Ir-doping effect on Morin temperature of ~-Fe_2O_3 (0001) thin film

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Morin transition temperature (T_M) of Hematite (α-Fe_2O_3) is the temperature at which, the antiferromagnetic spin configuration changes its direction from the [0001] axis to the (0001) basal plane [1]. The value of T_M in both bulk and particle hematite has been reported to be 263K. However, T_M in epitaxial α-Fe_2O_3 films has not been sufficiently investigated. Morin transition is explained by the competition between two different anisotropies: magnetic dipolar anisotropy (K_{MD}, in-plane anisotropy) and single-ion anisotropy (K_{FS}, perpendicular anisotropy) [2]. Use of 4*d* or 5*d* metal doping enhances K_{FS} because of the strong spin–orbit interactions of the 4*d* or 5*d* metal ions, and consequently T_M is increased. In this study, the successful observation of T_M in (0001) oriented Fe_2O_3 thin films and its enhancement by Ir-doping is reported.

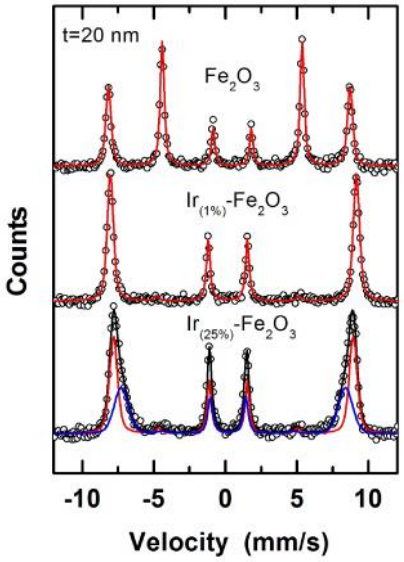

Fig.1: Room temperature CEMS spectra of Fe_2O_3, Ir(1%)Fe_2O_3 and Ir(25%)Fe_2O_3

Fe_2O_3 and Ir-doped Fe_2O_3 films are fabricated by reactive sputtering of metal target using RF magnetron sputtering. The concentration of Ir has been varied from 0 to 25% in the metal alloy target. In-plane magnetic measurements are carried out by using SQUID. A clear increase of in-plane magnetization and coercivity for Fe_2O_3 film has been observed indicating Morin transition, while that was not observed for Ir-doping case. These results indicate that by Ir-doping, T_M of Fe_2O_3 is dramatically enhanced. To clarify this assumption, conversion electron Mössbauer spectroscopy (CEMS) study has been employed at room temperature (Fig. 1). The results for the quadrupole shift and the intensity ratio confirm that the spin direction of α-Fe_2O_3 is in-plane and that T_M is below room temperature, while the spin direction of Ir–Fe_2O_3 is perpendicular to the film and T_M should be higher than room temperature [3]. With increasing Ir concentration, the line width of CEMS spectra is increased and hence for 25% Ir-doping case, the data is fitted with two subspectra. The additional subspectra having smaller hyperfine field is assigned to the Fe atoms surrounded by Ir ions. These results are powerful evidence confirming the enhancement of T_M to a value higher than 400K in Ir-Fe_2O_3.

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