Synthesis and magneto-dielectric properties of Ti-doped Ni0.5Zn0.5TixFe2 xO4 ferrite via a conventional sol–gel process

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Abstract

Ni–Zn-based ferrites (NZFO) need to possess the ideal ratio of dielectric and magnetic characteristics for uses involving electromagnetic fields. Consequently, the NZFO system has been modified by Ti^{4+} substitution at Fe^{3+} producing $Ni_{0.5}Zn_{0.5}Ti_xFe_{2-x}O_4$ (x = 0.00, 0.02, 0.04, 0.06, 0.08 and 0.10) and a conventional sol-gel process was followed for the synthesis. The structure of the synthesized samples was evaluated from the X-ray diffraction (XRD) patterns. Fourier transform infrared (FTIR) measurement provided information on chemical interaction with thermodynamic conditions. In addition, the grain sizes were obtained from scanning electron microscopy (SEM). Furthermore, the studied samples exhibit a notable light absorption in the visible spectrum with band gaps between 3.8 and 4.8 eV. The magneto-dielectric properties were analyzed by field (H) dependent magnetization (M), frequency-dependent permeability (μ), and permittivity (ε) measurements. Ti^{4+} substitution in NZFO led to a decrease in magnetic saturation (M_s) and μ while the values of creased and improved the mismatching impedance ($Z/\eta_0 = (\mu'/\varepsilon')^{1/2}$). The lowest value of M_s (14 emu g^{-1}) is achieved for the sample with x = 0.1 for which μ is also the lowest. Finally, a stable value of Z/η_0 (~4.0) has been obtained for the x = 0.10 sample over a wide range of frequencies (1–10 MHz), making it suitable as a miniaturizing device material in this frequency range.

Keywords: Spinel ferrite, Sol-gel method, Magnetic properties, Dielectric constants, and Matching impedance.