Magnetic characteristics adjustment through rare-earth lanthanum substitution in mechanically alloyed yttrium iron garnet nanoparticles

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Abstract: Yttrium iron garnet (YIG) is a very important ferrimagnetic ceramic and widely used in high frequency magneto-optical applications due to its high saturation magnetisation and low magnetic loss up to several GHz. Magnetic properties of YIG are strongly dependent on the processing technique, in which small amount of dopants can largely affect its properties. In this study, the effect of various lanthanum (La) content on structural, microstructural and magnetic characteristics of YIG was reported. The nanosized powders of La-subtituted YIG with La content of 0.0 to 0.5 were synthesised using mechanical alloying technique for 6 h followed by sintering at 1400°C. The physical characteristics of the samples were analysed using XRD, FTIR, TEM and SEM, meanwhile the magnetic and thermomagnetic characteristics of the samples were measured using VSM and LCR-meter respectively. The particle size of as-milled samples showed an increment from 38 to 53 nm with increasing La content and the XRD patterns of the samples showed evidently a highly crystalline and full phase YIG ferrite, regardless of its La content. While the microstructure of the samples barely remains consistent for all La content, the saturation magnetisation of the samples showed reduction with increasing La content. This is due to the magnetic dilution caused by La in overall superexchange interaction in magnetic moments of YIG, which is attributed to the paramagnetic nature of La rare earth ions at room temperature.

Keywords: yttrium iron garnet; lanthanum ion; soft ferrite; morphology; magnetic characteristics.

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