INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

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SHORT ABSTRACT

Spinel ferrites have gained attention for a long period of time due to their unique electrical, optical, and magnetic properties. They are also very promising for applications such as circulators, phase shifters, memory, magnetic recording devices, gas sensing, etc. The present thesis is focused on the synthesis of lithium ferrite-based ceramics and thin films. Lithium ferrite exhibits high Curie temperature, square hysteresis loop, high saturation magnetization, excellent dielectric properties, high resistivity, etc. The solid-state reaction method is used to prepare substituted lithium ferrites and composites. The effect of alkaline earth elements such as Sr and Mg on the structural, microstructural, dielectric (1 MHz – 1 GHz), and magnetic response is analyzed. Enhanced dielectric response (εr = 3034, $\tan\delta$ = 0.001 at RT, 1 MHz) is observed for the Mg composition, x = 0.005, whereas in the case of Sr series, the best dielectric response is observed for x = 0.003 (εr = 5986 and $\tan\delta$ = 1.17 at RT, 1 MHz). The obtained EA for LMFO and LSFO is 1.39 – 0.35 eV and 0.124 – 0.077 eV, respectively. The LMFO with x = 0.007 exhibited the best permeability (μr = 29) and magnetic properties (Ms = 55 emu/g) at room temperature. Also, in the LSFO series, x = 0.007 showed the highest magnetization among all samples (MS = 61 emu/g). Improved dielectric response with low magnetic as well as dielectric loss is observed for Mg substituted lithium ferrite as compared to Sr. The combined magnetic, dielectric, and permeability response made the Mg substituted lithium ferrite more suitable for circulators and phase shifters. Again, the lithium ferrite/carbon black and Dy substituted lithium ferrite/carbon black composites are prepared, and EMI shielding effectiveness is analyzed in the X (8.2 – 12.4 GHz) and Ku (12.4 – 18 GHz) frequency bands. Permittivity and permeability are also analyzed. Shielding effectiveness is enhanced with the carbon black as well as Dy content. The maximum shielding effectiveness of 24 dB was obtained for LD10FO/CB ~ 17 – 18 GHz. The Dy substitution enhances the magnetic as well as dielectric loss. Further, 99.68 % of Aeff is achieved with 20 wt % of CB reinforcement in LFO, whereas the maximum absorption efficiency of 99.6 % is obtained for LD10FO/CB ~ 17 – 18 GHz.This renders majorly absorption-based shielding rather than reflection-based shielding. The enhancement in the shielding efficiency is attributed to the synergetic effect of the dielectric loss and magnetic loss. Various contributions of magnetic loss, such as natural resonance, domain wall resonance, eddy current loss, hysteresis loss, and spin polarization, are discussed. Further, lithium ferrite and Dy substituted lithium ferrite in the form of thin films are synthesized by PLD having different film thicknesses. The strain-induced structural, microstructural, magnetic, dielectric, and electrical response is analyzed. The magnetization is reduced with the enhancement in film thickness which is explained on the basis of magnetoelastic energy density. The dielectric constant is enhanced, whereas the dielectric loss is reduced with the enhancement in the film thickness. The electrical conduction mechanism is also analyzed, which is in good agreement with Mott's VRH mechanism. The varying thickness of a film is an effective parameter for tuning the physical properties of the film. The observed results suggest that LDFO films are promising for magnetic oxide semiconductor applications.