

Synthesis, Characterization, and Applications of Doped Zinc Ferrites: An Overview

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Abstract

Doped zinc ferrites are an important class of spinel ferrite materials that have attracted considerable research interest because of their tunable structural, magnetic, electrical, dielectric, and optical properties. This overview presents the major approaches used for the synthesis, characterization, and technological applications of doped zinc ferrites. The incorporation of suitable dopant ions into the zinc ferrite lattice can significantly modify cation distribution, crystallite size, lattice parameters, surface morphology, electrical conductivity, magnetic behaviour, and dielectric response. Various synthesis techniques, including sol-gel, co-precipitation, hydrothermal, combustion, solid-state, and microwave-assisted methods, provide different advantages in controlling particle size, composition, homogeneity, and morphology. Structural and morphological characteristics are commonly investigated using X-ray diffraction, scanning electron microscopy, transmission electron microscopy, Fourier-transform infrared spectroscopy, and related analytical techniques. Magnetic properties can be evaluated through parameters such as saturation magnetization, coercivity, and magnetic susceptibility, while dielectric and electrical characteristics provide information about charge transport and polarization mechanisms. Depending on the dopant and preparation conditions, doped zinc ferrites can be tailored for applications in electromagnetic devices, high-frequency components, sensors, photocatalysis, energy storage, microwave absorption, and biomedical technologies. The relationship between synthesis conditions, dopant concentration, microstructure, and functional properties is therefore essential for optimizing performance. This overview highlights recent scientific approaches to the development of doped zinc ferrites and emphasizes the importance of controlled synthesis and systematic characterization for designing multifunctional ferrite materials with improved performance for emerging technological applications.

Keywords: Zinc Ferrites, Doped Ferrites, Spinel Structure, Synthesis, Characterization, Magnetic Properties, Dielectric Properties, Nanomaterials, Microwave Applications, Functional Materials.