Effect of cation distribution on physical properties of Ni-Zn-Al Nanoferrites

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Abstract: Due to the miniaturization, devices with small-size and exhibit high-performance are needed not only to reduce the cost but also to improve the efficiency of the system. Among the noteworthy magnetic materials, Ni-Zn ferrite is a promising ceramic magnetic spinel and used as core in low and high frequency devices [1-2]. However, improvement in magnetization and resistivity are essential to operate them safely with low losses at ultra high frequency regions. It is worthwhile to mention that, by modifying the cationic vacancies present at A (tetrahedral) and B (octahedral) sites of spinel unit cell; one can tailor the magnetic and electric properties for a specific application. With this idea, attempt has been made in this work to improve electrical and magnetic properties Ni-Zn ferrite by doping with Al^{3+} ions. It is well established that method of processing and sintering temperature plays a vital role to obtain Ni-Zn ferrite with optimum properties. Thus, sol-gel wet chemical combustion route is used to synthesize Ni-Zn-Al ferrite powders followed by Microwave sintering at 1100°C for 30 min. X-ray diffraction results confirm the presence of spinel phase and lattice constant decreases with the substitution of Al^{3+} ions, suggest that Al^{3+} ions enter in to spinel lattice (Fig 1). Further, Cation distribution estimated from X-ray data shows that Al^{3+} ions simultaneously enter in to both A and B sites of the spinel lattice, though they have preferential occupancy is B site only. In spinel ferrite, the net magnetic moment is directly influenced by the presence and orientation of magnetic ions reside at A and B site, as Al^{3+} ions enter in to both sites, it dilutes the magnetic moment, which results reduction of saturation magnetization (Fig 2). Variation of room temperature resistivity is also shown in figure 2. It is observed that Al^{3+} ions enhance the electrical resistivity, which is a direct consequence of reducing the hopping of charge carriers between Fe^{3+} and Fe^{2+} ions at B site. In general, formation of Fe^{2+} ions is due to the volatilization of Zn^{2+} when the samples are sintered at elevated temperatures. Thus it can be conclude that, shorter duration of microwave sintering would possibly reduced the loss of Zn, which in turn limits the formation of Fe^{2+} ions and then enhances the resistivity. Though, the magnetization decreases, samples with Al^{3+} concentration x=0.1 are useful for high frequency applications.

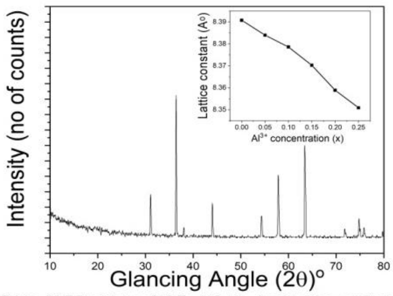

Figure 1 XRD patterns of Ni-Zn-Al ferrite. Inset Lattice constant.

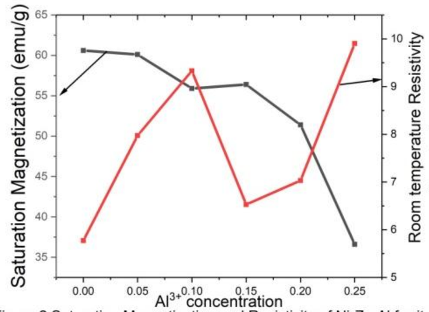

Figure 2 Saturation Magnetization and Resistivity of Ni-Zn-Al ferrite

***Keywords**:* Microwave sintering, Ni-Zn ferrites, Magnetization and Resistivity

References

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