An Investigation of Ion-beam Bombardment on the Antiferromagnet's Surface in Exchange Biased Bilayers with Photoemission Electron Microscopy (PEEM)

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In this report, the effect of ion-beam bombardment on an antiferromagnetic (AF) surface capped with a ferromagnet (FM) in exchange biased (FM/AF) bilayers was studied. CoFe(8nm)/(CoFe)O(10nm, 41% O_2/Ar) and NiFe(8nm)/NiO(15nm, 16% O_2/Ar) bilayers were prepared with a dual ion-beam deposition technique [1-2]. The bottom AF layer was bombarded using different ion-beam procedures before capping with a FM layer. The PEEM end-station was installed on beam line 05B2 at NSRRC and allowed us to explore the magnetic domain structure (for a detailed description about the instrument see Ref. 3). The x-ray polarization was at a incidence angle of 25° to sample plane. The CoFe domain images were obtained using the Co $L_{3,2}$ edge x-ray, and the NiFe domain images obtained using the the Ni $L_{3,2}$ x-ray.

Figure 1 shows the CoFe domain structures of different CoFe/(CoFe)O bilayers measured at room temperature; the dark-to-white areas indicate the spins have aligned in different directions in each area. A large domain (several hundred μm) can be observed, and distinct differences occur when the CoFe layer was in contact with (CoFe)O layers prepared differently (e.g. changes in interfacial composition and microstructure). These differences are attributed to the exchange bias phenomenon present affecting the interface magnetism between the FM and AF.

The NiFe domain structures of different NiFe/NiO bilayers are shown in Fig. 2. The NiFe domains clearly break into small domains when the bombardment periods of NiO layer increases from 5min. to 10 mins. The hysteresis loops of the bilayers (not shown) after being 20 kOe field cooled to 5 K show an unusual positive exchange bias field (H_{ex}~ +190 Oe for t_{bom}=5 mins), showing that ion-beam bombardment alters the exchange bias via affecting the overall domain structure of the FM film component.

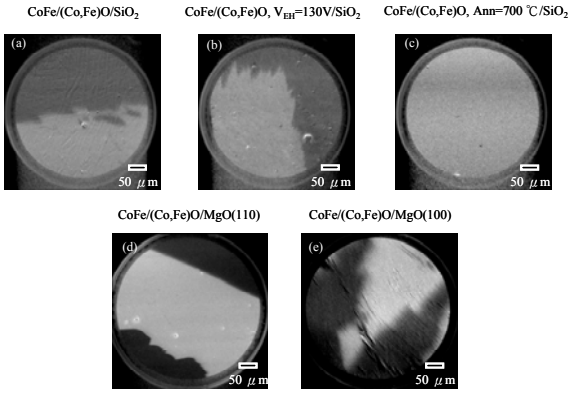

Fig. 1: The PEEM images of CoFe/(Co,Fe)O - 41% O_2/Ar bilayer at room temperature.

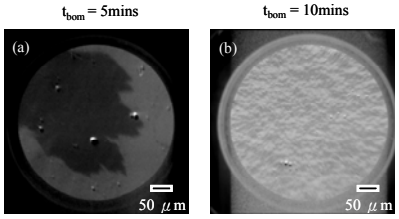

Fig. 2: The PEEM images of NiFe/NiO - 16% O_2/Ar bilayer at room temperature, (a) bombardment period (t_{bom}) of NiO layer = 5min., and (b) t_{bom} = 10min.

References

[1] J. van Lierop *et al.*, Phys. Rev. B **76**, 224432 (2007).
[2] K.-W. Lin and J.-Y. Guo, J. Appl. Phys. **104**, 123913 (2008).
[3] D. H. Wei *et al.*, J. Magn. Magn. Mater. **282**, 49 (2004).