

A New Vista in Synthesis, Characterization, and Applications of Doped Zinc Ferrites

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Abstract

Doped zinc ferrites have attracted considerable research interest because of their tunable structural, magnetic, electrical, optical, and catalytic properties. These materials belong to the family of spinel ferrites and can exhibit significant changes in their physicochemical behaviour through the controlled substitution of suitable dopant ions. This paper presents an overview of recent approaches to the synthesis, characterization, and applications of doped zinc ferrites, with emphasis on the relationship between composition, structure, particle size, morphology, and functional properties. Various synthesis techniques, including sol-gel, co-precipitation, hydrothermal, combustion, and solid-state methods, are discussed in terms of their influence on crystallinity, particle morphology, phase formation, and material performance. Characterization techniques such as X-ray diffraction, Fourier-transform infrared spectroscopy, scanning or transmission electron microscopy, vibrating sample magnetometry, and UV-visible spectroscopy are useful for understanding the structural and functional characteristics of these materials. The incorporation of dopant ions can modify cation distribution, lattice parameters, magnetic interactions, electrical conductivity, and optical behaviour, thereby enabling property optimization for specific applications. Doped zinc ferrites have potential applications in electromagnetic devices, sensors, photocatalysis, magnetic storage, microwave technology, environmental remediation, and energy-related systems. However, challenges associated with particle agglomeration, reproducibility, dopant concentration, scalability, and long-term stability require further investigation. The study highlights the importance of controlling synthesis parameters and establishing clear structure-property relationships for the development of high-performance ferrite materials. Continued interdisciplinary research may provide new opportunities for designing doped zinc ferrites with tailored properties for advanced technological and environmental applications.

Keywords: Zinc Ferrites, Doped Ferrites, Spinel Structure, Nanomaterials, Synthesis, Characterization, Magnetic Properties, Electrical Properties, Photocatalysis, Advanced Materials