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MAGNETIC PROPERTIES OF INDIUM SUBSTITUTED YTTRIUM IRON GARNET

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Indium을 치환 첨가한 Yttrium Iron Garnet의 자기 특성

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Ⅰ. INTRODUCTION

Microwave ferrite devices require polycrystalline single phase materials approaching high performance as thin or thick films in applications. Yttrium iron garnet(YIG) has been well known as microwave materials of low magnetic loss and applied to isolator, circulator, oscillator as devices[1-3]. In terms of high performance of YIG, those studies such as the magnetic crystallographic anisotropy of ferrimagnetic garnets have been carried out principally on the yttrium and rare-earth garnets. Substituted garnets, compounds in which part of the Fe^{3+} ions are replaced by other diamagnetic or paramagnetic ions, have been studied[4,5]. For example, magnetic anisotropy studies of substituted garnets are of great interest, since the charge of anisotropy upon substitution allows a better understanding of the mechanism of its formation.

Generally indium prefers the octahedral site in the garnet structures and make the anisotropic constant K_1 decreased with substitution. To investigate the effect of substitution on properties of YIG, we have selected indium as a substituent and temperature dependence of magnetization and hysteresis change with temperature for modified YIG were characterized mainly and their microstructures were also presented.

Ⅱ. EXPERIMENT

Polycrystalline samples of $Y_3Fe_{5-x}In_xO_{12}$ with $0 \leq x \leq 0.5$ were synthesized according to coprecipitation techniques. The raw materials, metal nitrates of $Y(NO_3)_3 \cdot 6H_2O$, $Fe(NO_3)_3 \cdot 9H_2O$, $In(NO_3)_3 \cdot 5H_2O$ and NH_4OH were mixed in glass vessel and reacted for 2 h at room temperature. The precipitate was fired for 2 hours at 850℃ in air to obtain the garnet single phase. The crystalline phase was identified by XRD analysis. The magnetic properties of thermo-magnetic behavior and magnetization vs. applied field were investigated using a vibrating sample magnetometer and SQUID magnetometer.

Ⅲ. RESULTS AND DISCUSSION

The magnetic structure of rare earth iron garnets consists of strongly coupled Fe^{3+} on 24*d* sites and Fe^{3+} on 16*a* sites, and loosely coupled R^{3+} on 24c sites which point antiparallel to the ferrimagnetic component of Fe^{3+}. The magnetic moments of the R^{3+} ions are too large, so that the resultant saturation magnetization is parallel to the magnetic moment of R^{3+} ions at low temperatures[6]. As much of indium substitution, single phase of YIG was obtained at a higher calcination temperature. Due to the size increase of In^{3+} radii over that of Fe^{3+}, the substitution of In^{3+} into garnet structure is somewhat limited to the larger of the available Fe^{3+} sites. We have also studied the temperature dependence of magnetization behavior of $Y_3Fe_{5-x}In_xO_{12}$ (x=0 ~ 0.5) from 5 to 400 K. At a low temperature of below 125 K, the magnetization of $Y_3Fe_{5-x}In_xO_{12}$ (x=0.3 ~ 0.5) was higher than that of x=0 ~ 0.2. As increasing temperature and amount of indium substitution, it was apparently shown that the magnetization decreased with strong temperature dependence. For all samples at 77 K rather than at 300 K, the hysteresis loop of x=0.1 exhibited a better ferrimagnetic behavior. These results indicate that a typical ferrimagnetic behavior of the modified YIG appears to be associated with magnetic moment distribution with indium content.

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