Kalanchoe Tubiflora Leaf Extract - *Synthesis* of Zinc Oxide Nanoparticles

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Abstract: **Synthesis and characterisation of Zinc Oxide nanoparticles by means of green approach using the bio component of Kalanchoe Tubiflora leaves is discussed in this research paper. The sample was characterized by X-Ray Diffraction (XRD) and UV-Vis spectroscopy. XRD confirms the growth of hexagonal ZnO wurtzite structure. The size of nano crystallites calculated using Debye-Scherrer's formula as 31.6nm. Energy band gap of 3.26eV and absorption at 347nm shows the presence of Zinc Oxide nano structure.**

Keywords: **Green synthesis, nanostructure, organic solar cells, energy conversion**

I. INTRODUCTION

The concept of nanotechnology by Richard Feynman manages and manipulates functional systems at the molecular or supramolecular scale. Nanotechnology plays a vital role in the field of advanced computing, medicines, electronics, photonics, textile engineering etc. because the nanoparticles exhibit superior properties than bulk materials [1].

Metal oxide nanoparticles have many impressive properties and thereby have broad range of applications like cosmetology, sensors, including transdermal antibiotic patches etc. Having wide bandgap, large binding energy and high piezoelectric properties Zinc Oxide nanoparticles (ZnO NPs) can be employed in the field of nanomedicines, energy conversion, photo catalyst and photo oxidizing agent.

Nanoparticles can be synthesised from sol-gel method [2], inert gas condensation [3], laser ablation [4], solvothermal [5], hydrothermal [6] etc. Chemical method often involves high temperature, high pressure, inert gas atmosphere and use of toxic capping and stabilizing agents. Biological approach using plants and animals is an alternate to the chemical method for synthesising nanoparticles [7-10]. Nanoparticles exhibits higher surface area to volume ratio with diminution in the size, distribution and morphology.

Green synthesis of ZnO NPs obtained from Kalanchoe Tubiflora leaves extract which was collected from Coimbatore, Tamil Nadu, India. Studies show that Kalanchoe Tubiflora is a potential anti-cancer agent [11]. To best of our knowledge, the use of leaf extract of Kalanchoe Tubiflora for the green synthesis of ZnO NPs has not been revealed. Hence, the present work was carried out to synthesis and characterization of ZnO NPs using Kalanchoe Tubiflora leaves extract. Figure 1 shows the succulent Kalanchoe Tubiflora.

Figure 1: Kalanchoe Tubiflora plant

II. MATERIALS AND METHODS

a. Preparation of leaves extract of Kalanchoe Tubiflora

For the preparation of leaf extract of Kalanchoe Tubiflora, the leaves were washed multiple times in running water and then washed with distilled water and dried in shade. Then 20gm of cut leaves along with 100ml DI water was taken in a 250ml borosil beaker and boiled until the solution changes its colour and cooled to room temperature. Then the solution was filtered using filter paper and extract was stored in refrigerator for future synthesis.the synthesis of ZnO nanoparticles in future.

b. ZnO nanoparticles - Green synthesis

20ml of leaf extract was heated for 10 min at 50^{o}C and 0.1M zinc acetate was added to the extract slowly under stirring. The mixture was cooled and washed a number of times with DI water followed by ethanol and acetone. The filtered sample was smashed in a mortar-pestle so as to get a finer nature for categorisation and heated for 2 hours at 120^{o}C. Figure 2 shows the green synthesised ZnO NPs.

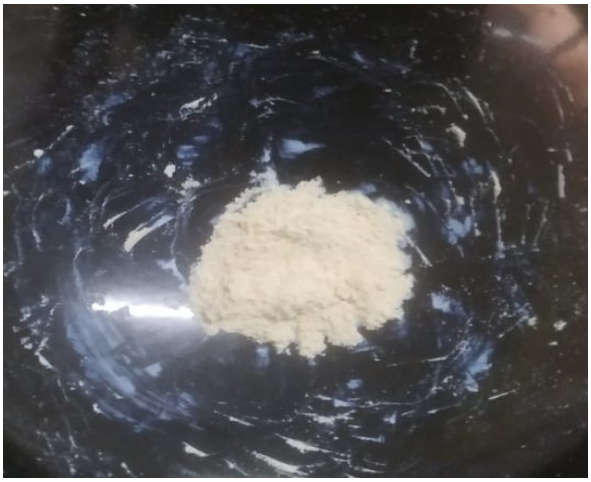

Figure 2: ZnO nanoparticles

III. RESULTS

X-ray Diffraction (XRD)

X-Ray Diffraction pattern was obtained using a CuKa1 X-Ray Diffractometer for checking the presence of ZnO and investigate the structure. From the XRD patterns analysis, we determined peak intensity, position and width, full-width at half-maximum (FWHM) data. The graph shows main peaks corresponding to 2θ values of 36.20°, 34.40° and 31.72° shown in Figure 3. It indicates that the samples were polycrystalline wurtzite structure. All measurable peaks can be indexed to ZnO wurtzite structure (JCPDS File No.89-0510). Lattice parameters such as *d*, the distances between adjacent crystal planes (hkl), were calculated from the Bragg equation, $\lambda = 2d \sin\theta$. The lattice constants *a*, *b*, and *c*; the inter-planar angles, the angle ϕ between the planes (h_1 k_1 l_1) of spacing d_1 and the plane (h_2 k_2 l_2) of spacing d_2 ; and V, the primary cell volumes, were determined from the Lattice Geometry equation. The (101) and (100) planes were used to calculate the lattice parameters of the prepared ZnO-NPs, and the following values were obtained: $d_{(101)} = 0.2475$ nm, $d_{(100)} = 0.28135$ nm, a = b = 0.3249 nm, c = 0.5206 nm, $\phi = 90°$, and V = 47.58 nm^3 .

Using the Scherrer equation, $D = (k\lambda/\beta_{hkl}\cos\theta)$, the crystalline sizes of the ZnO-NPs was calculated where D is the crystalline size in nanometres (nm), λ is the wavelength of the radiation (1.54056 Å for CuKα radiation), k is a constant equal to 0.94, β_{hkl} is the peak width at half-maximum intensity, and θ is the peak position. The (101) plane was selected to calculate the crystalline size (either plane can be used). The crystalline sizes of the ZnO-NPs were observed to be 31.6nm.

Moreover, it also confirms that the synthesized nano powder was free of impurities as it does not contain any characteristics XRD peaks other than ZnO peaks.

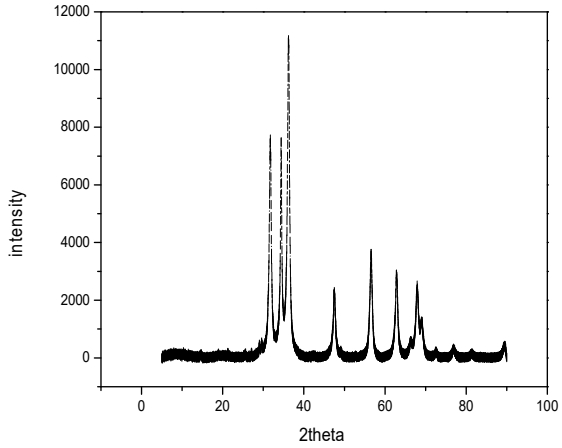

Figure 3: XRD pattern of Zinc Oxide nanoparticles

UV-Vis Absorption Spectrum.

The size of the nanoparticles plays a crucial role in shifting the entire properties of material. UV-visible absorption spectroscopic technique is widely being used to examine the optical properties of synthesized nano particles. Figure 4 shows the absorption spectrum of ZnO nano particle which exhibits an absorption band at about 347 nm. The optical band-gap energy awas found to be 3.27eV (Tauc plot method). Bandgap energy (E_g) plays an important role in the optoelectronic application. The absorption of the ZnO-NPs in the UV region proves its applicability in medical application such as sunscreen protectors or as antiseptic ointments or in energy conversion application.

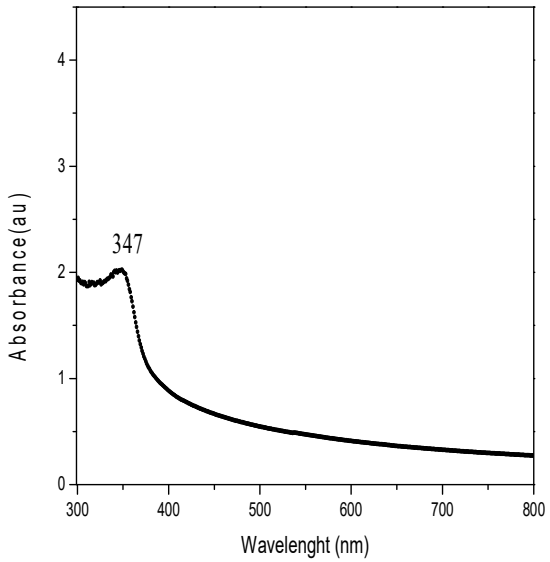

Figure 4: UV-vis spectrum of ZnO nanoparticles

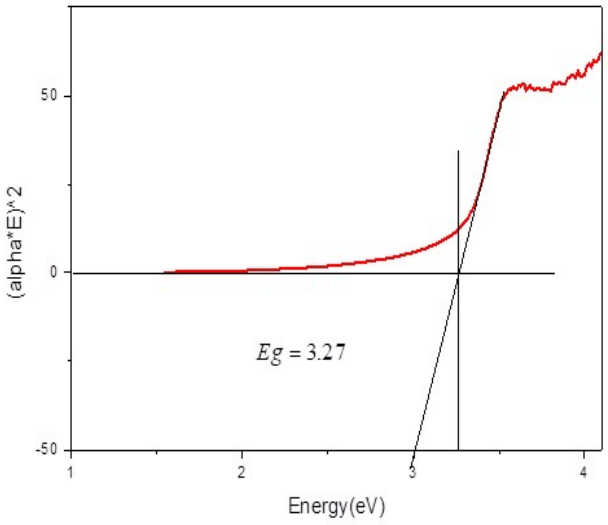

Figure 5: Bandgap energy of ZnO nanoparticles

IV. CONCLUSION

In summary, ZnO NPs are prepared by an eco-friendly, non-toxic, simple and rapid method called green synthesis method using leaves extract of Kalanchoe Tubiflora. The size and structure of nanoparticles are confirmed with XRD technique. Using Scherrer's formula the synthesised ZnO NPs crystallite size was found to be 31.6nm. In future, as synthesized ZnO NPs can be incorporated into organic a solar cell which makes them suitable for energy conversion applications.

Funding: This work was not funded by any funding agency.

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.

ACKNOWLEDGEMENTS

The authors are thankful to the members of Physics Department, Karpagam Academy of Higher Education, and Coimbatore, India for their support of this work.

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