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Wet-Chemical Synthesis of $ZnFe_2O_4$ MNPs by Sol-gel Auto-Combustion Method, Structural, Magnetic, and DC-Electrical Characterizations

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Abstract: *$ZnFe_2O_4$ magnetic nanoparticles (MNPs) were successfully synthesized using the sol-gel auto-combustion method, with citric acid ($C_2H_2O_2$) employed as the fuel. X-ray diffraction (XRD) analysis confirmed the formation of a cubic spinel structure with the Fd3m-Oh7 space group, and the lattice constant (a) was measured to be 8.384 ± 0.05 Å. Debye-Scherrer's method for analyzing peak broadening revealed an average crystallite size of 36 nm. Fourier-transform infrared (FT-IR) spectroscopy identified two key metal-oxide bands at approximately 541 cm^{-1} (O-M Oct) and 409 cm^{-1} (O-M Td), which correspond to the metal-oxygen bonds at the octahedral and tetrahedral sites, respectively, thereby validating the structural integrity of the synthesized material. Magnetic characterization showed a saturation magnetization (Ms) of ~50 emu/g, a remanent magnetization (Mr) of ~17 emu/g, and a magneton number (nB) of 1.77 emu/g. The activation energy (Ea) was calculated to be 3.11 eV. Furthermore, DC electrical resistivity measurements, consistent with the Arrhenius equation, confirmed the semiconducting nature of the $ZnFe_2O_4$ MNPs.*

Keywords: $ZnFe_2O_4$ MNPs, Sol-gel synthesis, Infra-Red spectroscopy, DC-Electrical property.