Influence of CaO and SiO2 co-doping on the magnetic, electrical properties and microstructure of a Ni–Zn ferrite

ABSTRACT

Effect of CaO and SiO2 additions on the grain growth and magnetic and electrical properties of a Ni-Zn ferrite was studied. The common oxides (x = 0.4CaO + 0.8SiO2) were added in different moles (x = 0, 0.02, 0.06, 0.012, 0.24 and 0.48) to Fe2O3, 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 ε at x = 0.48. The experimental density of the samples displayed an upward trend for x < 0.06, increasing from 5.39 g cm-3 (x = 0) to 5.51 g cm-3 (x = 0.06): afterwards, their values presented a downward trend, reducing to 4.01 g cm-3 at x = 0.48. Magnetic behaviors such as saturation magnetization (Ms) and induction magnetization (Bs) 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 SiO2 and CaO in the grain boundaries. The electrical resistivity was determined in the order of 6.9 × 1010 cm for x = 0 and 6.4 × 1011 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 SiO2; Electrical properties; Magnetic materials; Magnetic properties; Microstructure