Fabrication of MTJ based magnetic sensors using $L1_2$-ordered Mn_3Ir pinned layer

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Researches on magnetic tunnel junctions (MTJs) for bio-magnetic field sensors have been actively conducted. For magnetic sensor applications, suppression of magnetization fluctuation in both free and pinned layers is required to reduce magnetic noise in MTJ-based sensors. In addition, an orthogonal alignment of magnetic easy axis for free and pinned layers by double-annealing process is required to obtain a linear magneto-resistance (MR) curve [1]. However, it is not easy to obtain a perfect orthogonal alignment, because annealing temperature to induce magnetic anisotropy in free layer is close to blocking temperature of pinned layer. In previous work, both giant exchange anisotropy [2] and high blocking temperature [3] were observed in $L1_2$-ordered Mn_3Ir/CoFe bilayers. In this work, we investigated magnetic properties of $L1_2$-ordered-Mn_3Ir/CoFe bilayers to apply them to pinned layers of MTJ-based sensors.

The films were deposited using an ultra-high-vacuum magnetron sputtering. For optimization of Mn_3Ir thin films, Si/SiO_2/Ta(5) /Ru(20)/Mn.Ir(30)/Ta(1)/Ru(1) (in nm) was prepared by varying Ar gas pressure. Films with structure of Si/SiO_2/ Ta(5)/Ru(10)/ Mn-Ir(10) /CoFe(2)/Ru(0.9)/CoFeB(3)/MgO(2.5) were prepared to investigate magnetic properties. The crystal structure and the magnetic properties were examined by X-ray diffiraction (XRD) and vibrating sample magnetometer (VSM).

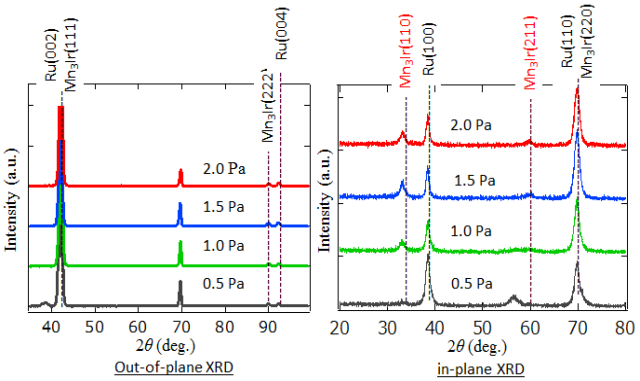

Fig. 1 Out-of-plane and In-plane XRD profiles of Mn-Ir films fabricated by various Ar gas pressure.

Fig. 1 shows out-of-plane and in-plane XRD profiles for Mn-Ir films grown by various Ar gas pressure. We confirmed (111)-orientation of Mn-Ir films from out-of-plane XRD profiles. We observed (110) and (211) peaks at $2\theta_\chi = 33°$ and 60° in in-plane XRD profiles except for the films prepared at P_{Ar} = 0.5 Pa. This result indicates that Mn-Ir films prepared at $P_{Ar} \geqq 1.0$ Pa shows $L1_2$-ordred structure. Fig. 2 shows the magnetization curve in Mn_3Ir/CoFe/Ru/CoFeB films prepared at P_{Ar} = 1.0 Pa. 1st annealing temperature was 350℃ and 2nd annealing temperature was varied 200 to 275℃ with the magnetic field applied vertically to 1st annealing. The shift of magnetization curves were clearly observed below annealing temperature of 250°C. The obtained high thermal stability is due to the high blocking temperature of $L1_2$-ordered Mn_3Ir layer.

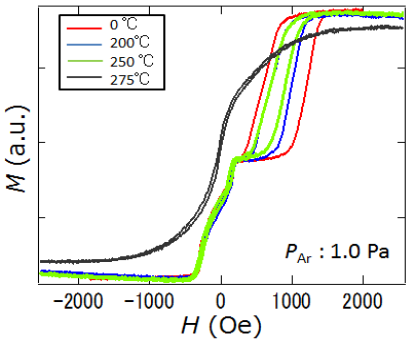

Fig. 2 Magnetization curves for Mn-Ir/CoFe bilayers

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