

## Influence of CaO and SiO<sub>2</sub> co-doping on the magnetic, electrical properties and microstructure of a Ni–Zn ferrite

### ABSTRACT

Effect of CaO and SiO<sub>2</sub> additions on the grain growth and magnetic and electrical properties of a Ni–Zn ferrite was studied. The common oxides ( $x = 0.4\text{CaO} + 0.8\text{SiO}_2$ ) were added in different moles ( $x = 0, 0.02, 0.06, 0.12, 0.24$  and  $0.48$ ) to Fe<sub>2</sub>O<sub>3</sub>, Zn, and NiO. The mixed powders were mechanically alloyed for 12 h using a high energy ball mill before heating at 1200 °C for 240 min. The products were characterized by x-ray diffraction (XRD), field emission scanning electron microscopy, energy-dispersive x-ray spectroscopy, vibrating sample magnetometer and static hysteresisgraph, and later by an impedance analyzer with a frequency range from 1 MHz to 1.8 GHz. The XRD results indicate a formation of single phase spinel structure in all the samples. The average grain size was affected by the additive contents so that their sizes grew, up to  $x = 0.06$ , and after that their sizes reduced from 0.631 to 0.371  $\mu\text{m}$  at  $x = 0.48$ . The experimental density of the samples displayed an upward trend for  $x < 0.06$ , increasing from 5.39 g cm<sup>-3</sup> ( $x = 0$ ) to 5.51 g cm<sup>-3</sup> ( $x = 0.06$ ): afterwards, their values presented a downward trend, reducing to 4.01 g cm<sup>-3</sup> at  $x = 0.48$ . Magnetic behaviors such as saturation magnetization ( $M_s$ ) and induction magnetization ( $B_s$ ) degraded as well as the real permeability of the samples by increasing the  $x$  content. The loss factor i.e. hysteresis loss also remarkably decreased by accumulation of SiO<sub>2</sub> and CaO in the grain boundaries. The electrical resistivity was determined in the order of  $6.9 \times 10^{10}$   $\Omega\text{cm}$  for  $x = 0$  and  $6.4 \times 10^{11}$   $\Omega\text{cm}$  for  $x = 0.48$ . Therefore, low relative loss factor and high resistivity make these ferrites particularly useful as inductor and transformer materials for high frequency applications.

**Keyword:** Co-doping of CaO and SiO<sub>2</sub>; Electrical properties; Magnetic materials; Magnetic properties; Microstructure