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OPTICAL PROPERTIES OF ZINC OXIDE NANOPARTICLES USING *ALLIUM CEPA* EXTRACT

R. Zema Ferin, G. Joesna, T. Gunachitra, D. Sankar and M. Gulam Mohamed*

Department of Physics, The New College (Autonomous), Chennai-600014.
*****Corresponding author email: mgulammohamed@gmail.com

Abstract: ZnO NPs is synthesized via eco-friendly synthesis using *Allium cepa* extract with simple solvothermal method using a domestic microwave oven. Lattice parameters are determined by carrying out X-ray powder diffraction measurements. The band gap energy (E.g.) curve with a band gap of 3.35 eV and absorption spectrum of ZnO NPs. Optical properties of green synthesized ZnO may be used in nano and opto-electronic devices.

***Keywords*:**Allium cepa, Domestic microwave oven, ZnO, XRD.

1.INTRODUCTION

Nanotechnology is a developing area of science which much attentions on the manipulation of matter at nanoscale [1]. It is a multidisciplinary field, provides a great platform to generate and novel engineer materials with distinctive properties [2-3]. Significantly, the applications of nanoscale materials are expanding because of their peculiar behavior of optical, electrical and mechanical properties. Nanomaterial attracts the attention of many chemists and scientists due to its attractive size-dependent properties. However, it is challenging to synthesis a nanomaterial with uniform shapes and sizes in a simple and economical way [4]. Recently, some synthesis methods are excellent in controlling the required properties and size of nanomaterials which are wet chemical method, sol-gel method, co-precipitation method, solution combustion synthesis, hydrothermal reaction, spray pyrolysis and ball-milling technique, etc., [5]. Particularly, the green synthesis method is an environmentally friendly and cost-effective approach so researchers are keen to get nanomaterials in the method. In the present investigations, a new approach of domestic microwave method to synthesize ZnO NPs using *Allium cepa*extract as a reducing and capping. The success of the synthesized material was confirmed by the results of XRD. Optical properties of the synthesized NPs were also investigated.

2. EXPERIMENTAL

The Bulb Onion, *Allium cepa* is herbaceous biennial plant belonging to the family Amaryllidaceae. After collection, *A.cepa* were washed thoroughly in clean water. The onion skin is peeled and the inner fleshly bulb is grated into fine small pieces by using a stainless steel grater, then collected in small cotton cloth and pressed gently on the upper end of the cloth. The obtained onion extract is filtered by using Whatmann filter paper and collected in clean vial for further experiment.

All chemicals used for the synthesis were of high-quality grade materials without further purification. The stoichiometric ratio of zinc acetate and urea were taken as 1:3, then dissolved in 1:1 ratio of ethylene glycol (EG) and *Allium cepa* as mixed solvent in order to obtain a homogeneous solution. The prepared solution was thoroughly stirred magnetically for about 1 hour. The solution was kept in domestic microwave oven (2.45 GHz microwave irradiation and 600 W power output) until the solution evaporates. The pale yellow semi-colloidal precipitate was achieved within 16 minutes. Upon cooling to room temperature, the precipitate was washed many times with double distilled water and acetone to remove any organic residues. The dried powder was placed annealed in a muffle furnace at 200 °C to for 2 hours.

3.RESULTS AND DISCUSSION

3.1 Powder X-ray Diffraction

The powder X-ray diffraction (PXRD) patterns were recorded using PANalytical X'Pert Pro X-ray diffractometer equipped with CuKa radiation (λ = 1.5418 Å). X-ray diffraction patterns of the prepared ZnO powders as displayed in Figure 1, exhibit well-defined and relatively broad peaks, signifying the formation of nanocrystalline phase. The observed peaks can be indexed as (100), (002), (101), (102), (110), (103), (200), (112), and (201) reflections of the hexagonal wurtzite-type structure of ZnO phase, in agreement with JCPDS card No. 36-1451 [6]. No additional peaks can be detected within the resolution

\limit of the XRD apparatus, thereby indicating the formation of ZnO phase without any impurities. The crystallite size has been calculated which is 23 nm.

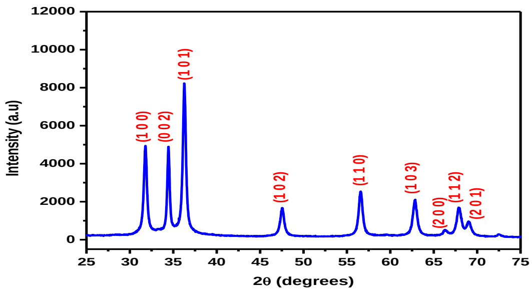

Figure 1. *Powder XRD of ZnO-A. cepa nanoparticles*

3.2 UV-Vis Spectral Analysis

Optical property of the present nanoparticles was studied by Shimadzu UV-2400 PC spectrophotometer. The UV-Visible study was executed to find the optical qualities of the green synthesized ZnO nanoparticles. The absorption spectrum of the present nanoparticles is displayed in Figure 2. The low absorption edge is observed in the UV region for the ZnO NPs. The absorption peak at 370 nm indicates the charge transfer from the valence band to conduction band in the sample. A significant absorption for the ZnO nanoparticles confirms the quantum confinement of nanoparticles. The corresponding energy band gap value was 3.35 eV hitch was calculated using Tauc plot, as shown inFigure 3. The energy band gap depends on the size ofthe particles. The present material may be useful to the opto-electronic applications

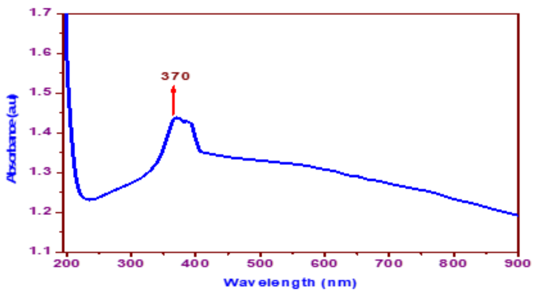

Figure 2. *Optical absorption spectrum of ZnO-A. cepa nanoparticles*

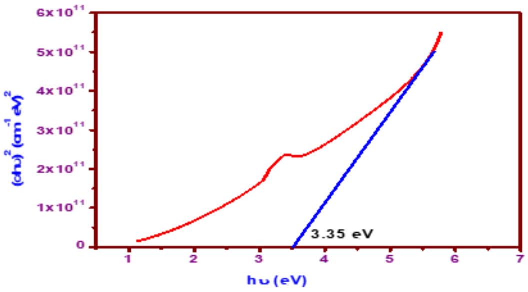

Figure3. *Plot of (αhv) 2 versus hv for ZnOA. cepa nanoparticles*

3.3 Photoluminescence

Instrument LS-45 Fluorescence spectrometers was used for photoluminescencestudy. The large band gap semiconductor of ZnO has been broadly used in luminescent devices due to its luminescence in the visible range. The photoluminescence (PL) spectrum of the ZnO nanoparticles in room temperature was examined at the excitation wavelength of 350 nm. Generally, the particle size, shape and crystal surface state are important fact to play the PL properties of particles. From Figure 4, a very small peak is observed the near excitonic emission at 360 nm and the emission peak at 402 nm for green synthesized ZnO nanoparticles is due to the deep trap occurred by the recombination of electrons at the internal oxygen vacancy donor energy level with the holes trapped at the internal zinc vacancy acceptor energy level. The high crystalline with lower concentration of defects benefit the intensities of emission. The ZnO nanoparticles with higher crystallinity perfection in order to reduce the defect mechanisms controlling the optical properties.

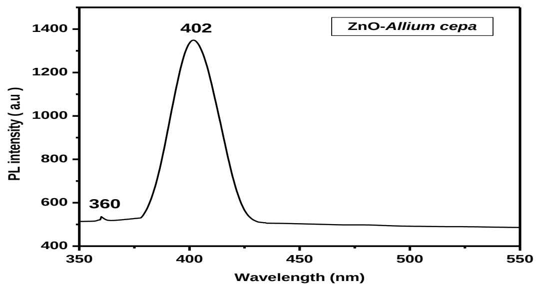

Figure 4. *The photoluminescence spectrum of ZnO-A. cepa nanoparticles*

4.CONCLUSION

The nanoparticles of ZnO were synthesized through cost-effective solvothermal method using domestic microwave oven and *Allium cepa*extract acting as reducing and stabilizing agent. The X-ray diffraction study confirmed the formation of hexagonal wurtzite structure with narrow mean crystallite size was 23 nm. Optical quality of the nanoparticles was confirmed by UV-Vis and PL spectrum which is important for the fabrication of opto-electronic devices.

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