20a-E7-9

CoFeB/Ta/[Co/Pd]強磁性電極を用いた磁気トンネル接合

Magnetic tunnel junctions using CoFeB/Ta/[Co/Pd] ferromagnetic electrodes

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To realize high-density nonvolatile memory with perpendicular anisotropy magnetic tunnel junctions (p-MTJs), one needs to achieve both a high thermal stability factor (Δ) and a low intrinsic critical current (I_{C0}) at reduced dimension [1]. For high Δ, multilayer electrodes have an advantage because the product of effective magnetic anisotropy energy density and thickness can increase by increasing stacking number. We reported that a high Δ over 90 was obtained in MTJ using multilayer electrodes consisting of CoFeB/Ta/[Co/Pt]$_6$ at the junction diameter less than 20 nm [2]. However, I_{C0} is too large to switch magnetization solely by current, which may be due to a large damping constant (α) of Co/Pt multilayer [3]. In this work, we investigate magnetic and MTJ properties for CoFeB/Ta/[Co/Pd] ferromagnetic electrodes, since a low α is expected for the Co/Pd compared with Co/Pt.

All films are deposited on thermally oxidized Si substrates by dc/rf magnetron sputtering. The stack structures are, from the substrate side, Ta(5)/Pt(5)/synthetic-ferrimagnetic reference layer/MgO/ $Co_{20}Fe_{60}B_{20}$(1.6)/Ta(0.4)/[Co(0.4)/Pd(t_{Pd})]$_n$/Ru(5). Pd thickness t_{Pd} is varied from 0.4 to 1.2 nm and stacking number n is varied from 4 to 6. For magnetization measurement, vibrating sample magnetometer is used. We fabricate MTJs by using electron beam lithography, reactive ion etching and Ar ion milling. All films are annealed at 300°C for 1 hour under a perpendicular magnetic field of 0.4 T.

Magnetization measurement reveals a perpendicular easy axis in the films with $t_{Pd} \geq 0.8$ nm and $n \geq 4$. For MTJ with $t_{Pd} = 0.8$ nm and $n = 6$, we evaluate Δ by measuring switching probability ($P(\tau)$) as a function of the amplitude of pulse magnetic field. Fig. 1 shows $P(\tau)$ as a function of magnetic field of MTJ with the junction diameter of 31 nm. A high Δ of 218 is obtained.

This work was supported by the FIRST program of JSPS, R&D for Next-Generation IT of MEXT, and Grants for Excellent Graduate Schools of MEXT.

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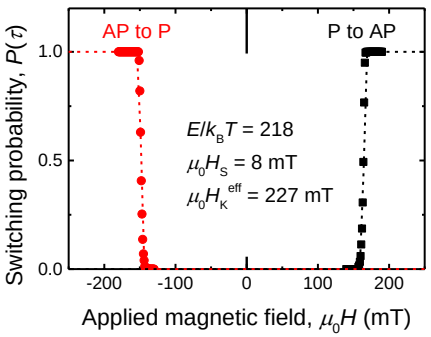

Fig.1 Switching probability as a function of applied magnetic field.