Fabrication of magnetic tunnel junctions with a metastable bcc-Co_3Mn alloy

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A magnetic tunnel junction (MTJ) is a key device for spintronic applications such as magnetic sensors, magnetoresistive random access memories, and neuromorphic applications. One of the remaining issues for applications is to further enhance the tunnel magnetoresistance (TMR) ratio of MTJs. Currently, a combination of a MgO barrier and CoFeB alloy electrodes has been used as a standard MTJ. For the TMR enhancement, broad investigation on ferromagnetic materials is required. A Co rich CoMn binary alloy forms a hcp or fcc phase as a thermodynamically stable phase. Recently it has been reported that bcc CoMn alloy was obtained in thin film grown on GaAs(001) and MgO(001) single crystalline substrates by molecular beam epitaxy (MBE) as a metastable phase [1][2]. However, there are no reports on growth by sputtering and MTJ fabrication with bcc CoMn alloy electrodes to date. Here, we report the TMR effect observed in MTJs with bcc CoMn alloy as a bottom electrode. The MTJs stacking structure was MgO sub./ Cr(40)/ Co_3Mn(10)/ Mg(0.4)/ MgO(2)/ $Co_{20}Fe_{60}B_{20}$(4.5)/ Ta(3)/ Ru(5) (thickness is nm). The microfabrication of the MTJs was performed using photolithography and Ar ion milling. TMR was measured by a four-probe method. TMR curves were measured at room temperature (RT) for a 20×2 μm^2 sized MTJ annealed at 350°C. A representative TMR curve is shown in Fig. 1. Although the anti-parallel magnetization configuration is not well defined because of the nature of a pseudo-spin valve type MTJ studied here, the definite resistance changes are observed corresponding to the coercivity difference of the top and bottom ferromagnetic layers. The maximum TMR ratio obtained in this stack is approximately 158%. This result indicates that the metastable bcc Co_3Mn alloys possess relatively high spin polarization, which shows their potential for applications. This work was partially supported by JST CREST (No. JPMJCR17J5).

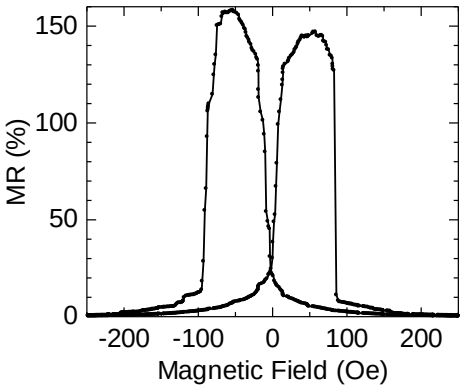

Fig. 1. Typical MR curve for the MTJs with a Co_3Mn alloy electrode.

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[2] R.J. Snow et al., J. Magn. Magn. Mater. 419, 490 (2016).

[3] K. Kunimatsu et al., submitted.