19a-S2-7

Junction size dependence of intrinsic critical current and thermal stability factor of MgO/CoFeB/Ta/CoFeB/MgO recording structure

CSIS, Tohoku Univ.[1], CIES, Tohoku Univ. [2], Laboratory for Nanoelectronics and Spintronics, RIEC, Tohoku Univ. [3], WPI – AIMR, Tohoku Univ.[4] Hideo Sato[1,2], Eli Christopher I. Enobio[1,3], M. Yamanouchi[1,3], S. Ikeda[1,2,3], S. Fukami[1,2], S. Kanai[3], F. Matsukura[4,1], and H. Ohno[1,2,3,4]

E-mail: hsato@csis.tohoku.ac.jp

Intrinsic critical current (I_{C0}) and thermal stability factor (Δ) are important characteristics for magnetic tunnel junctions (MTJ) to be used in spintronics based very large scale integrated circuits and spin-transfer-torque magnetoresistive random access memory. It was reported that MgO/CoFeB/Ta/CoFeB/MgO recording structure shows higher Δ while keeping comparable I_{C0} compared to MgO/CoFeB recording structure.[1,2] In this study, we investigate junction size dependence of intrinsic critical current and thermal stability factor for the MTJ with MgO/CoFeB/Ta/CoFeB/MgO recording structure down to junction diameter (D) of 11 nm.

Stack structure consisting of, from substrate side, Ta(5)/Pt(5)/$[$Co(0.4)/Pt(0.4)$]_{x6}$/Co(0.4)/Ru(0.4)/$[$Co(0.4)/Pt(0.4)$]_{x2}$/Co(0.4)/Ta(0.3)/CoFeB(1)/MgO/CoFeB(1.6)/Ta(0.45)/CoFeB(1)/MgO/Ta(5)/Ru(5) is deposited by dc/rf magnetron sputtering. Numbers in parentheses are nominal thicknesses in nm. Circular MTJs with D varied from 11 to 56 nm are fabricated by electron beam lithography, reactive ion etching, and Ar ion milling, followed by annealing for 1 hour under 0.4 T perpendicular magnetic field.

Δ is evaluated by measuring switching probability as a function of pulse magnetic field amplitude with duration of 1 s. Δ shows almost constant value down to D of ~30 nm, below which it starts to reduce, indicating that nucleation size of the recording structure is around 30 nm. The D dependence of Δ can be explained by magnetic properties of blanket film with correction of demagnetization factors. I_{C0} is evaluated by measuring switching probability with respect to applied pulse current amplitude I with duration of 0.1 s or 5 ms. I_{C0} decreases monotonically with decreasing D. To discuss D dependence of STT switching efficiency, a ratio of Δ/I_{C0} is plotted with respect to D as shown in Fig 1. Δ/I_{C0} shows continuous increase with decreasing D, suggesting that higher STT switching efficiency can be obtained at reduced dimensions.

The work was supported by the FIRST program of JSPS and R&D for Next-Generation Information Technology of MEXT, and R&D Subsidiary Program for Promotion of Academia-industry Cooperation of METI.

[1] H. Sato *et al.*, Appl. Phys. Lett. **101**, 022414 (2012).

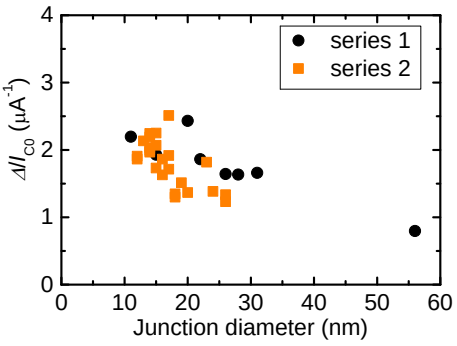

Fig. 1. A ratio of thermal stability factor to intrinsic critical current is plotted against junction diameter.