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Enhanced Magnetoresistance in Mn_xGa_{100-x}/MgO/CoFeB perpendicular magnetic tunnel junctions by FM interlayer

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The ordered MnGa alloy exhibits high perpendicular magnetic anisotropy (PMA), high spin polarization, low magnetization and low damping constant, which make it an excellent candidate for spintronics devices especially for Gbit STT-MRAM [1-4]. Recent report shows that, only small MR ratio for MgO/MnGa MTJs was obtained due to the interface states and Mn diffusion [5]. Introduction of the 3d metal and/or alloy is a typical method to optimize the interface and improve the MR ratio in perpendicular magnetic tunnel junction (p-MTJ). However, the coupling between MnGa and the FM layer is complicated for MnGa case [5, 6]. In this work, the magnetic properties and the magnetoresistance (MR) effect of p-MTJs with core structure of MnGa/FM(FM = Fe, Co, $Co_{40}Fe_{40}B_{20}$)/MgO/CoFeB were investigated.

The MnGa alloy has $L1_0$ and $D0_{22}$ structure depends on the composition. The MTJ stack structures are Cr(40)/ Mn_xGa_{100-x}(30)/ FM(t_{FM})/ Mg(0.4)/ MgO(2.2)/ CoFeB(1.2)/ Ta(5)/ Ru(7) (nm), where x = 57, 62, and 70. The MnGa/FM bilayer exhibits PMA when t_{FM} was limited within 1.5 nm. Both the Fe and Co interlayers were shown to be effective to enhance the MR ratio of the MTJs, and the MR values reach 50% and 100% at 300 K [Fig. 1(c) and 2(d)] and 5 K. However, the magnetic and transport properties show completely different behaviors. The remnant magnetization of the samples with Fe interlayer increases as the tFe increases, while it decreases for Co interlayer. Besides, the MR(H) of the MTJs with Co interlayer shows four low-resistance states in one full loop [Fig. 1(b)], while it is two for Fe case [Fig. 1(a)].

The results are discussed by considering the coupling effect between Fe, Co and MnGa. The samples with CoFeB interlayer show the similar behavior with the ones with Fe interlayer, but with lower MR ratio

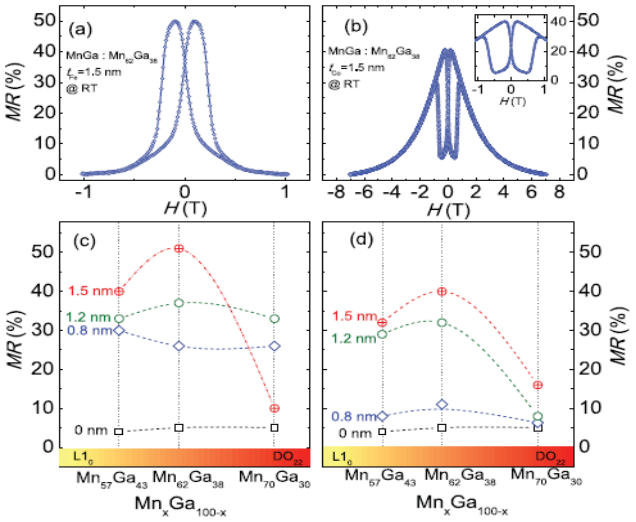

Fig 1. The MR(H) loops of sample with Fe (a) and Co (b) interlayer. The MnGa composition dependence of MR ratio for samples with different Fe (c) and Co (d) thickness.

possibly due to the present of the B element. By considering the contribution of magnon excitation and impurity assisted hopping to the spin dependent tunneling, the temperature dependence of the transport property of the p-MTJs will be discussed in detail. [7]

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