17a-P16-2

Enhancement of perpendicular magnetic anisotropy of $L1_0$-ordered FePd films using CoFe interlayer

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From the viewpoint of device reliability of STT-RAM, it is necessary to realize small critical switching current and high thermal stability. In order to have high density MRAM, the MTJ cell size should be very small, which works in favor of STT-RAM, because the switching current scales down as the MTJ size shrinks. The theoretical expressions predict that lower critical currents for switching and high thermal stability can be achieved by using PMA materials. $L1_0$ ordered FePd is expected to be a promising candidates for new generation high density magnetic memory devices because of their high magnetic anisotropy [1, 2]. In our previous study, a very thin CoFeB layer was inserted between $L1_0$-FePd and the MgO barrier for the reduction of the thickness of free layer as well as for lowering the switching current density [3, 4]. In this work, we investigated the influence of amorphous CoFe interlayer on the structural and magnetic properties of FePd thin films for the use of the free layer in magnetic tunnel junctions. We also compared the magnetic properties of $L1_0$-FePd films with CoFe and CoFeB interlayer inserted between FePd and MgO layers. $L1_0$ ordered FePd thin films with a very thin CoFe (0.5 nm) layer between FePd and MgO layers were prepared by ultrahigh vacuum magnetron sputtering system with $P_{base} < 10^{-7}$ Pa onto MgO(001) substrates. Crystallographic texture of the films was studied by the XRD measurements with Cu K_α radiation, whereas the magnetic anisotropy was investigated measuring hysteresis loops at room temperature using a superconducting quantum interface device magnetometer. From the *M-H* curve of the films, the magnetic easy axis for Cr(40)/Pd(10)/FePd(2)/CoFe(0.5)/MgO(2)/Ta(2) (unit: nm) films is found along the perpendicular direction of the films, whereas the magnetic easy axis of that film with amorphous CoFeB (0.5) inter layer, was along to the in-plane direction of the films. The value of magnetic anisotropy field corresponding to the magnetic hard axis is found ~12 kOe for the films with CoFe interlayer, whereas in the case of amorphous CoFeB interlayer we obtained the PMA for the film with $t_{FePd} \geq 3.0$ nm. PMA was obtained for the films with CoFeB interlayer when it was annealed [4]. Our findings illustrate that the crystallographic ordering of the $L1_0$ face-centered tetragonal (fct) FePd phase was significantly promoted when CoFe was deposited as interlayer of the film and PMA was obtained without annealing. Thus it can be an important issue for the application of such as magnetic memory devices.

Acknowledgments: This work was partially supported by the Funding Program for World-Leading Innovative R&D on Science and Technology (FIRST Program) by the JSPS and Grant-in-Aids for Scientific Research and by a research grant from the Tanaka Holdings Co. Ltd.

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