Influence of indium substitution and microstructure changes on the magnetic properties evolution of Y3Fe5−xInxO12 (x = 0.0–0.4)

ABSTRACT

The role of indium (In) substitution in the dynamics of ferrimagnetism, structure and microstructure of yttrium iron garnet (YIG) employing sintering temperature as a temporary agent of composition and microstructural changes was examined closely and reported in this study. The nanoparticles of YIG powder samples with various In content (x = 0.0, 0.1, 0.2, 0.3, 0.4) were prepared via the mechanical alloying (MA) technique. A brief, yet revealing characterization of the samples was carried out by using a transmission electron microscopy, X-ray diffraction, Raman spectroscopy and scanning electron microscopy to analyse the structural and morphological properties, whereas Bï H hysteresis graph and LCR-meter were used to measure the magnetic and thermo-magnetic behaviour respectively. The X-ray diffraction analysis of the samples prepared via the MA indicates the formation of single phase YIG structure at much lower sintering temperature than that in the conventional ceramic technique. The lattice constant increases as In content increases which obeys Vegardôs law due to the larger In3+ ions replacing the smaller Fe3+ ions. The grain size also increased with In content, indicating that the In3+ ion acts as a grain growth promoter. The saturation induction increased reaching about 699.1 G for x = 0.3 and decreased with further In substitution. Three stages of ordered magnetism formation were identified which attributed to development of crystallinity and larger grains for magnetic domain accommodation. The Curie temperature shows a decrement of 60 °C for In content changes from x = 0.0 to x = 0.4 due to weakening of superexchange interactions. Raman shifts from 268.1 to 272.2 cmī 1 with increasing In content were observed due to stress developed in the YIG crystal structure. Possible mechanisms contribute to these properties are discussed in this paper.

Keyword: Indium substitution; Magnetic; Microstructure changes; Yttrium iron garnet