30p-A7-8

Tunnel magnetoresistance effect in Fe/MgO/Fe_2O_3/Fe/IrMn junctions

AIST Spintronics Research Center [1], CREST-JST [2]

○Takayuki Nozaki[1,2], Hitoshi Kubota[1,2], Akio Fukushima[1,2], Shinji Yuasa[1,2]

E-mail: nozaki-t@aist.go.jp

A ferromagnetic oxide tunneling barrier has been widely investigated for the realization of high magnetoresistance effect or a highly-efficient spin injection source through the spin filtering effect. And recently, spin transfer torque in these materials also attracts a new interest. However, high tunneling magnetoresistance effect exceeding 100% at room temperature have never been reported in a magnetic tunnel junction with a ferromagnetic oxide barrier. Possible reasons are difficulty in the formation of a high-quality thin layer without an oxygen defect and poor magnetization reversal property of ferromagnetic oxide materials. In this study, we fabricated a fully epitaxial magnetic tunnel junction, consisting of Fe(50 nm)/MgO (2 nm)/γ-Fe_2O_3 (t_{FeO})/Fe (10 nm)/IrMn(10 nm) and investigated the tunnel magnetoresistance effect through the ferromagnetic oxide γ-Fe_2O_3 layer.

Multilayers were deposited on a single crystal MgO(001) substrate by molecular beam epitaxy. A γ-Fe_2O_3 layer was synthesized by depositing metal Fe in atomic oxygen atmosphere supplied from a thermal gas cracker. MgO barrier was introduced for the template of epitaxial growth of the γ-Fe_2O_3 layer and also for preventing the magnetic coupling between the bottom Fe and γ-Fe_2O_3 layers. In order to improve the magnetization reversal property of the thin γ-Fe_2O_3 layer, an Fe layer of 10 nm was deposited on it and exchange-coupled by a sputter-deposited IrMn layer. The film was patterned into magnetic tunnel junctions of 3×12 μm in size.

Owing to the exchange coupling with the top Fe layer, very steep magnetization reversal of the reference layer was obtained (not shown here). Figure 1 shows a γ-Fe_2O_3 thickness (t_{FeO}) dependence of resistance area (RA) product (●) and MR ratio(●). The RA value increases exponentially with increasing the t_{FeO}, indicating that the high-quality tunneling barrier is formed, and the observed MR effect originates from the tunneling through the γ-Fe_2O_3 layer. The MR ratio decreases monotonically in the thin thickness region of t_{FeO} < 0.2 nm, however, interestingly, clear recover of the MR ratio up to 120% was observed at around t_{FeO} = 0.3 nm. This value is almost comparable to the one obtained in the Fe / MgO / Fe junction (140%).

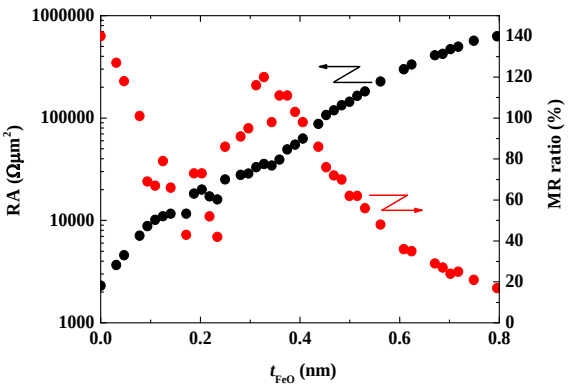

Fig.1 The γ-Fe_2O_3 layer thickness dependence of the RA value and MR ratio in Fe / MgO / γ-Fe_2O_3 / Fe / IrMn junctions.