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Studies on Green Synthesis and Characterization of Zinc Oxide Nanoparticles by Using NEEM (Azadirachta Indicia) Extract

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ABSTRACT
A promising alternative to the standard chemical approach is the production of metal oxide nanoparticles from plant extract. Use of plant materials has been considered a green route and a reliable method for the synthesis of nanoparticles owing to its environmental friendly nature. Hence an attempt has been made to synthesize the Zinc oxide nanoparticle using aqueous neem (Azadirachta indica) leaf extract. The aqueous leaf extract acts as a solvent with manifold roles as promoter, stabilizer and template for the synthesis of nanoparticles. This work aimed to synthesize zinc oxide nanoparticles. The synthesized ZnONPs were characterized by UV–Visible spectroscopy, X-ray diffraction (XRD) and scanning electron microscopy (SEM) with EDS profile. The XRD studies confirmed the presence of pure crystalline shapes of ZnO nanoparticles. X-ray diffraction (XRD) result confirmed that the synthesized ZnO nanoparticles have wurtzite hexagonal structure without any impurities. The results of the SEM studies of green synthesized ZnO nanoparticle showed the formation of spindle shaped nanoparticles and Zinc oxide nanoflakes. EDX studies confirm the chemical composition of the nanoparticles. It has also been observed that at room temperature ultraviolet visible (UV-Vis) absorption band is around 355 nm (blue shifted as compared to the bulk)

Keywords: Green Synthesis, Zinc Oxide, Nanoparticles, XRD, SEM, Metal Oxide.

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I. INTRODUCTION

According to Willard et al. (2014), nanotechnology is a modern, well-established discipline of science and engineering that refers to the nanoscale, or 1 to 100 nm. One of the most active study fields in contemporary material science is the topic of nanotechnology. Nanotechnology has emerged as the greatest advancement in science and technology over the past few decades. A nanoparticle is a tiny item that functions as a single entity in terms of its characteristics and mobility in nanotechnology. (2012) Prathna et al. In comparison to other types, metal nanoparticles are more medicinal (Sanita Banerjee, 2012). ZnO is a non-toxic substance that is utilised in a variety of industrial applications, including the environment, artificial textiles, food, packaging, healthcare, and the medical field, as well as building and decorating (Barnali Ashe, 2011). Conventional physical and chemical methods for synthesising nanoparticles have drawbacks, including the need for hazardous chemicals, costly ingredients, extended reflux times, toxic byproducts, and more. A few biomimetic methods have been developed as a result of the search for an ecologically friendly synthesis technique. The word "biomimetics" refers to the application of biological principles to the creation of materials.

The green synthesis of nanoparticles has become one of the most popular techniques in recent years and has achieved major relevance. An interesting area of nanotechnology is the green manufacturing of nanoparticles (Barnali Ashe, 2011). The organic substance in the unprocessed leaf extract and the plant source both play a role. Senthilkumar and Sivakumar (2014), Gnanasangeetha et al. (2014), Vanaja et al. (2013), Awwd et al. (2013), and Senthilkumar and Sivakumar (2014) are only a few of the studies that have been conducted on green synthesis of nanoparticles. Thus, the goal of the work is to create zinc oxide nanoparticles using Azadirachta indica, an extract from neem leaves, and to characterise them using SEM and XRD analyses.

II. MATHERIAL AND METHODS

2.1: Preparation of neem (azadirachta indicia) leaf extract

For the preparation of leaf extract, 50 gm of neem (azadirachta indicia) leaf is washed with distilled water several times to remove any dust or impurity in it and in 100 ml distilled water there leaves was boiled for about half an hour to get its extract. After this, the extract was filtered using Whatmann filter paper and required neem (azadirachta indicia) leaf extract was obtained.

2. 2: Synthesis of Zinc Oxide (ZnO) Nanoparticles using azadirachta indicia leaf extract

10.975 g of zinc acetate was dissolved in 50 ml water and 10 ml of the leaf extract was taken and the solution was stirred using a magnetic stirrer for 30 minutes to which 1M NaOH solution was added drop wise while stirring. The precipitate was then filtered and the filtered was allowed to dry in an oven for one hour at 90^0C. The dried precipitate was repeatedly washed with distilled water to remove the basicity of the solution. To get ZnO nanoparticles, calcinations were done in a muffle furnace at 500^0C for three hours.

2.3: Instrumentation

The Structural properties of the NPs were studied using X-Ray diffraction data. XRD studies in the present work were carried out at NIT Raipur using Panalytical 3KW X'pert powder-Multifunctional X-ray diffractometer. The morphological properties and elemental composition of the synthesised NPs were studied using SEM and EDS studies respectively. EDS analysis is carried out to confirm the elemental composition of constituent atoms as well as impurity atoms. The SEM and EDS studies in the present work have been done at NIT Raipur using ZEISS EVO 18 Scanning Electron Microscope and INCA 250 EDS with X-MAX 20nm detector. The optical property of the sample was examined by UV-Visible spectrophotometer (Perkin Elmer λ-45) in the wavelength range of 200-800 nm.

III. RESULTS AND DISCUSSIONS

3.1: Analysis of Structural Studies

Only ZnO-related peaks could be seen on the X-ray diffraction graph (Figure 1). Strong diffraction peaks were observed for zinc oxide nanoparticles produced by neem (azadirachta indica) leaf at 31.7, 34.4, 36.3, 47.6, 56.6, 62.9, 66.4, 68.0, 72.6, 77.0, 81.1, and 89.6 degrees of 2. All of the crystal planes (100), (002), (101), (102), (110), (103), (200), (112), (004), (202), (104), and (203) were shared by all of the biologically produced zinc oxide nanoparticles. The Scherer equation was used to calculate the average crystallite sizes of ZnO nanoparticles, which were found to be 48.2, 65.4, and 61.6 nm. The observed diffraction peaks have been classified as ZnO wurtzite hexagonal phase using standard JCPDS No. 036-1541, with maximum intensity always falling inside the (101) plane.

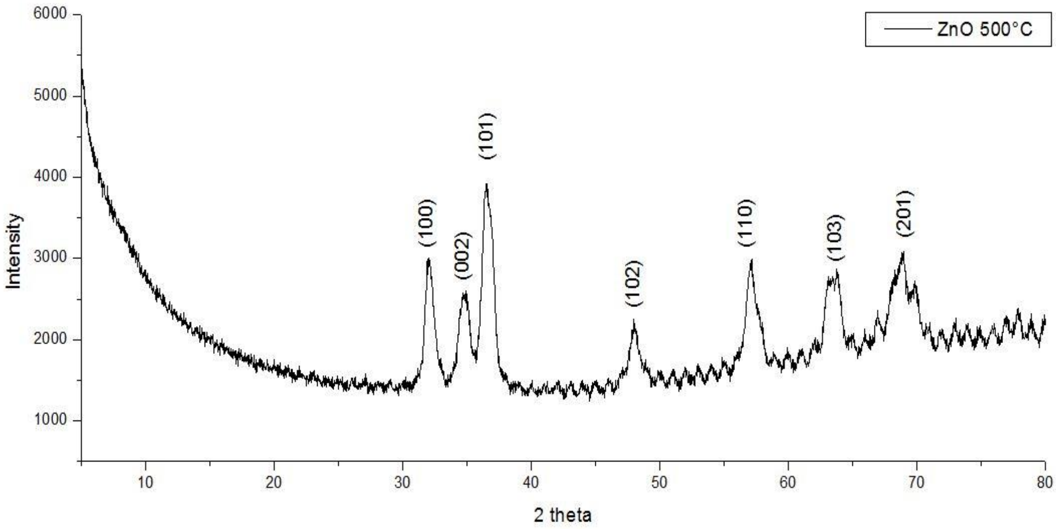

Figure 1: XRD pattern of ZnONPs with neem (azadirachta indicia) leaf extract at 500˚C calcinations temperature.

3.2: Analysis of Morphological and EDS Studies

Figure 2 represents the micrograph of the fabricated nanostructured zinc oxide powder exhibiting highly agglomerated particle forming intricate nanostructures. SEM studies on Zinc Oxide Nanoparticles synthesized using neem (Azadirachta indica) leaves extract revealed the formation of stable Zinc oxide nanoflakes and spindle shaped nanoparticles. EDS results of the nanostructured zinc oxide powder elemental study illustrated in Figure 3. It showed a weight percentage of 64.44 % zinc and 35.56 % oxygen atoms.

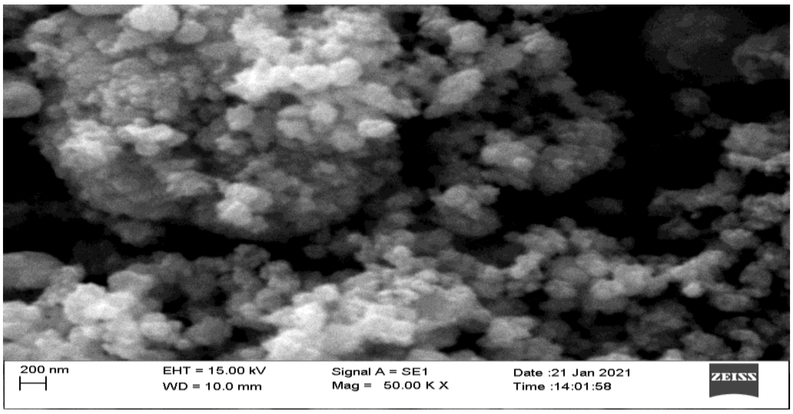

Figure.2: SEM micrograph of ZnO NPs synthesised with neem (Azadirachta indica) leaf extract at 500°C calcinations temperature at 50 KX.

Element	Weight%	Atomic%
O K	27.70	61.02
Zn K	72.30	38.98
Totals	100.00	

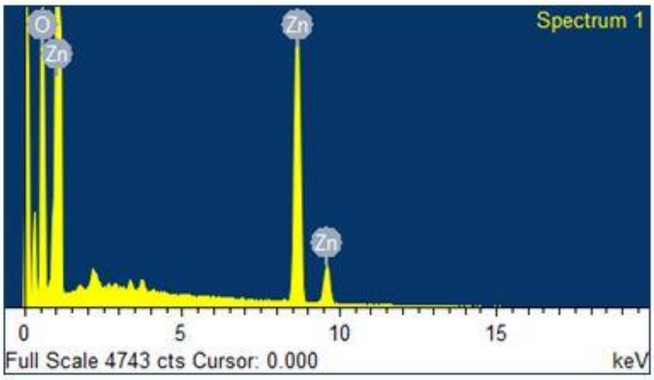

Figure 3: EDS Spectra of ZnONPs synthesised with neem (Azadirachta indica) leaf extract at 500°C calcinations temperature.

3.3: Study of Optical Property

Figure 4 displays the ZnO nanorods' UV-Vis absorption spectra. The particle size has a significant impact on the optical characteristics. The significant excitonic absorption peak at 355 nm is visible in the room temperature spectra. A clearly defined exciton band at 355 nm can be seen in the absorption spectra, as well as a considerable blue shift in comparison to the bulk exciton absorption (373 nm) [11]. Due of ZnO's tiny size, the blue shift phenomena is primarily connected to the quantum confinement effect [12].

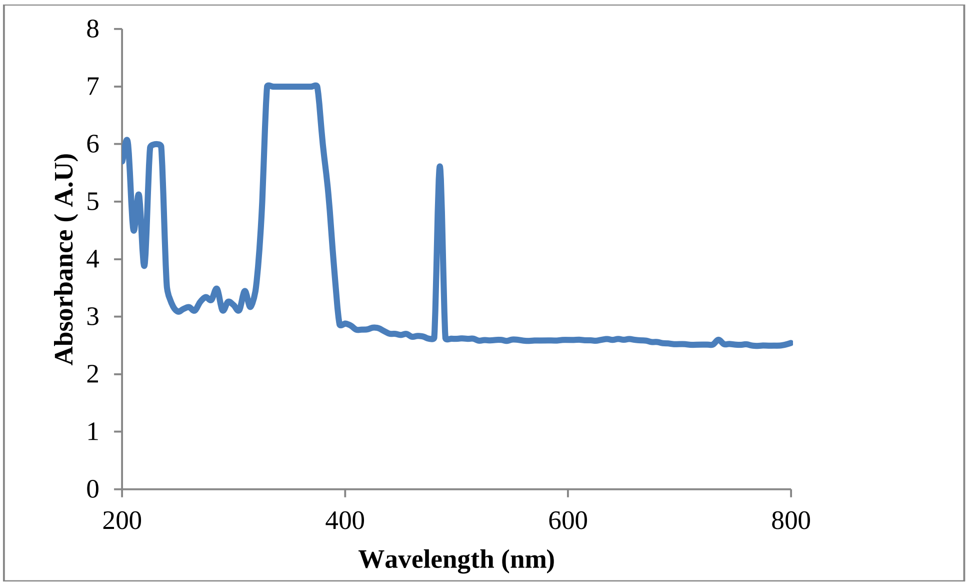

Figure 4: UV-VIS absorption spectra of ZnONPs synthesised with neem (Azadirachta indica) leaf extract.

IV. CONCLUSIONS

Therefore, it can be concluded from the current study that the neem (Azadirachta indica) leaf extract was responsible for the synthesis of zinc oxide nanoparticles. UV-visible spectroscopy, XRD, SEM, and EDS were used to characterise the resulting nanoparticles. This research describes an initial attempt to use zinc oxide nanoparticles that were created using green chemistry. Future research may be done to improve the particle structure and synthesise homogeneously distributed particles with intense luminescence. The development of nanoflakes and spindle-shaped nanoparticles was discovered through SEM research. Thus, the development of "green chemistry," which uses plants to synthesise nanoparticles, has drawn a lot of interest. Due to the wealth of benefits linked to this eco-friendly character, it has been investigated as a potent catalyst for a number of organic transformations. This study begins with a brief tutorial on creating zinc oxide nanoparticles on a natural scale. Therefore, it is essential to create a green synthetic strategy to get nanomaterials aimed at various uses in order to pursue a healthy life and environment.

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