International Journal of PharmTech Research
CODEN (USA): IJPRIF, ISSN: 0974-4304
Vol.7, No.2, pp 287-290, 2014-2015

Antifungal activity of pure and aluminium doped zinc oxide nanoparticles against aspergillus nigar and aspergillus flavus

N. Srinivasan[1]*, J. C. Kannan[2] and S. Satheeskumar[3]

[1*]Department of Physics, Kongu engineering college, Perundurai, Erode, Tamilnadu, - 638 058, India
[2]Department of Physics, KSR Institute for engineering and technology, Tiruchengode - 637 215, India
[3]Department of Physics, Sri Shanmugha College of engineering and technology, Sankari, Salem – 637304, India

Abstract: The present work aimed for estimating the antifungal activity of pure and aluminium doped zinc oxide nanoparticles. Antifungal activity of all the prepared nanoparticles was probed against aspergillus nigar and aspergillus flavus. The nanoparticles were prepared by soft chemical method. The growth of aspergillus nigar was controlled by pure zinc oxide nanoparticles and zone of Inhibition diameter value was found maximum 11 mm for 100µg/ml. The aluminium doped zinc oxide nanoparticles were inhibited the growth of aspergillus flavus. The nanoparticles were characterized by ultraviolet spectroscopy, photoluminescence spectroscopy and energy dispersive X-ray spectroscopy.
Key words: Antifungal activity, zinc oxide nanoparticles, UV spectroscopy and soft chemical method.

1. Introduction

Zinc oxide nanoparticles are multifunctional materials. Zinc oxide nanoparticles are cost effective n-type semi conductors with wurtzite structure[1]. Zinc oxide nanoparticles have unique optical properties[2]. The doping of elements with zinc oxide nanoparticles enhance their properties. The elements such as Al, Mg and Ni were doped with zinc oxide nanoparticles[3-5]. The methods such as microwave method and chemical synthesis were widely employed for the synthesis of zinc oxide nanoparticles[6, 7]. Researchers have researched for the development of cost effective antifungal agents. The antibacterial activity of zinc oxide was probed by many researchers[8, 9]. The antifungal effects of zinc oxide nanoparticles were also tested[10, 11].

The present study has been aimed to prepare pure and aluminium doped zinc oxide nanoparticles by soft chemical method. The antifungal activity of the prepared nanoparticles was tested against two pathogenic fungi (aspergillus nigar and aspergillus flavus).

2. Experimental details

2. 1. Preparation and characterization

Analytical grade reagents obtained from Merck chemicals were used without further purification. The zinc nitrate hexahydrate [$Zn(NO_3)_2.6H_2O$] was used as host precursor. The aluminium nitrate nonahydrate [$Al(NO_3)_3.9H_2O$] was used as dopant precursors. The sodium hydroxide [NaOH] and pure de-ionized water were used in precursor solutions. The nanoparticles were prepared by soft chemical method. The precursor solution was allowed for 24 hours reaction time at room temperature. The resulting precipitate was purified

with de-ionized water. It was dried at air for 3 hours for the preparation of nanoparticles. The growth temperature was chosen as 120 °C. The prepared nanoparticles were pure and aluminium doped zinc oxide nanoparticles. The synthesized nanoparticles were characterized by ultraviolet spectroscopy, photoluminescence spectroscopy and energy dispersive X-ray spectroscopy.

2. 2. Antifungal activity

Antifungal activity of the samples was tested against the strains aspergillus nigar and aspergillus flavus by disc diffusion method. The wells were loaded with 25, 50, 75 and 100 µg/ml of nanoparticles. The diameter of zone of inhibition of the samples was estimated.

3. Results and discussion

3. 1. UV-vis absorption spectra analysis

The UV-vis absorbance spectra of prepared samples were shown in Figure 1. The absorption peaks present in the individual samples and band gap values were listed in Table 1. The absorption peak values were in close agreement with the reported values[3, 7]. The band gap values calculated were larger than that of bulk and substantiated the formation of small size particles. The decrease in particle size originates from the quantum confinement effect. The blue shift was observed in the absorbance spectra of nanoparticles. The absorption peak was observed at 360 nm in sample a. The incorporation of aluminum decreased the value of absorption peak at 327 nm. The band gap of the nanoparticles were calculated by $E_g = [(hc)/(\lambda e)]$ eV.

Table 1. Measured parameters from UV absorption spectra of the samples.

Sample	Absorption wavelength(nm)	Band gap (eV)
a	360	3.45
b	327	3.79

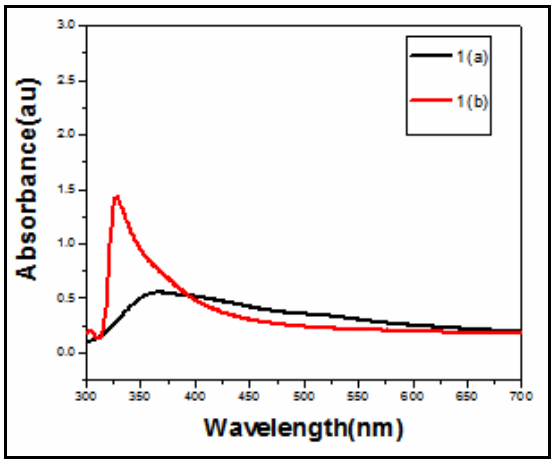

Figure 1. UV-vis absorbance spectra of (a) pure, (b) Al doped ZnO nanoparticles.

3. 2. Photoluminescence spectra analysis

The room temperature photoluminescence spectra of the prepared nanoparticles all the samples were shown in Figure 2. The photoluminescence analysis was used to discover the optical quality of the samples. The peaks at 382 nm and 369 nm were revealed the presence of UV near band edge emission in the samples a and b. These peak positions agreed well with the reported values[7]. The peaks around 380 nm was due to free exciton recombination in zinc oxide nanoparticles. The broad green emission peaks at 570 nm (sample-a) and 510 nm, 591nm (sample-b) were associated to the intrinsic defects of the samples. The presence of broad peaks showed that the samples were with less intrinsic defects.

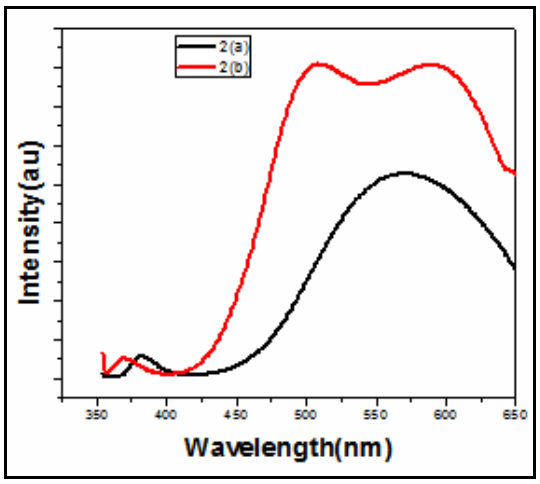

Figure 2. Photoluminescence spectra of (a) pure, (b) Al doped ZnO nanoparticles.

3. 3. EDAX analysis

EDAX spectrum of aluminium doped zinc oxide nanoparticles was shown in Figure 3. The peaks for Zn, Al and O were clearly seen in the EDAX analysis. The EDAX analysis confirmed the incorporation of Al in the prepared nanoparticles. There was no impurity peaks in samples.

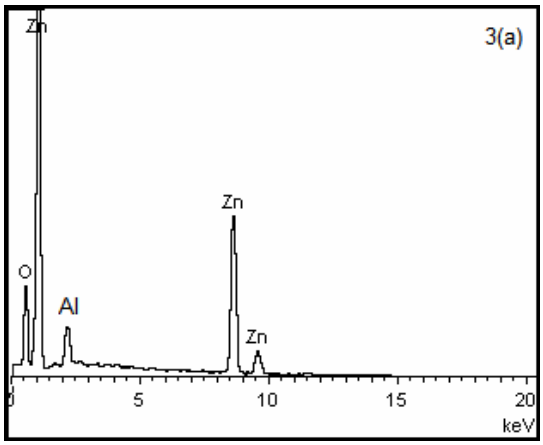

Figure 3. EDAX spectra of (a) Al doped ZnO nanoparticles.

3. 4. Antifungal studies

The disc diffusion method was employed in antifungal studies of prepared nanoparticles. The antifungal activity of the nanoparticles was tested against aspergillus nigar and aspergillus flavus. The Zone of inhibition diameter values of the nanoparticless were determined and tabulated in Table 2.

Table 2. Zone of inhibition diameter of nanoparticles (mm).

Strains	Diameter -Zone of Inhibition (mm)							
	a				b			
	25	50	75	100	25	50	75	100
Aspergillus nigar	4	6	7	11	0	0	0	0
Aspergillus flavus.	0	0	0	0	6	7	8	13

The mechanism of antibacterial activity was elucidated in many research works[8]. The entry of nanoparticles in cell membrane was reported for the reason of massive cell death. The prepared nanoparticles were highly reactive due to their high surface-to-volume ratio. The formation reactive oxygen species (ROS) was responsible for the increase in the permeability of the cell membrane.

The increase in permeability of membrane brought a distrubtion of activity of cell membrane and enables the cell death. The DNA code of the micro-organisms was also affected by the nanoparticles. The antifungal activity of zinc oxide nanoparticles were examined by few researchers[10, 11].

The zone of Inhibition diameter values were measured for four different concentrations (25, 50, 75 and 100 µg/ml). The fungal inhibition was increased with increase in the concentration of nanoparticles. The pure zinc oxide nanoparticles were most effective against aspergillus nigar. The growth of aspergillus nigar was not controlled by samle-b. The aluminium doped zinc oxide nanoparticles were controlled the growth of aspergillus flavus.

4. Conclusion

In conclusion, the antifungal activities of prepared nanoparticles were investigated against aspergillus nigar and aspergillus flavus. The pure zinc oxide nanoparticles were found to be efficient fungicide against aspergillus nigar. The aluminium doped zinc oxide nanoparticles were active against aspergillus flavus. The zone of Inhibition diameter value of pure zinc oxide against aspergillus nigar was found maximum 11 mm for 100µg/ml. The zone of Inhibition diameter value of aluminium doped zinc oxide against aspergillus flavus was found maximum 13 mm for 100µg/ml. The increase in permeability of membrane enables the cell death. The DNA code of the microorganisms was also affected by the nanoparticles. In UV-Vis spectra analysis, the incorporation of aluminum decreased the value of absorption peak (327 nm). PL studies showed the presence intrinsic defects in the prepared nanoparticles. The zinc oxide and aluminium doped zinc oxide nanoparticles can be used as good fungicides.

References

1. Raoufi, D., Synthesis and microstructural properties of ZnO nanoparticles prepared by precipitation method, Renewable Energy, 2013, 50, 932-937.
2. Ma, M. G., Zhu, Y. J., Cheng, G. F. and Huang, Y. H., Microwave synthesis and characterization of ZnO with various morphologies, Materials Letters, 2008, 62, 507-510.
3. Saravanakumar, K. and Ravichandran, K., Synthesis of heavily doped nanocrystalline ZnO:Al powders using a simple soft chemical method Journal Materials Science: Mater Electron, 2012, 23, 1462-1469.
4. Justin Raj, C., Karthick, S. N., Hemalatha, K. V., Son, M., Kim, H. and Prabakar, K., Magnesium doped ZnO nanoparticles embedded ZnO nanorod hybrid electrodes for dye sensitized solar cells, Journal of Sol-Gel Science and Technology, 2012, 62, 453-459.
5. Pazhanivelu, V., Selvadurai A. P. B. and Murugaraj, R., Effect of Ni Doping on Structural, Morphological, Optical and Magnetic Properties of $Zn_{1-x}Ni_xO$ Dilute Magnetic Semiconductors, Journal of Superconductivity and Novel Magnetism, 2014, doi:10.1007/s10948-014-2499-y.
6. Krishnakumar, T., Jayaprakash, R., Pinna, N., Donato, N., Bonavita, A., Micali, G. and Neri, G., CO gas sensing of ZnO nanostructures synthesized by an assisted microwave wet chemical route, Sensors and Actuators B, 2009, 143, 198-204.
7. Giri, P. K., Bhattacharyya, S., Chetia, B., Panigrahi, B. K., Nair, K. G. M. and Iyer P. K., Novel Low Temperature Chemical Synthesis and Characterization of Zinc Oxide Nanostructures, Journal of Nanoscience and Nanotechnology, 2008, 8,1-5.
8. Sharma, N., Kumar, J., Thakur, S., Sharma, S. and Shrivastava, V., Antibacterial study of silver doped zinc oxide nanoparticles against Staphylococcus aureus and Bacillus subtilis, Drug Invention Today, 2013, 5, 50-54.
9. Vidic, J., Stankic, S., Haque, F., Ciric, D., Goffic, R., Vidy, A., Jupille, J. and Delmas, B., Selective antibacterial effects of mixed ZnMgO nanoparticles, Journal of Nanoparticle Research, 2013, 15, 1595-1605.
10. Chitra, K. and Annadurai, G., Antimicrobial activity of wet chemically engineered spherical shaped ZnO nanoparticles on food borne pathogen, Int. Food Research Journal, 2013, 20(1), 59-64.
11. He, L., Liu, Y., Mustapha, A. and Lin, M., Antifungal activity of zinc oxide nanoparticles against Botrytis cinerea and Penicillium expansum, Microbiological Research, 2011, 1, 2011, 66, 207-215.

*****