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Short Communication

Synthesis and characterization of zinc oxide nanoparticles using green method

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Abstract

Major focus of researchers in recent years the development of efficient method for synthesis of metal nanoparticles. In this article we followed green method for the synthesis of zinc oxide nanoparticles using leaf extract of guava plant. Reduction of metal ions through leaf extracts leading to the formation of zinc oxide nanoparticles. The size, structure, morphology of synthesized nanoparticles was characterized by FTIR, X-ray diffraction, SEM-EDS.

Keywords: Zinc oxide nanoparticles, guava leaf extract, XRD, SEM-EDS, green method.

Introduction

Unique size dependent properties of nanoparticles have received an increasing amount of research interest since last three decade[1-3]. Nanoparticles have higher surface to volume ratio with their small size have many potential applications. Nanoparticles of zinc oxide reflect UV light better than micro-particles. Zinc oxide nanoparticles used as ingredients in cosmetics and sunscreen and also widely used as nanosensors[4-6]. Zinc oxide have extensive application in water purification, it can be used as photo catalytic degradation materials of environmental pollutants[7].

For such nanoparticles there are various chemical and physical methods which include sol-gel[8], photochemical reduction, electrochemical reduction[9], etc. are used for synthesis of nanoparticles. One more environmentally friendly green method is used. In our work leaves extract of guava plant have been used for zinc oxide nanoparticles synthesis.

Materials and Methods

Materials: zinc acetate (99%) and NaOH were purchased from sigma Aldrich. Leaves of *psidium guajava* (guava) were collected from the campus of Dr. Babasaheb Ambedkar Marathwada university, Aurangabad, Maharashtra, India.

Preparation of leaf extract of guava plant: The leaves of guava (10 mg) were thoroughly washed, dried and then boiled in 100ml distilled water for 15 min. The resulting extract was cooled, filtered using Whatman No. 1 filter paper and used as the extract solutions.

Synthesis of zinc oxide nanoparticles: In this method, 0.02 M solution of zinc acetate (50ml) was taken and 2ml leaves extract was added drop-wise and the resulting mixture was stirred for 10minutes. The pH of the mixture was maintained at 12 by adding 1M NaOH drop-wise and the solution was stirred continuously for 2 hr. A pale white precipitate resulted which is washed by distilled water 2-3 times followed by ethanol, filtered and dried at 50^0C overnight in oven. Pale white powder of zinc oxide nanoparticles was store for characterization.

Characterization of synthesized nanoparticles: The synthesized zinc oxide nanoparticles were characterized by FT-IR, XRD, SEM-EDS, techniques. The FT-IR spectra were recorded on [JASCOFTIR/4100] Japan. The XRay powder diffraction patterns of the zinc oxide nanoparticles were recorded on miniflex gonimeter under 30kv/15Ma, Xray scanning mode is continuous, scan axis- 2θ/θ data was taken for the 2θ range 20 to 80. The elemental composition and morphology were examined using SEM-EDS.

Results and discussion

FT-IR spectroscopy: Figure-1 for IR spectrum of zinc oxide nanoparticles after Calcinated at 500^0C, in this peak at 3600-3700 O-H starching vibration, band at 3000cm^{-1} C-H asymmetric stretching frequency.

X-Ray diffraction: XRD give regularity in atomic arrangement. In Figure-2 shows X-ray diffractogram of zinc oxide nanoparticles, Calcinated at 500^0C in muffle furnance for 2hr. The Sharpe peaks at (100), (002), (101), (102), (110), (103) (112), (201), (202) with lattice parameter a=3.249, b=3.249, c=5.206, $\alpha=90^0$, $\beta=90^0$, $\gamma=120^0$ with hexagonal phase shows good agreement with JCPDS card No. 36-1451. Obtained Zinc oxide nanoparticles are of high purity because impurities are absent as indicated by XRD.

The average size of the zinc oxide nanoparticles is found to be 21.9nm according to the Debye-Scherrer's equation (1)

$$D=\frac{0.94}{\beta cos\theta}\lambda \qquad (1)$$

Where: D - Average particle size, λ – Wavelength (1.5405A^0), θ - Diffraction angle, β - Full width at half maximum.

SEM-EDS analysis: Synthesized zinc oxide nanoparticles sample was analyzed at STIC-COCHIN by scanning electron microscope (SEM). SEM image shows external morphology of synthesized nanoparticles in the range of 10 μm because SEM shows lateral dimension of particles (including the reducing agent also may be agglomerated of the nanoparticles is of the order of few tens of nm) synthesized zinc oxide nanoparticles are spherical in nature Figure-3.

For chemical composition Energy dispersive X-ray spectra also recorded for zinc oxide nanoparticles.

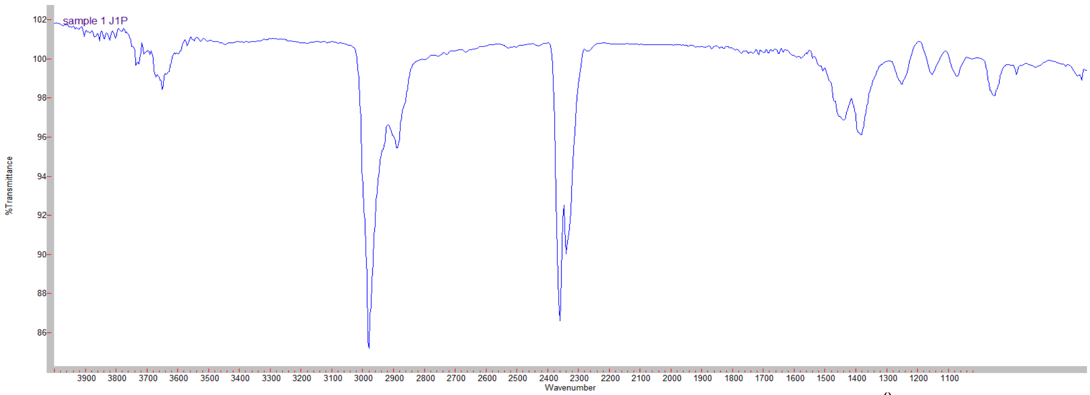

Figure-1: IR spectrum of zinc oxide nanoparticles calcinated at 500^0C

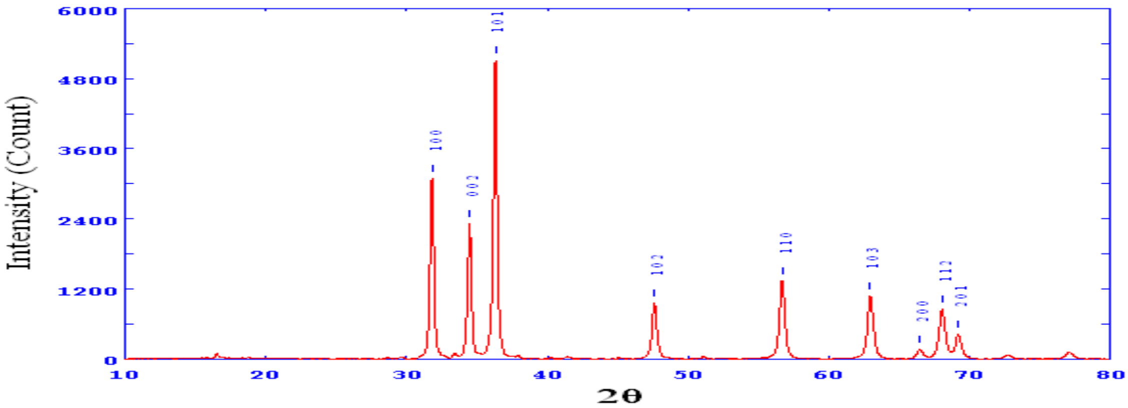

Figure-2: X-ray diffractogram of zinc oxide nanoparticles.

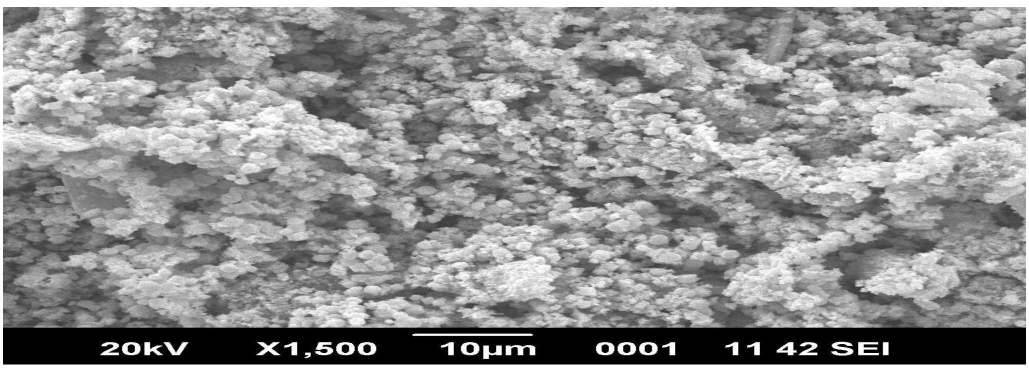

Figure-3: SEM image of ZnO NPs.

EDS spectrum shows that the spherical nanoparticles containing only oxygen and zinc elements shows in Table-1 with mass and atom %

Table-1: EDS Spectrum analysis of ZnO NPs.

element	kev	Mass%	Atom%	K
O	0.525	39.81	39.56	0.2263
Zn	8.53	86.19	60.44	1
		100	100	

Conclusion

Zinc oxide nanoparticles are biosafe, biocompatible and can be used for biomedical application. Green synthesis of shows good result for the synthesis of crystalline, spherical, hexagonal nanoparticles of zinc oxide with 21.9nm size at atmospheric condition. This study conclusively reports an eco-friendly approach for synthesis of zinc oxide nanoparticles.

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