© 2018 IJSRSET | Volume 4 | Issue 1 | Print ISSN: 2395-1990 | Online ISSN : 2394-4099
Themed Section : Engineering and Technology

Green Synthesis of ZnO Nanoparticles their Structural and Biological Applications

Rajesh Siddanna[1], Hajeebaba K. Inamdar[1*], Archana Mugalgaon[2], M.V.N. Ambikaprasad[2]
[1]Department of P. G. Studies and Research in Physics, Reshmi College , Kalaburagi, Karnataka, India
[2]Department of P. G. Studies and Research in Physics, Gulbarga University, Kalaburagi, Karnataka, India

ABSTRACT

Green synthesis of multifunctional Zinc oxide nanoparticles (NPs) were prepared by low temperature solution combustion route employing Aleo vera leaves extract as fuel. The resulted ZnO NPs were characterized by PXRD, FTIR, The Morphologies were carried out by SEM. The obtained NPs were subjected to antibacterial activity studies. PXRD pattern shows the hexagonal wurtzite structure of the final product. The particle size was analyzed by PXRD and it was found to be in the range of 20-38nm. SEM images indicated the formation of various shaped ZnO NPs. The antibacterial studies indicated that ZnO NPs of concentration 500, 750 and 1000 μg resulted in significant antibacterial activity on E. coli, S.aureus in agar well diffusion method. The current investigation demonstrated green engineering method for the synthesis of multifunctional ZnO NPs with interesting morphologies, antibacterial ausing Aleo vera leaves extract.

Keywords: ZnO Nps, XRD, SEM, TEM & antibacterial studies.

I. INTRODUCTION

Current development in nanotechnology has engineered nanomaterials that are possibly safe toward human welfare. The application of nanotechnology is endless with a multidisciplinary facet comprising molecular diagnostics, catalysis, electronics, drug delivery, sensing and surfaces-enhanced Raman scattering and cancer [1-3]. The early phase of this technology amalgam both physical and chemical methods for the synthesis of nanomaterials using toxic chemicals and harsh reaction conditions. These nanostructures have the affinity to release harmful by-products into the environment leading to toxicological issues [2]. To overcome this, there is a need for clean, non-toxic, bio-compatible and environment friendly materials synthesized via ‘green’ approach. ZnO nanostructures can be easily prepared in various shapes and sizes using different chemical methods [8–10]. Due to good thermal stability, high specific surface area, can be used as a SPME active material in the sorbent phase for pre concentration and determination of a wide range of organic compounds [2-3]. Nanostructure metal oxides are known to have a unique ability [1]
to promote faster electron transfer kinetics between the electrode and the active site of the desired species [3-4]. Among the metal oxide nanoparticles, zinc oxide (ZnO) nanoparticles have been exploited as a potential material for biosensing because of their unusual properties such as high surface area for strong adsorption (high isoelectric point of 9.5), good biocompatibility, chemical sta- bility[5-7]

Zinc oxide (ZnO) is one of the most appropriate semiconducting materials with a wide band gap (3.37 eV), As a result, a variety of ZnO structures with different morphologies and dimensions have been fabricated. Self-assembly of micro/nano/super structures of ZnO have wide practical/potential applications.

II. EXPERIMENTAL

2.1 Preparation of Plant extract

Freshly collected leaves Aleo vere plant were first washed thoroughly with pure tab water several times and distilled water twice before extraction. The leaves of Aleo vera plant were then collect the aleo vera gel. The resulting extract was cooled to room temperature preared :2 raio of Aleo vera and Deionized water then it was used as the fuel for the green combustion synthesis ZnO NPs.

2.2 Bio-Mediated Synthesis of ZnO Nanoparticles

The Zinc oxide nanoparticles were synthesized by 'self-propagating low temperature combustion method', employing Zinc nitrate ($Zn(NO_3)_2.6H_2O$)) as precursor and Aloe-Vera gel as a fuel. In fact 2.97 g of Zinc nitrate was taken in 300 ml petri-dish and 10 ml of Aloe-Vera gel was added to the petri-dish and kept on a magnetic stirrer for ~10 min. The uniform mixture of both oxidizer as well as the fuel was then introduced into the pre-heated muffle furnace kept at 450 ^{0}C. The mixture boils with froth yielding finally a black powder of ZnO nanoparticles. The average particle size of the ZnO was found by Debay Sherer Method to be ~15 nm.

2.3 Characterization

Phase purity and crystallinity of ZnO structures were studied using a powder X-ray diffractometer (XRD, Shimadzu 7000), Cu k_α(1.541Ǻ) radiation with Zinc filter was used. Scanning electron microscopy (SEM), Transmission electron Microscopy(TEM) Fourier Transmission Infrared Spectroscopy(FTIR) and biological Applications.

III. RESULTS AND DISCUSSION

3.1.Structural analysis

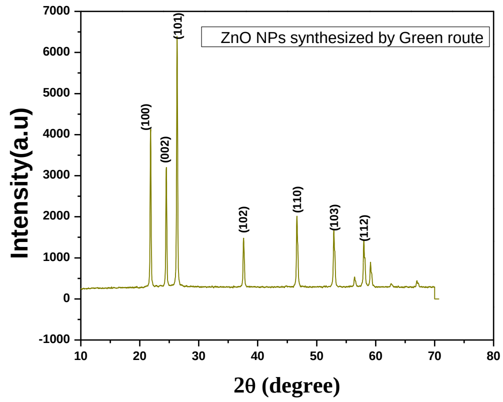

Figure 1. X-ray Diffraction Pattern of Polyaniline

Figure 1 depict the PXRD patterns and Williamson – Hall plots of ZnO NPs prepared with different M.P concentrations (5 – 30 ml). The characteristic diffraction peaks of ZnO including (100), (002), (101), (102), (110), (103), (200) and (112) were observed for all the samples. In addition, all the diffraction peaks are well assigned to the hexagonal Wurtzite phase ZnO (JCPDS card No. 36-1451) [2]. The presence of the high intensity peaks inferred that the products were highly crystalline in nature. Additionally, the XRD patterns confirm that no extra peaks were detected under the different sonication conditions.
Diffraction pattern peaks of the material was analysed by using Debye–Scherer equation,

$$d = {k\lambda}/{\beta \cos \theta} \qquad \text{---------------- (1)}$$

Where, D is crystalline size, λ is wavelength of X-ray, β is full-width at half-maximum and θ is angle of diffraction. The average crystallite size of synthesized ZnO was found to be 34 nm.
Figure 1 (b) shows the W-H plot of ZnO sample. The calculated value of D and Scherer's formula is 28.24 nm [3-4].

3.2 FTIR spectroscopy

Figure 2 shows FTIR spectra of ZnO nanoparticles. Infrared studies were carried out in order to ascertain the purity and nature of the metal nanoparticles. FT-

IR is an effective method to reveal the composition of products. Figure No. is a typical FTIR spectrum of pure ZnO nanoparticls, the peak at 398cm-1 is the characteristic absorption of Zn-O bond and the broad absorption peak at 2450 cm-1 can be attributed to the characteristic absorption of hydroxyl. These data are similar to the results observed by others [5]. Anyhow, the FTIR and XRD results show high purity of the obtained ZnO nanoparticles. ZnO nanoparticles synthesized by plant extract ,which was aquired in the range of 400-4000 cm-1 .The band between the 390-450 cm-1 corelated to metal oxide bond ZnO. From this FTIR we can also observe that increasing the annealing temperature sharpens of the characteristic peaks for metal oxide, sugesting that, the crystalline nature of ZnO increases on increasing the calcination temperature. The peaks in the range of 1350-1400cm-1 corresponds to the C=O bonds. The adsorbed band at 1359 cm-1 is assigned O-H bending vibrations. The peak at 1359m1 and and higher cm-1 corresponds to C=O and O-H bending vibrations respectively diminishes gradually for sample annealed at higher temperature[4].

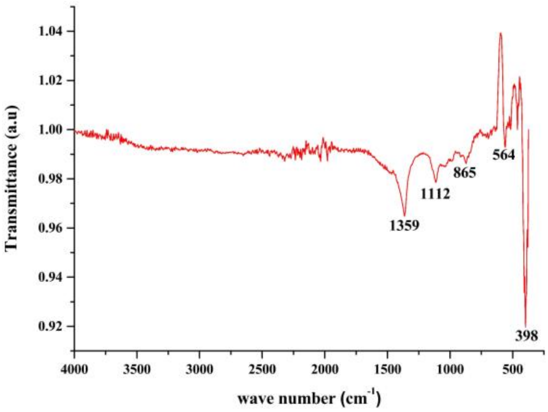

Figure 2. FTIR of pure ZnO nanoparticles

3.3.Microscopic Tchniques

surface morphology of the obtained ZnO, was studied by SEM and TEM. The SEM images (figure 3(a) and figure 3(b) elemental analysis of ZnO nanoparticles Figure 3 (c)&(d)shows the TEM and SAED image and was obtained the particle size was nearly 32nm arly uniform spherically shaped particles. Its good agreement between the XRD analysis and TEM which was given approximately the particle size in the range of nanometer only.

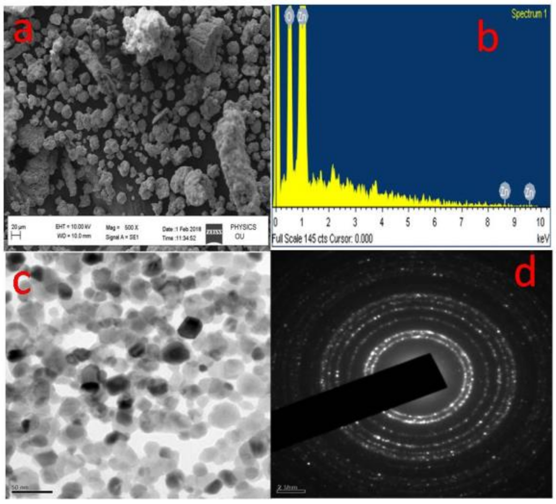

Figure 3. Micrograph of (a)SEM (b)EDS (c)TEM & (d)SAED of pure ZnO nanoparticles

4.Antibacterial assay of green synthesized ZnO NPs

Figure 5 (a) shows the antibacterial activity of ZnO nanoparticles prepared using 20 ml of Aleo vera. extract under two different pathogenic microorganisms. ZnO NPs were showed significant inhibition against E. coli,and S.aureus. In relation to MBC test, E. coli again showed a higher susceptibility to ZnO nano-structures (0.00025 μg/mL) than to E. coli (2.5 μg/mL) with 0.0025 μg/mL of ZnO prepared with plant extract (20 ml) and it showed identical results to the MIC test for both agents [8].

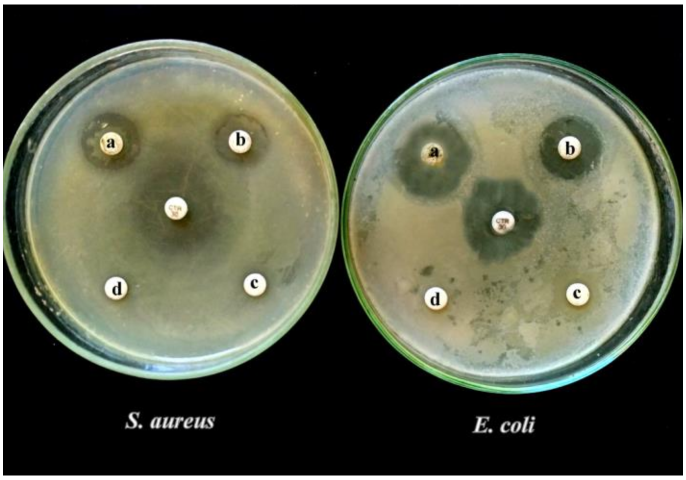

Figure 5(a). Antibacterial activity of ZnO nano particles prepared with two different pathogenic bacteria (E. coli, S.aureus).

IV. CONCLUSIONS

The ZnO nano-structures were synthesized by green combustion route using Aleo vera leaf extract as a fuel to study antibacterial studies. The crystal size of ZnO NPs was found to be in the range of 20-38nm. It was also obtained that the crystal size calculated from PXRD pattern was in strong agreement with the value obtained by Debye – Scherer method and TEM results.

In relation to MBC test, E. coli again showed a higher susceptibility to ZnO nano-structures (0.00025 μg/mL) than to E. coli (2.5 μg/mL) with 0.0025 μg/mL of ZnO prepared with plant extract (20 ml) and it showed identical results to the MIC test for both agents

V. REFERENCES

[1]. I.O. Sosa, C. Noguez, R.G. Barrera, J. Phys. Chem. B 107 (2003) 6269-6975.

[2]. Y.G. Sun, B. Mayers, T. Herricks, Y.N. Xia, Nano Lett. 3 (2003) 955-960

[3]. Hajeebaba K Inamdar1,, H. Nagabhushana2, Basavaraja Sannakki1, R.D. Mathad1 * Materials Today: Proceedings 3 (2016) 3850-3854.

[4]. Sharanabasamma M Ambalagi*, Hajeebaba K Inamadar and Basavaraja Sannakki*, Materials Today: Proceedings 3 (2016) 3945-3950

[5]. A. Ingle, A. Gade, S. Pierrat, C. Sonnichsen, M. Rai, Curr. Nanosci. 4 (2008) 141- 144.

[6]. N. Duran, P.D. Marcato, O.L. Alves, G. Souza, J. Nanotechnol. 3 (2005) 1-7.

[7]. H.Rajanaika et.al, Journal of Taibah University for Science,9,(2015)7-12.

[8]. D.suresh et.al, Spectr. Acta Part A: Molecular and Biomo. Spectro., 136 (2015) 1467-74

[9]. S. Park, R.S. Ruoff, Nature Nanotechol. 4, 217 (2009).

[10]. Guixiang Du, Xiaoxu Wang, Lidong Zhang, Yan Feng, Yan Li, Mater. Lett. 96, 128 (2013).