Structure and transport properties of epitaxial Fe3O4 thin film grown on MgO (001) substrate by MBE

Duong Anh Tuan*, Dang Duc Dung, Yooleemi Shin, Sunglae Cho,
Department of Physics, University of Ulsan, Ulsan 680-749, Republic of Korea
* Electronic mail: slcho@ulsan.ac.kr

Fe_3O_4 is predicted to possess as half-metallic nature, ~ 100% spin polarization, and has a high Curie temperature and an high room temperature magnetoresistance (MR) for tunneling magnetoresistance (TMR) junctions with Fe_3O_4 electrodes [1]. However, for the TMR junction, a highly conductive under layer and the sharp between interfaces are required because the poor conductivity and roughness of films may lead to a non-uniform current distribution [2]. In addition, the Verwey transition (T_V, a first order metal-insulator transition) of 120 K in bulk Fe_3O_4 is still under controversy because many parameters such as orientation of substrate, buffer layer, thickness, pressure, and thermo-chemical treatment affect the T_V[3, 4]. The Fe_3O_4 thin films have been grown on MgO (001) substrate at various temperatures from room temperature to 600^{o}C using molecular beam epitaxy (MBE). The fcc Fe_3O_4 single structure phase (004) were observed for all Fe_3O_4 thin films in the XRD pattern. The Verwey transition temperatures (T_V, a first order metal-insulator transition) were observed about from 102 to 118 K. The positive anomalous Hall effect (AHE) was obtained indicating that main carrier was dominated as the nature of Fe_3O_4. The negative MR were obtained due to spin depend scattering and the highest MR ratios were obtained for sample growth at high temperature.

References

[1] Z. Zhang et al., Phys. Rev. B 44, 13319 (1991).
[2] P. H. Huang et al., J. Appl. Phys. 97, 10C311 (2005).
[3] E. J. W. Verwey et al., Physica 8, 979 (1941).
[4] A. R. Muxworthy et al., Geophys. J. Int. 140, 101 (2000).