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Research Article

ENERGY DRINK MEDIATED LOW TEMPERATURE COMBUSTION SYNTHESIS AND CHARACTERIZATION OF ZINC OXIDE NANOPARTICLE

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ABSTRACT
Eco-friendly, cost effective and bio template route was used to synthesize Zinc Oxide nanoparticles (NPs) using *i-charger* energy drink (15ml) by modified combustion method. Prepared samples were characterized for structural, morphological and compositional details. PXRD pattern confirmed the hexagonal wurtzite structure of the product with the average crystallite sizes of about ~20 nm. The SEM images shows non-uniformity, agglomeration morphology. EDX spectra confirms the perfect purity of the ZnO NPs. The UV-Visible absorption spectra consists absorption peak at 214 and 362 nm. The estimated energy band gap using Wood and Tauc's relation is 2.74 eV. The Photoluminescence spectra recorded at 350 nm excitation consists high intensity peak at 401 nm and a less intense peak at 433 nm. Since both high intense and low intense peaks are in blue region, this might be a good phosphor material for display applications.

Keywords: *i-charger* energy drink; ZnO; Nanoparticles; Green synthesis.

1. INTRODUCTION
Zinc oxide (ZnO) semiconductor materials have attracted a lot of attention in optoelectronics applications because of its relatively large band gap [1]. ZnO is a good candidate for solid-state white illumination because of its high emission efficiency [2]. In solar cells, it is currently employed as a transparent conductor [3]. It is also an active ingredient in varistors and UV-absorbing substance in sunscreens [4, 5]. At room temperature, ZnO crystallizes in Wurtzite structure with *p63mc* space group and the lattice parameters a = 0.324 nm, c/a = 1.602 [6].
ZnO offers a number of practical advantages that make it a desirable industrial material. Large single crystals may be generated quite easily in comparison to GaN [7]. ZnO is utilized as a food additive in animal feed and has a lesser environmental impact and toxicity than most other semiconductors. ZnO is economically competitive for transparent conductor applications due to its lower cost than Indium. In addition to conventional solid-state processing ZnO is prepared by many other methods [8- 16].
The development of an environmental friendly strategy for the manufacture of nanophosphors has been aided by a growing awareness of green chemistry and other biological processes. For the synthesis of nano-phosphors, environmental friendly materials such as plant leaf extract, bacteria, fungus, enzymes and repeatable microbes offer various advantages in terms of eco-friendliness and compatibility for pharmaceutical and other biomedical applications [17-21]. *i charge* energy drink is formulated with 5 different herbs including the Kanna, Ashwagandharishta, Balarishta, Patrangasava and Drakshasava. The present investigation reports the synthesis of ZnO nanophosphors by ecofriendly, inexpensive and bio-mediated solution combustion route using *i charge* energy drink (15 ml) as a fuel. The sample was characterized and photo-luminescence emission property was discussed in detail.

2. MATERIAL AND METHODS
2.1. Synthesis and characterization of ZnO nanoparticles
Stoichiometric amount of $Zn(NO_3)_3.6H_2O$) was dissolved in minimum quantity of double distilled water and mixed with 15 ml of *i-charge* energy drink. This

mixture is placed in a muffle furnace that has been warmed to 320°C for 30 minutes. The reaction mixture boils, froths, and dehydrates thermally, generating ZnO NPs, and the entire process took less than 4 minutes. The sample was characterized with different techniques and analyzed.

3. RESULTS AND DISCUSSION

3.1. PXRD analysis

Fig.1 depicts the PXRD pattern of light yellowish colored ZnO NPs. The diffraction peaks are well indexed to hexagonal wurtzite crystal structure (JCPDS No. 80-0075) with space group *P63mc* [22]. In addition to ZnO peaks, few peaks (002), (101), (102), (103) and (110) corresponding to metallic zinc are also observed [23]. No other impurity peaks were detected. The average crystallite size estimated by using the Scherrer's equation was found to be 25 nm [24].

3.2. Morphological analysis

The SEM images of ZnO NPs at different magnification are shown in Fig.2. The SEM image consists few hexagonal shaped ZnO NPs along with irregular shaped NPs. The particles are slightly agglomerated in nature.

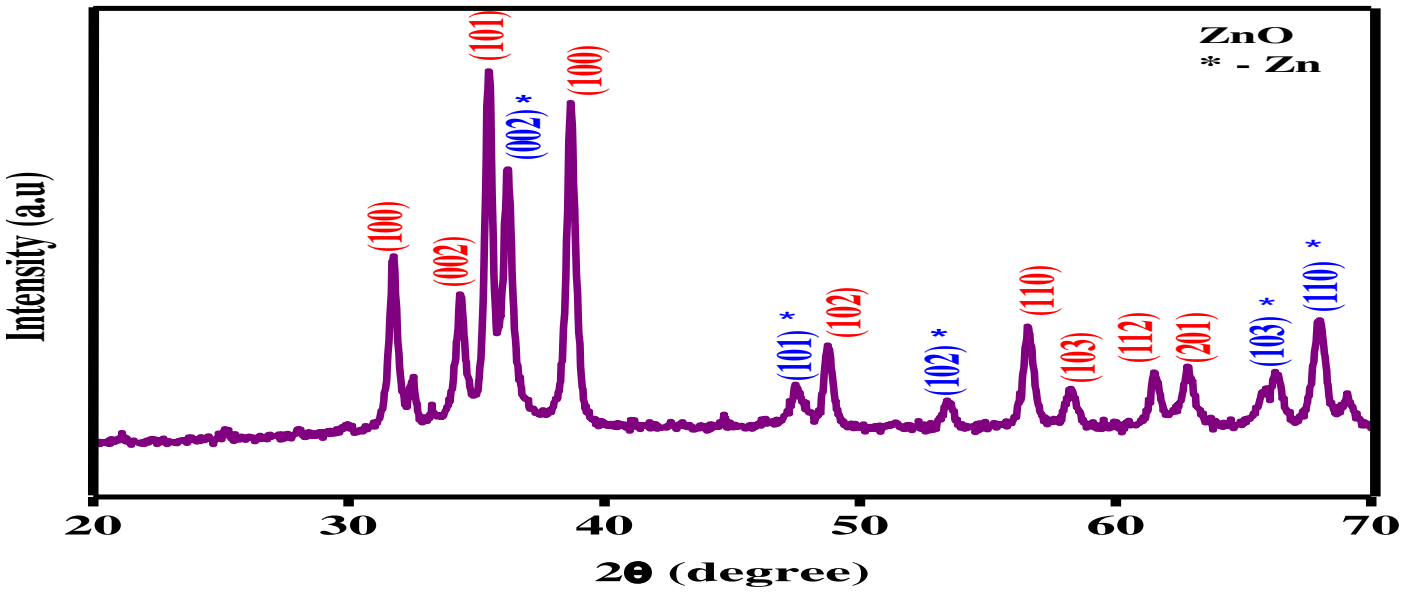

Fig. 1: PXRD analysis of ZnO NPs

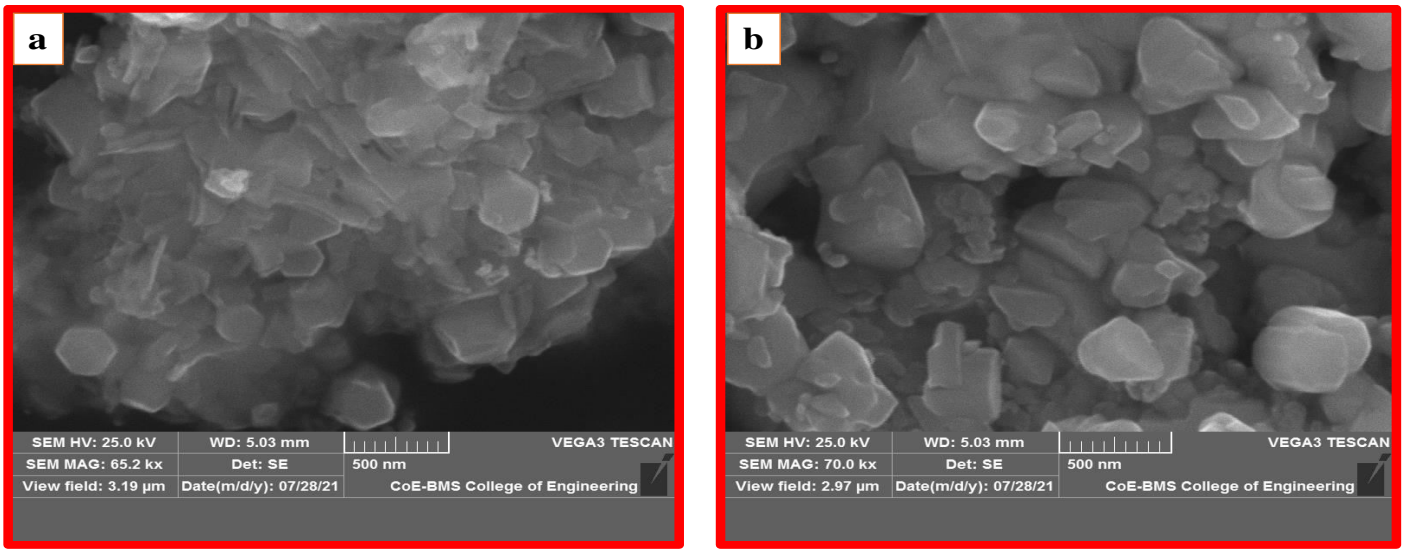

Fig. 2: SEM image analysis of ZnO NPs at different magnification (a and b)

3.3. FTIR analysis of ZnO NPs

Fig. 3 shows the FTIR spectra of ZnO NPs possessing a series of absorption peaks from 500-4000 cm^{-1}. The IR absorption peak and the corresponding assigned group is given in Table 1 [25].

3.4. UV-Visible absorption spectra of ZnO NPs

Inset of Fig.4 represents the UV-Visible absorption spectra of ZnO NPs. The UV-Visible absorption spectra consists two strong absorption peaks at 222 and 367 nm. The band gap energy the sample was determined by using Wood and Tauc's relation by plotting the graph between $(\alpha h\nu)^2$ Vs Energy (eV). The estimated direct energy band gap was found to be 2.74 eV.

3.5. PL emission analysis of ZnO NPs

The room temperature PL spectra excited at 320 nm wavelength was shown in Fig. 5. The spectrum consists a strong emission band at 401 nm with a satellite peak at 433 nm. The emission band appeared at blue region is associated with oxygen vacancies or Zn interstitials. The emission at blue region clearly indicates that the present ZnO NPs might finds an application in the white light emitting diodes as a phosphor material.

Table 1: Wavenumber and Group assigned to the corresponding IR absorption peak in ZnO NPs

Sl. No	Wavenumber corresponding to IR absorption peak	Group assigned
1	3466.7 cm^{-1}	O-H stretching mode of hydroxyl group
2	1626.6 and 1381.6 cm^{-1}	asymmetrical and symmetrical stretching of the Zinc carboxylate respectively
3	1112.3 and 897.6 cm^{-1}	Zn-O stretching mode
4	2028.2 cm^{-1}	stretching vibrations of C-N functional groups of amines and C-O-C/C - O bonds of water soluble heterocyclic compounds present in the *i-charge* energy drink

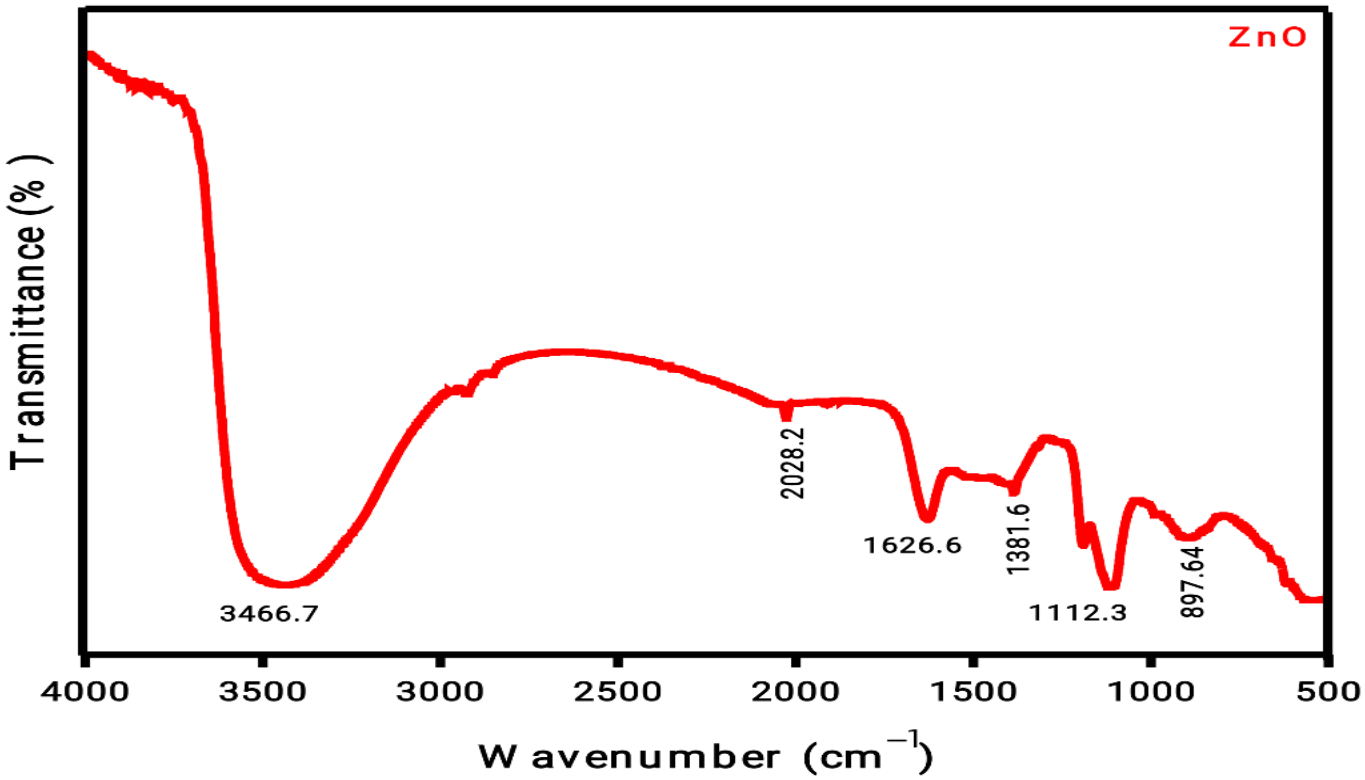

Fig. 3: FTIR spectra of ZnO NPs

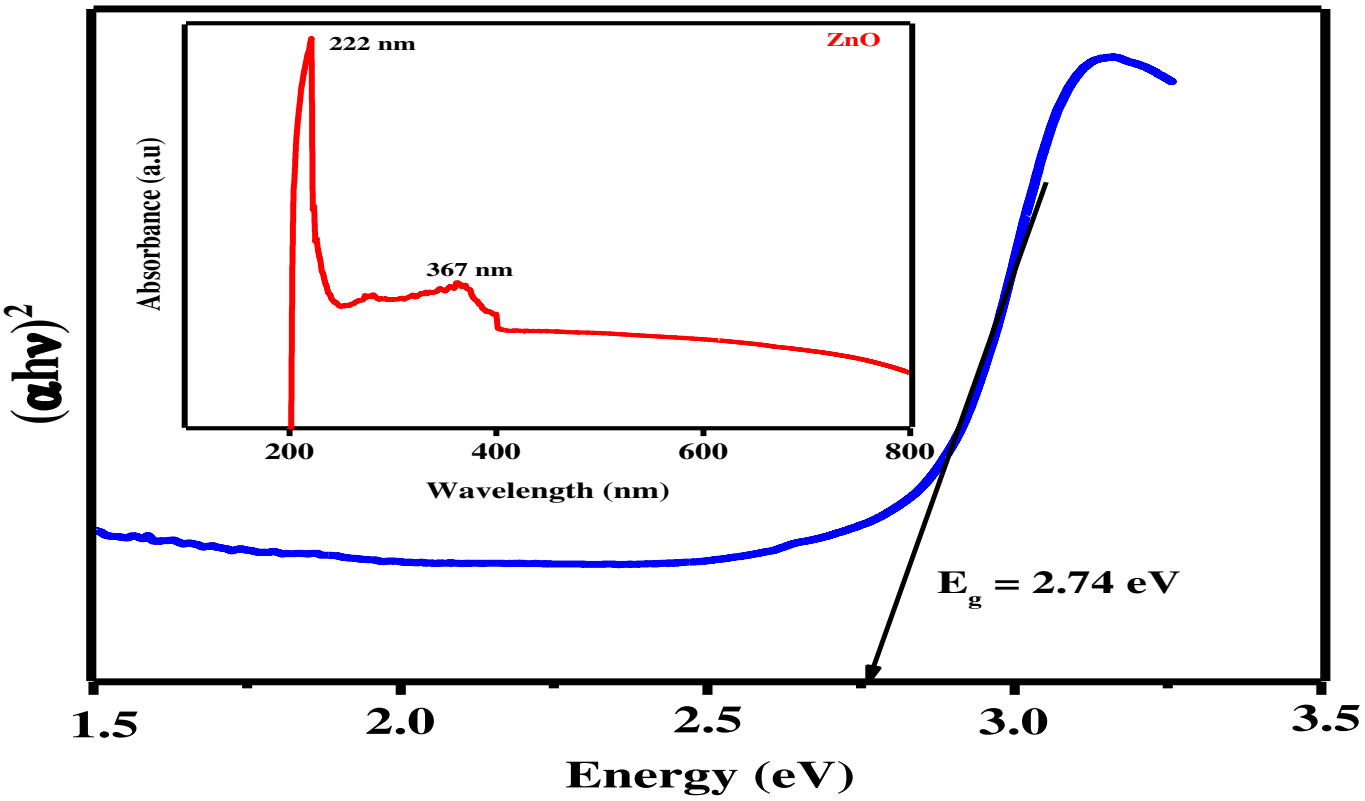

Fig. 4: Wood and Tauc's relation (Inset: UV-Visible absorption spectra of ZnO NPs)

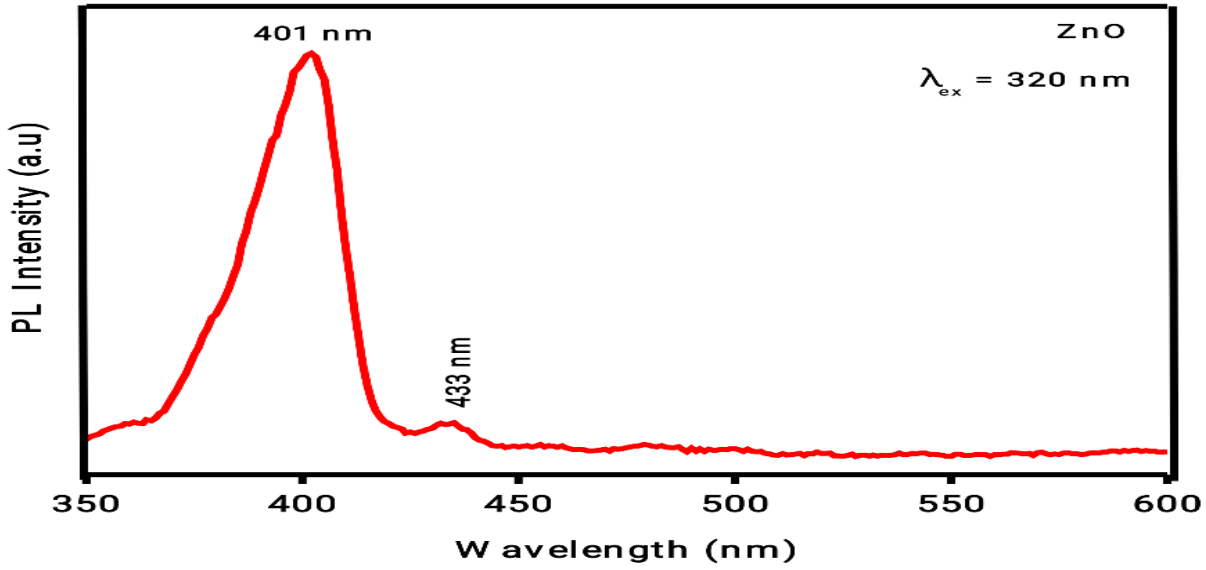

Fig. 5: PL emission spectra of ZnO NPs (λ_{ex} = 320 nm)

4. CONCLUSION

The ZnO NPs are synthesized successfully by using eco-friendly and low cost *i-charge* energy drink for the first time using solution combustion method. The synthesized sample was characterized with PXRD, SEM, FTIR, UV-Visible absorption spectroscopy. The PXRD pattern consists hexagonal Wurtzite ZnO planes along with few metallic Zinc planes. The surface morphology confirms the formation of ZnO NPs. The estimated direct energy band gap using Wood and Tauc's relation

was found to be 2.74 eV. The PL emission spectra recorded at 320 nm excitation consists sharp emission peak centred at blue region which corresponds to oxygen vacancies or Zn interstitials. The emission at blue region clearly indicates that the present ZnO NPs might finds an application in the White light emitting diodes as a phosphor material.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

5. ACKNOWLEDGEMENTS

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