CT15

Damping Constants for Permalloy Single Crystal Thin Films

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Gilbert's damping constant α of soft magnetic thin films is an important factor to develop high-frequency magnetic recording system. The α values of permalloy polycrystalline thin films are overestimated, because of the distribution of the crystal orientation in the thin films. We investigated the α of $Ni_{82}Fe_{18}$(001) single crystal thin films prepared on MgO(001) single crystal substrates by employing a Q-band (35 GHz) ferromagnetic resonance (FMR) analyses. The FMR spectrum of the 10nm-thick specimen showed a single resonance peak at the resonance field H_r of 8.1 kOe with applying magnetic field parallel to the $[100]_{NiFe}$ direction (ϕ= 0 deg) in the film plane. The α value was estimated to be 0.005 from the resonance peak width ΔH of 120 Oe by using the relationship of $\Delta H = 4\pi\alpha f_r/\gamma$, where γ is gyromagnetic ratio, and f_r is resonance frequency. As shown in Fig. 1, with changing the field direction in the film plane from ϕ=0 to 180 deg ($[-100]_{NiFe}$ direction), H_r and α have the constant values. The α also had the constant values, when the field direction was changed out of plane between the $[100]_{NiFe}$ and the $[001]_{NiFe}$ directions, which were similar to those of the Ni single crystal thin films[1]. These results mean the α values of the fcc crystal structural magnetic thin films does not depend on the crystal direction. Figure 2 shows the magnetic layer thickness t dependence of α at ϕ = 0 deg. With decreasing the t, the α monotonically decreases from 0.007 (t = 20 nm) to 0.004 (t = 5 nm), then extremely increases to be 0.010 at t = 2 nm. These results are probably caused by the lattice distortion of the $Ni_{82}Fe_{18}$ layer at the interface of MgO substrate.

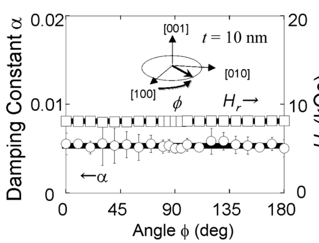

Fig. 1. ϕ dependence of H_r and α.

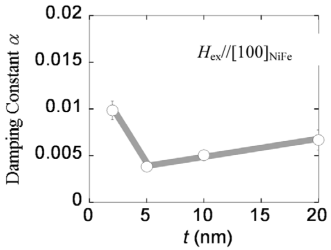

Fig. 2. t dependence of α.

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REFERENCES

[1] N. Inaba,. N. Fujita, M. Ohtake, F. Kirino, and M. Futamoto, Proceedings of Joint International Conference Materials for Electrical Engineering, June 2008, Bucharest Rumania, 168.

CU01

Effect of Interface Roughness on Magnetoresistance and Magnetization Switching in Double-Barrier Magnetic Tunnel Junction

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A double-barrier magnetic tunnel junction (DMTJ) comprising an amorphous ferromagnetic $Co_{70.5}Fe_{4.5}Si_{15}B_{10}$ (in at.%) layers [1, 2] were employed with an emphasis given on understanding amorphous ferromagnetic layer effects on the bias voltage dependence. The DMTJ structure consisted of Ta 45/Ru 9.5/IrMn 10/CoFe 7/AlOx/free layer 7/AlOx/CoFe 7/IrMn 10/Ru 60 (nm). Various free layers such as CoFe 7, CoFeSiB 7, and CoFe 1.5/CoFeSiB 4/CoFe 1.5 were prepared and compared. The DMTJ with an amorphous CoFeSiB free layer offers smooth surface roughness confirmed by X-ray reflectivity (XRR) and transmission electron microscopy. The CoFeSiB-free layer DMTJ (Hi = 27 Oe) showed lower interlayer coupling than the CoFe-DMTJ (Hi = 40 Oe). And the normalized TMR ratio at the applied voltages of +0.4 V and -0.4V showed higher values in the CoFeSiB-DMTJs (0.79, 0.78) than CoFe-DMTJs (0.51, 0.74), respectively. An amorphous free layer offers smooth interface roughness, resulting in reduced interlayer coupling field and bias voltage dependence.

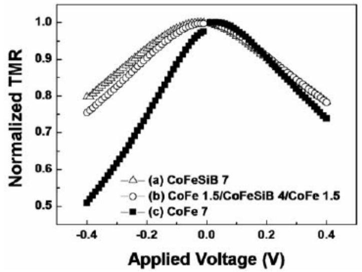

Fig. 1. Bias voltage dependence of TMR ratio.

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REFERENCES

[1] M. S. Song, B. S. Chun, Y. K. Kim, I. J. Hwang, and T. W. Kim, J. Appl. Phys. 97, 10C917 (2005).
[2] J. Y. Hwang, J. R. Rhee, B. S. Chun, Y. K. Kim, and T. Kim, J. Appl. Phys. 99, 08T315 (2006).