 6(c) shows the histogram of ZnO nano rods. Fig 6(d) shows the selected area electron diffraction (SAED) pattern of the ZnO nano rods .

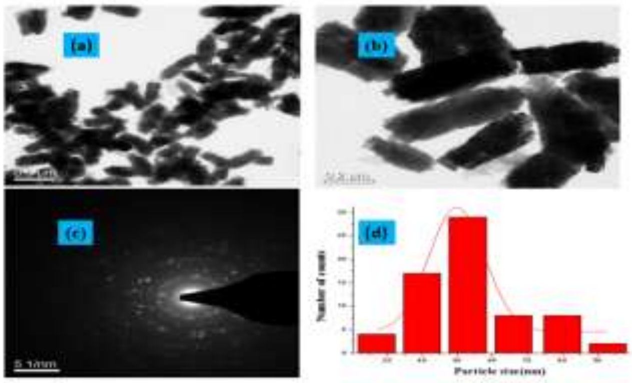


Fig.6(a-b). TEM images of synthesized ZnO nano rods (c) SAED of synthesized ZnO nano rods(d) Histogram of ZnO nano rods.

IV. CONCLUSION

We synthesize first ZnO Nano rods using aqueous leaf extract of *Ficus Hispida* L. The obtained ZnO nano rods shows characteristic absorption band at 375 nm. The band gap of ZnO nano rods was 3.15 eV. The synthesized ZnO nano rods are having wurtzite phase with 35.68 nm average crystallite size. From FESEM,TEM study we found that ZnO having nano rod shape with average particle size 50 nm.

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