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Study of Electrical Properties of Zinc Oxide (Zno) Nanopowder By Impedance Spectroscopy

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Abstract

The electrical properties of zinc Oxide (ZnO) were investigated by impedance spectroscopy over the frequency1 Hz to 10 MHz at room temperature**.** Scanning electron Microscopy (SEM) and Raman Spectroscopy has been done of Zinc Oxide Nanopowder ranging 40-50 nm in diameter. The morphological analysis of Zinc Oxide Nanopowder has been done by (SEM) informing the identical particles and diameters ranging 40-50 nm. Additional, the Raman shift deviation exhibit reliable peak found at 333 and 438 cm^{-1} of Zinc Oxide Nanopowder. The electrical studies of the Zinc Oxide (ZnO) Nanopowder have been inspected in order to obtain the dependency of electrical parameters (mainly dielectric permittivity, loss, conductivity, loss-tangent, impedance, and admittance) on frequency. Considerable dependency of the conductivity on frequency which is achieved owing to significant change in particle diameter. It calculated that the electrical parameters of Zinc Oxide Nanopowder have a great dependency on the frequency.

Keywords: ZnO;, SEM; Raman spectroscopy; Loss tangent and Electrical Conductivity.

1. Introduction

From last few decades, metal oxide nanoparticles has especial attention for research; ZnO has surprising electronic, optical, mechanical, magnetic and chemical properties that are significantly different from those of bulk corresponding item [1]. In present days, materials having 10^{-9} m range implies in several fields of discipline its action for materials and devices using different techniques at 10^{-9} m scale. Nanoparticles are a part of nanomaterials that are defined as a single particle 1–100 nm in diameter [2].

Recently doped semiconductor nano particles have established plentiful consideration because such doping can transform and expand optical properties of nanoparticles by large amount [3-6]. Zinc Oxide reflects electric properties. ZnO has energy band gap of 3.37eV and excitation binding energy of 60 meV at ordinary temperature. ZnO is very effective material due to special electronic properties and auspicious applications in various fields such as photonic catalysis [7],

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light emitting diodes, field emission, gas sensors [8], fluorescent materials and solar cells

In the last few years, progress has been achieved in synthesis, structural characterization and physical properties of ZnO nanoparticles. ZnO show novel physical properties due to their nanoscale size as compared to these of ordinary materials. Now days, nanoparticles of Zinc oxides have been the emphasis on research of unusual properties that are estimated upon nanosize regime [9, 10].

On the basis of above study we have follow the Electrical parameters such as, Electrical Conductivity (σ), and Loss Tangent (Tan δ) of Zinc Oxide at Room Temperature 28 ºC.

2. Results and Discussions

2.1. Morphological analysis

The morphology of Zinc Oxide Nanopowder was explored scanning electron microscope displayed in Fig. 1 ZNO nano particles.

These pictures display the formation of Zinc Oxide Nanopowder. The pictures also exhibit the standardized particle size and specific range of diameters 30-40 nm.

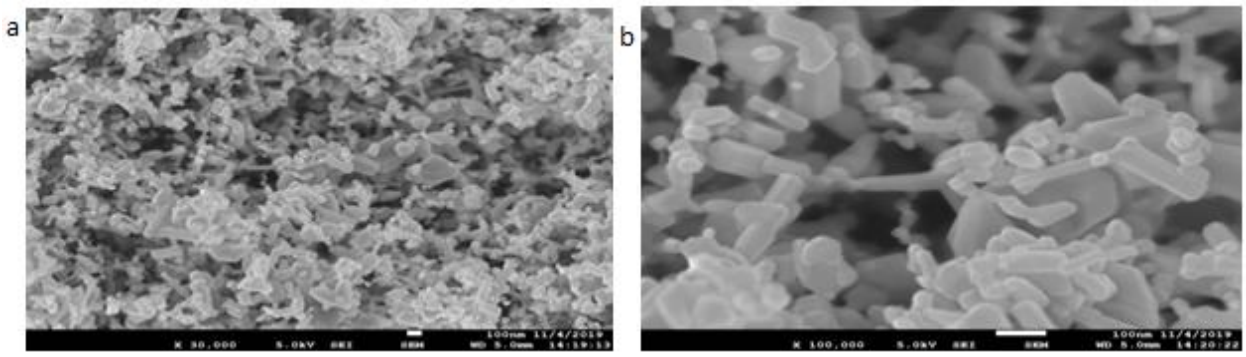

Fig. 1. (a) SEM image of ZnO at 30000 X magnification; (b) SEM image of ZnO at 100000 X magnification.

2.2. Raman analysis

Figure 2 shows Raman spectra of ZnO using a green laser with λ =785 nm. BN exhibits a characteristic peak occurs at ≈333 and 438 cm-1. The intensity of the spectra is ~1500. Raman spectrograph display the regular peak. Raman spectra of ZnO confines the Zinc Oxide Nanoparticles (ZnO).

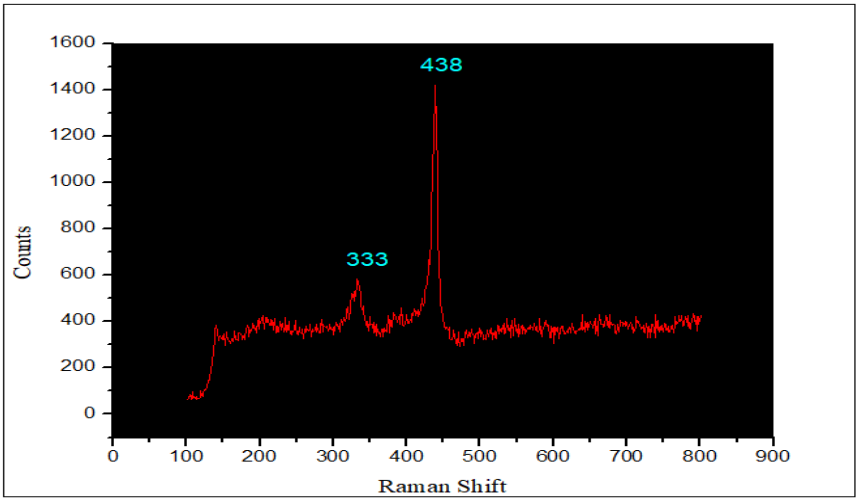

Fig. 2. Raman shift (cm-1) vs. intensity of the Zinc Oxide (ZnO) nanopowder at 28 ℃.

2.3. Electrical Study

References The Electrical studies of sample were investigated by Novo impedance analyser α-type. The dependency of Electrical parameters (Electrical Conductivity and Dissipation Factor) on the frequency is given in the following table.

Table 1. An Variation of Electrical Parameters viz. Frequency of Zinc Oxide at Room Temperature 28 ºC..

Frequency (Hz)	Z (Ω)	Y $(\Omega)^{-1}$	ε'	ε''	σ $(S\text{-}m^{-1})$	Tan δ
1 kHz	8.32×10^{4}	1.20×10^{-5}	12.12	190	1.69×10^{-5}	1.87
10 kHz	5.11×10^{4}	1.96×10^{-5}	10.99	31.5	2.75×10^{-5}	2.86
100 kHz	3.07×10^{4}	3.26×10^{-5}	3.285	5.05	4.58×10^{-5}	1.53
1 MHz	1.58×10^{4}	6.32×10^{-5}	1.43	0.98	8.88×10^{-5}	0.68
10 MHz	8.26×10^{3}	1.21×10^{-4}	1.08	0.19	1.70×10^{-4}	0.176

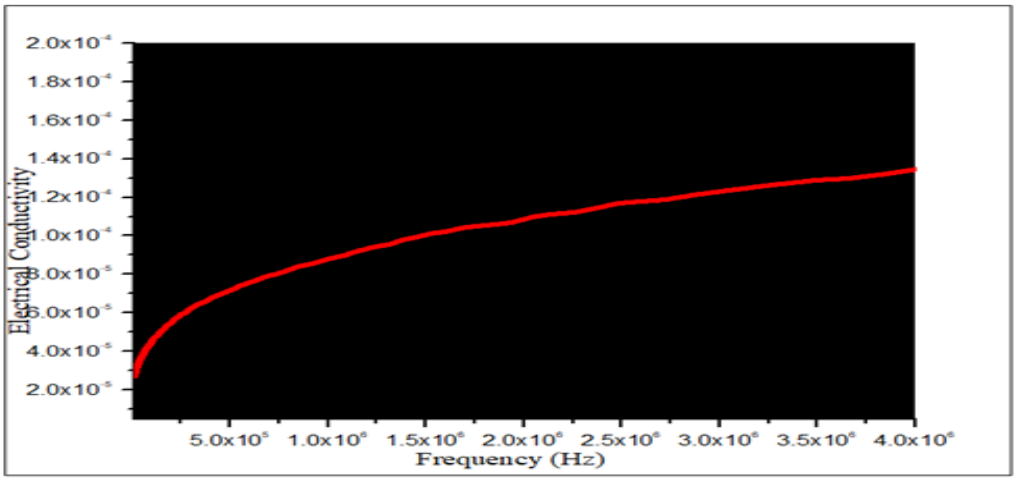

Fig. 3. Dependency of electrical conductivity (σ) on frequency (Hz) of ZnO at Temperature 28 ºC.

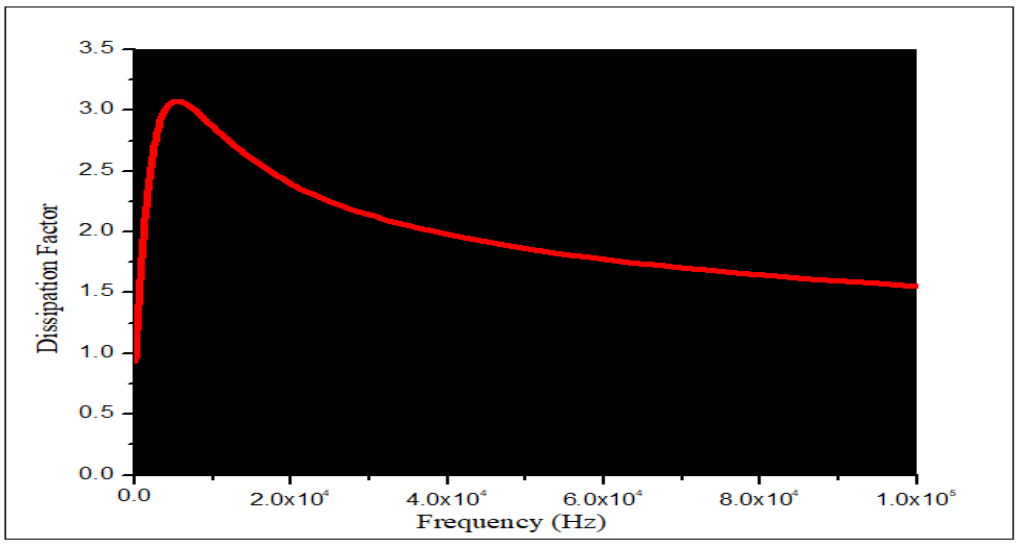

Fig. 4. Dependency of loss tangent (Tan δ) on frequency (Hz) of ZnO at Temperature 28 ºC.

These figures 3 and 4 are representing the deviation of Conductivity and Loss tangent with the frequency. Here appreciable variation in electric parameters with variation in frequency in Zinc Oxide Nanoparticles as compare to normal size Particles of Zno. The values of the different Electric parameters such as Electrical conductivity and Loss Tangent with different frequency range is given in the table 1.which indicates the large variation in the parameters in with frequency range.

3. Conclusion

This study has described that at room temperature the structural and electrical study of Zinc Oxide (ZnO) has done. It is found that the Zinc Oxide with homogeneous size of 40-50 nm,

shape distribution agglomeration of particles, with diameters extending from 40 to 50 nm have been characterized by SEM, XRD and RAMAN SPECTROSCOPY it is found that the ZnO has crystalline structure and homogeneous size of the particles within the Nano scale . In addition, Electrical parameters of ZnO such as dissipation factor (Tan δ), and electrical conductivity (σ) with the frequency analyzed by Novo Impedance Analyzer and found that conductivity [σ] varies from 1.69×10^{-5} (S-m^{-1}) to 1.70×10^{-4} (S-m^{-1}) with frequency 1 KHz to 10 MHz, while the Loss Tangent Varies from 1.87 to 0.176 with the same frequency range. This variation was obtained owing to drop in the size of Zinc oxide Nano Powder. On the basis of this analysis the zinc oxide Nanopowder can be used as dielectric material.

Acknowledgements

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Conflict of Interest

This Study does not have any conflict of interest.

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