XRR and XMCD investigation of 120 MeV Ag^{8+} ion irradiation in Fe/MgO/Fe multilayer

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For present investigation, Fe/MgO/Fe mulitlayers has been grown on Si-substrate by e-beam evaporation method in ultra high vacuum (2×10^{-8} Torr), details are discussed earlier [1]. Multilayer sequence from substrate is as follows: MgO(10)/Fe(20)/MgO(5)/Fe(10)/Au(5) (Values in parenthesis are thickness in nm). The multilayer stack has been irradiated by using 120 MeV Ag^{8+} at different fluencies ranging from 1×10^{11} to 1×10^{13} ions/cm^2 in ultra-high vacuum by using Pelletron Accelerator at IUAC, New Delhi.. XRR analysis shows that thickness of various layers for pristine stack are 11, 12, 6, 7, 4 nm for MgO, Fe, MgO, Fe, and Au layers in the stack respectively. In the XRR analysis Fe-O_x layer of thickness 1.3 and 1.9 nm has also been considered at Fe/MgO and MgO/Fe interfaces. Further analysis carried out on irradiated stack shows change in interface roughness with fluence of irradiation and slight increase of Fe-oxidation at interface. It may be contemplated that confined energy in the stack by the heavy-ions increases the possibility of intermixing at interface, resulting the Fe-O_x to be thicker. Fe L-edge near edge fine structure (NEXAFS) measurements shows presence of Fe^{2+} and Fe^{3+} valence state with dominant feature corresponding to Fe^{3+} states in pristine as well as irradiated samples. It is well established that magnetic moment aligned along the direction of ion-trajectory during the irradiation experiment [2]. Since, SHIs incident perpendicular to the film surface during irradiation, hence the dominant changes are observed in the perpendicular hysteresis. This is in agreement with X-ray magnetic circular (XMCD) measurements where the in plane XMCD signal intensity reduces with fluence from 9.6% to 0% at room temperature. This envisages that few magnetic moments are aligned in the direction of ion trajectory reducing the strength of the in-plane XMCD signal at room temperature. Alignment of magnetic moment in irradiated material has also been discussed in our previous work [3]. The detailed investigation and correlation of magnetization with interface is under investigation.

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