**Investigation on structure, thermodynamic and multifunctional properties of Ni–Zn–Co ferrite for Gd3+ substitution**

M. D. Hossaina, A. T. M. K. Jamila, Md. Sarowar Hossainb, S. J. Ahmeda, H. N. Dasc, R. Rashidc, M. A. Hakimd and M. N. I. Khanc\*

aDepartment of Physics, Dhaka University of Engineering and Technology (DUET), Gazipur, Bangladesh

bS N Bose National Centre for Basic Sciences, Kolkata 700106, West Bengal, India

cMaterials Science Division, Atomic Energy Center, Dhaka 1000, Bangladesh

dDepartment of Glass and Ceramic Engineering, Bangladesh University of Engineering and Technology (BUET), Dhaka 1000, Bangladesh

E-mail: ni\_khan77@yahoo.com

**Abstract**

This study presents a modification of structure-dependent elastic, thermodynamic, magnetic, transport and magneto-dielectric properties of a Ni–Zn–Co ferrite tailored by Gd3+ substitution at the B-site replacing Fe3+ ions. The synthesized composition of Ni0.7Zn0.2Co0.1Fe2-xGdxO4 $\left(0\leq x\leq 0.12\right)$ crystallized with a single-phase cubic spinel structure that belongs to the Fd3m space group. The average particle size decreases due to Gd3+ substitution at Fe3+. Raman and IR spectroscopy studies illustrate phase purity, lattice dynamics with cation disorders and thermodynamic conditions inside the studied samples at room temperature (RT=300 K). Ferromagnetic to paramagnetic phase transition was observed in all samples where Curie temperature (TC) decreases from 731 to 711 K for Gd3+ substitution in Ni–Zn–Co ferrite. In addition, Gd3+ substitution reinforces to decrease the A-B exchange interaction. Temperature dependent DC electrical resistivity $\left(ρ\_{DC}\right)$ and temperature coefficient of resistance (TCR) have been surveyed with the variation of the grain size. The frequency-dependent dielectric properties and electric modulus at RT for all samples were observed from 20 Hz to 100 MHz and the conduction relaxation processes were found to spread over an extensive range of frequencies with the increase in the amount of Gd3+ in the Ni–Zn–Co ferrite. The RLC behavior separates the zone of frequencies ranging from resistive to capacitive regions in all the studied samples. Finally, the matching impedance $(Z/η\_{0}) $ for all samples was evaluated over an extensive range of frequencies for the possible miniaturizing application.

**Keywords:** Hopping length, Elastic wave, Atomic force constant, Curie temperature, Matching impedance.