World Academy of Science, Engineering and Technology
International Journal of Materials and Metallurgical Engineering
Vol:17, No:01, 2023

Thickness-Tunable Optical, Magnetic, and Dielectric Response of Lithium Ferrite Thin Film Synthesized by Pulsed Laser Deposition

Authors : Prajna Paramita Mohapatra, Pamu Dobbidi

Abstract : Lithium ferrite (LiFe5O8) has potential applications as a component of microwave magnetic devices such as circulators and monolithic integrated circuits. For efficient device applications, spinel ferrites in the form of thin films are highly required. It is necessary to improve their magnetic and dielectric behavior by optimizing the processing parameters during deposition. The lithium ferrite thin films are deposited on Pt/Si substrate using the pulsed laser deposition technique (PLD). As controlling the film thickness is the easiest parameter to tailor the strain, we deposited the thin films having different film thicknesses (160 nm, 200 nm, 240 nm) at oxygen partial pressure of 0.001 mbar. The formation of single phase with spinel structure (space group - P4132) is confirmed by the XRD pattern and the Rietveld analysis. The optical bandgap is decreased with the increase in thickness. FESEM confirmed the formation of uniform grains having well separated grain boundaries. Further, the film growth and the roughness are analyzed by AFM. The root-mean-square (RMS) surface roughness is decreased from 13.52 nm (160 nm) to 9.34 nm (240 nm). The room temperature magnetization is measured with a maximum field of 10 kOe. The saturation magnetization is enhanced monotonically with an increase in thickness. The magnetic resonance linewidth is obtained in the range of 450 – 780 Oe. The dielectric response is measured in the frequency range of 104 – 106 Hz and in the temperature range of 303 – 473 K. With an increase in frequency, the dielectric constant and the loss tangent of all the samples decreased continuously, which is a typical behavior of conventional dielectric material. The real part of the dielectric constant and the dielectric loss is increased with an increase in thickness. The contribution of grain and grain boundaries is also analyzed by employing the equivalent circuit model. The highest dielectric constant is obtained for the film having a thickness of 240 nm at 104 Hz. The obtained results demonstrate that desired response can be obtained by tailoring the film thickness for the microwave magnetic devices.

Keywords : PLD, optical response, thin films, magnetic response, dielectric response
Conference Title : ICMSE 2023 : International Conference on Materials Science and Engineering
Conference Location : Paris, France
Conference Dates : January 23-24, 2023