$L1_0$-MnAl thin film with high perpendicular magnetic anisotropy grown on $L1_0$-PtMn seed layer

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Spin-orbit torque (SOT) induced magnetization switching in high spin Hall angle (SHA) material / ferromagnet (FM) heterostructures has been devoted lots of research attention as it shows promise for future ultrafast and power conservation magnetic memories [1]. For FM layers, magnetic thin films with high perpendicular magnetic anisotropy (PMA) are needed for a prolonged data retention, which promote research of Mn-based alloys, such as $L1_0$-MnAl with high PMA [2]. Comparing to those heavy metals with high SHA such as Pt, W, Ta, etc., Mn-based $L1_0$ and $L1_2$ type antiferromagets (AFM) XMn_Y (X=Ir, Pt, etc., Y=1, 3) are of significant interest not only due to their simple structure as well as the possibility of depositing Mn-based alloys with high PMA epitaxially on them [3], but also their possess high SHA [4-6]. Although both $L1_0$-MnAl and $L1_0$-PtMn show application prospects for memory devices, experimental reports about epitaxial growth of MnAl on PtMn are absent. In this work, we report the crystal and magnetic properties of $L1_0$-MnAl thin films deposited on $L1_0$-PtMn seed layer.

All the samples were prepared by magnetron sputtering system. The stacking structure was MgO(001) sub. / PtMn (15) / MnAl (3-40) / Ta (3) in nm. We tuned substrate temperature (T_s), post annealing temperature (T_a), and post annealing time to improve the $L1_0$ crystal orientation of both MnAl and PtMn.

Fig. 1 shows the thickness dependence of magnetic properties of prepared MnAl films. Although PMA magnitude K_u decreased rapidly with decreasing MnAl thickness, we have still measured a relative high K_u around 3 Merg/cc in the 3nm MnAl film. The decreased K_u with decreasing thickness is regarded as insufficient $L1_0$ structure of MnAl in thin film region since saturation magnetization M_s also decreased. This work was supported in part by GP-spin program

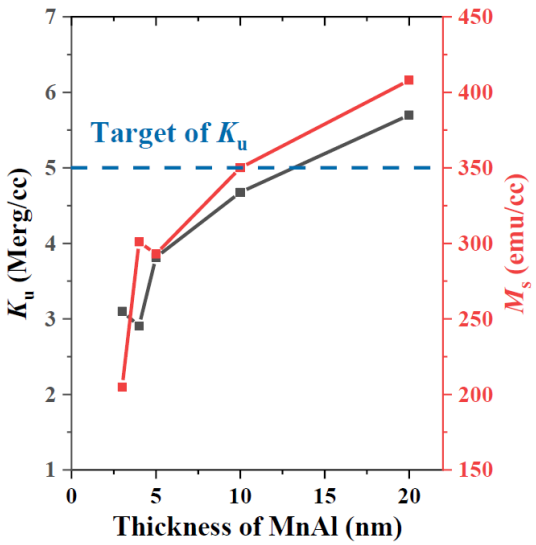

Fig. 2 Magnetic properties dependence of different MnAl thickness.

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