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REVIEW CHARACTERIZATION TECHNIQUES AND APPLICATION OF FERRITE NANOPARTICLES

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ABSTRACT:

This paper reports the different and important characterization techniques of ferrite nanoparticles. The use of ferrite nanoparticles in microdevices, electronic devices, magnetic devices, and memory storage devices is crucial. This study reports the different characterization techniques such as X-ray diffraction (XRD), SEM EDX, FTIR, UV-DRS, FESEM, TGA, VSM, TEM

KEYWORDS: *Ferrite nanoparticles, characterization, XRD, SEM , TEM,VSM*

1. Introduction:

Microdevices, telecommunication electrical devices, electronics, magnetic gadgets, catalysts, gas sensors, magneto-optical high-frequency electronic devices, integrated circuits sensors, spintronics, and memory storage devices all rely heavily on ferrite nanoparticles. A class of advanced technological materials that shape the structure of society known as ferrites, are employed in the creation of magnetic, electrical, and microwave devices. (1,2) Due to its high resistivity and little eddy current losses, ferrites have become increasingly important in technology. The chemical and physical properties of materials in smaller sizes are often different from bulk characteristics. The nanoparticles of ferrite are characterized using surface analysis techniques and typical bulk material characterization procedures. Surface analysis techniques have been used extensively in the characterization of nanomaterials and nanostructures, which is beneficial for researchers in a variety of domains. This paper reports the characterization techniques such as XRD, SEM, FTIR, TEM, VSM, TGA (1,2)

1.1 XRD-X-Ray diffraction:

To determine the lattice constant, grain size, and crystalline size of solid crystals, XRD is a fundamental experimental technique. It is possible to measure the phases of crystal structures and related parameters of ferrites using XRD data. It is also possible to determine the effects of doping and substitution on the crystal structure of ferrite particles. **(3)**

- The lattice constant can be calculated from Bragg's formula below,
  $A=d_{hkl}\sqrt{h^2+k^2+l^2}$
- Peak broadening can be calculated by using the Scherrer formula below
  $D=0.9\lambda/\beta\cos\theta$

D spacing value, lattice parameter, FWHM value, crystalline size, and volume can be calculated from XRD graphs. XRD is one of the important factors in the case of the characterization technique (3)

1.2 SEM EDX: SEM utilizes a focused electron beam to create high-resolution images of the sample surface. It allows for detailed visualization of surface morphology, elemental composition, and three-dimensional imaging of materials. Scanning Electron Microscope provides good resolution of various samples, typically 5 to 10 nm images. This process is simple and hence its analysis is quicker thanits counterparts.(4)

1.3 Transmission Electron Microscopy (TEM): TEM employs a beam of electrons transmitted through the sample to obtain information about materials' internal structure and atomic arrangement. It is usefulfor studying nanoscale features, such as crystal defects and grain boundaries.(5,6)

1.4 Vibrating Sample Magnetometer (VSM): A Vibrating Sample Magnetometer is an instrument used to measure the magnetic properties of a sample material. It operates based on the principle of Faraday's law of electromagnetic induction. By employing VSM, researchers can gain valuable insights into the magnetic behavior of materials, enabling advancements in diverse fields ranging from materials science and nanotechnology to electronics and biomedical applications. (6)

1.5 Conclusion: Characterization techniques in materials science are essential for understanding the properties, structure, and behavior of various materials. Microscopy techniques allow for visualizing the microstructure, while spectroscopic techniques provide valuable information about composition and electronic properties. X-ray diffraction enables the determination of crystal structure, and thermal analysis techniques offer insights into thermal behavior. By employing a combination of these techniques, scientists and researchers.(7,8)

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