Deposition Sequence and Exchange Bias Field in FeMn/NiFe Bilayers with Ta/Cu Underlayer

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When antiferromagnetic (AF) layer is grown on top of ferromagnetic (F) layer or vice versa in the applied magnetic field during growth (in-situ field growth) or they are field-cooled from above blocking temperature after growth (ex-situ field cooling), center shift and broadening of magnetic hysteresis (M-H) loop from zero along negative or positive field axes, are simultaneously shown owing to the interfacial exchange coupling between F and AF layers and are named as exchange bias field and coercivity enhancement, respectively. Generally, it is well-known that the deposition of AF layer on top of fully saturated F layer is preferable to the other case to get the large exchange bias field. γ fcc $Fe_{50}Mn_{50}$ is a noncollinear antiferromagnetic phase and (111) orientation is a perfectly compensated spin structure at the interface. γ fcc $Fe_{50}Mn_{50}$(111) is the most relevant factor in order to get the largest exchange bias field in NiFe/FeMn bilayers empirically. FeMn and NiFe layers are grown on Ta(5 nm)/Cu(5 nm) underlayer to promote γ fcc FeMn(111) texture. The sample structure we made by magnetron sputtering technique consists of Si(substrate)/Ta(5)/Cu(5)/*NiFe(5)/FeMn(5)*/Ta(5) and Si/Ta(5)/Cu(5)/*FeMn(5)/NiFe(5)*/Ta(5). The number in above parenthesis represents the layer thickness in nanometer unit. We prepared in-situ field-growth sample and ex-situ field cooling sample as well in order to compare the exchange bias field among them. For structural analysis, we measured low-angle x-ray reflectivity and high-angle x-ray diffraction. For compositional depth profile, we measured x-ray photoelectron spectroscopy(XPS) depth profiling. For magnetic analysis, we measured vibrating sample magnetometer(VSM). We report the experimental evidence that exchange bias of FeMn(bottom)/NiFe(top) bilayer is larger than that of NiFe(bottom)/FeMn(top) bilayer for both in-situ field growth and ex-situ field cooling cases. We suggest that the composition ratio of FeMn at the F/AF interface affects dominantly the exchange bias field of our samples.

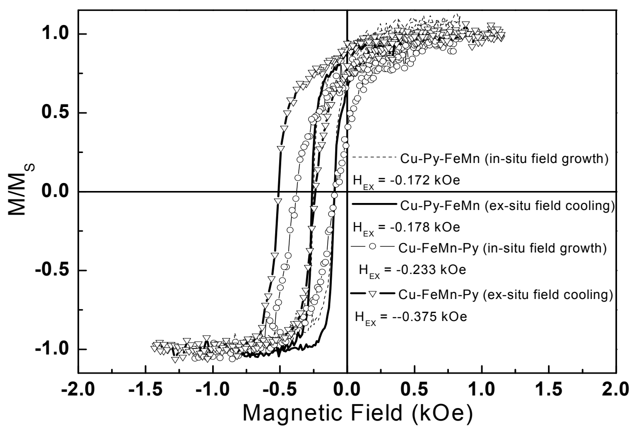

Fig. 1. Magnetic hysteresis loops and each exchange bias field of FeMn/NiFe and NiFe/FeMn bilayers with Ta/Cu underlayer on silicon substrate.