Antiferromagnet Driven Perpendicular Exchange Bias in Py/Mn/Cu_3Au(001)

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Ferromagnet (FM)/Antiferromagnet (AFM) exchange coupling is a very important issue in magnetic thin films. The commonly reported manifestation of this exchange interaction is a shift in the hysteresis loops. Recently, our study shows another interesting effect: the γ-phase Mn on Cu_3Au(001) inference the magnetic anisotropy of the proximity ferromagnetic layer. In fact, it drives the spin orientation of FM layer from in-plane to perpendicular. In order to investigate the spin orientation and the relation between exchange coupling and magnetic domains in FM/AFM exchange coupling systems. We performed Py ($Ni_{78}Fe_{22}$)/Mn bilayers on Cu_3Au(001) single crystal with grown epitaxially (layer by layer). The samples were grown at room temperature. 600 Oe field cooling perpendicular to the film plane were applied before measurement. The magnetic hysteresis loops were taken by Magneto-Optical Kerr Effect. Besides, the magnetic domain images were obtained by photoemission electron microscopy (PEEM) with X-ray magnetic circular dichroism (XMCD). The experiment were performed at 05B2 beamline of National Synchrotron Radiation Research Center.

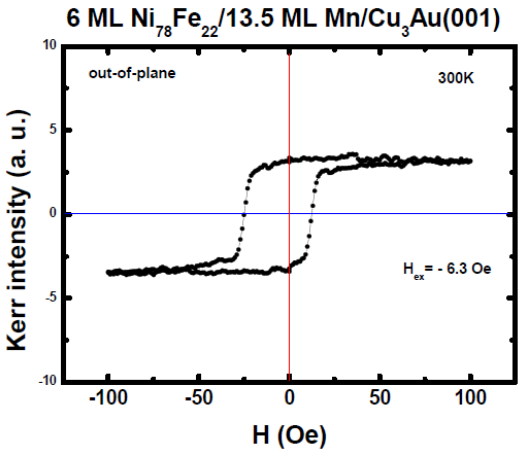

Fig.1: Magnetic hysteresis loop of 6 ML Py/13.5 ML Mn/Cu_3Au(001) measured in polar geometry..

In Fig. 1, the perpendicular exchange bias of 6 ML Py/13.5 ML Mn/Cu_3Au(001) sample was found. In particularly, exchange bias is still apparently observable at room temperature. Temperature dependent exchange bias in 9.1 ML Py/14 ML Mn/ Cu_3Au(001) were showed in Fig. 2. The bias field decrease as a function of temperature increase. Because the magnetic anisotropy of 6 ML Py/Cu_3Au(001) is in-plane direction. Our study shows that the strong proximity exchange coupling between Py and γ-phase Mn could not only drive the magnetic moments in Py layer from in-plane direction to perpendicular direction but also pin the magnetic moments to reveal shifted hysteresis loops

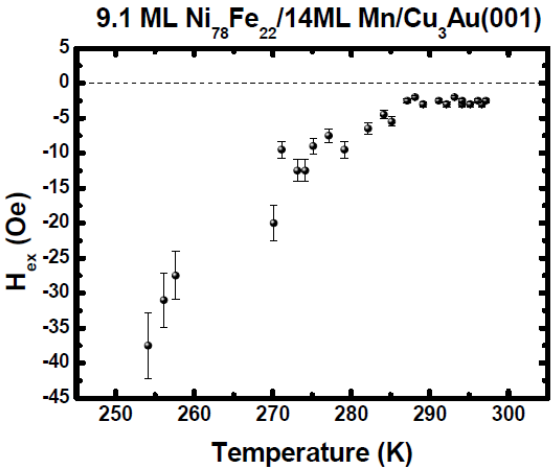

Fig. 2: Temperature dependent exchange bias in 9.1 ML Py/14 ML Mn/ Cu_3Au(001)

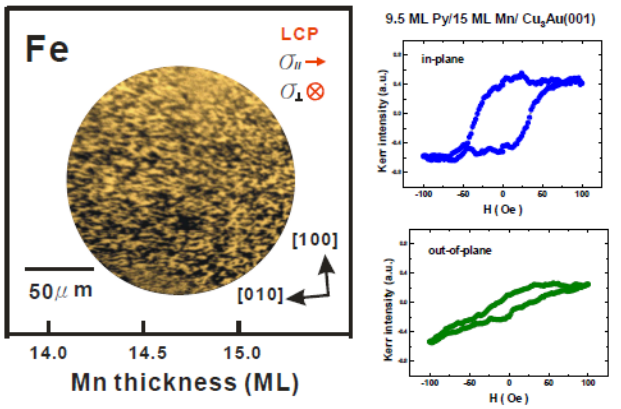

Fig. 3: The magnetic domains of 9.5 ML Py/wedge Mn/Cu_3Au(001) reveal small irregular patterns. MOKE measurement of the sample shows the magnetization tilt slightly to the perpendicular direction.

Figure 3 shows the magnetic domains of 9.5 ML Py/wedge Mn/Cu_3Au(001) and the corresponding magnetic hysteresis loops. The magnetic hysteresis loops indicate the direction of magnetic moments tilt slightly to the perpendicular direction in the Mn thickness range from 14.5 ML to 15.0 ML. The magnetic domains of 9.5 ML Py/14~15 ML Mn/Cu_3Au(001) reveal irregular patterns and the domain size is quite smaller than the domains of 9.5 ML Py/0~11 ML Mn/Cu_3Au(001) with in-plane magnetic anisotropy.