Distribution of interlayer-exchange coupling on MTJ multilayer

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Ever since the discovery of spin valve structure consisting of ferromagnetic free-FM/spacer metal or insulator/ferromagnetic pinned-FM/antiferromagnetic (AF) multilayer there has been renewed interest in the investigation of exchange coupling due to its role on magnetoresistance response in external field. In this work, the local M-H loops have been measured on the free layer of a magnetic tunneling junction (MTJ) with the structure of Ta(50Å)/Cu(100Å)/Ta(50Å)/NiFe(20Å)/ Cu(50Å)/$Mn_{75}Ir_{25}$(100Å) /$Co_{70}Fe_{30}$(25Å)/Al_2O_3(15Å)/$Co_{70}Fe_{30}$(25Å)/Ta(50Å) using the magneto-optical Kerr effect (MOKE) system, with 2 μ m spatial resolution, to investigate the mechanism of exchange bias field (H_E) and coercivity (H_C) on free layer. Two-dimensional plots of H_E and H_C show symmetric saddle shapes with their axes aligned with the pinned layer due to the shadow mask effect during deposition, as shown in Fig.1 (a)(b). In general there is a linear relationship between local variations of H_E and H_C measured over the junction, indicating a common factor in the microscopic origin of enhanced H_C and H_E. Based on these results, we propose new model with a dipole interaction for the mechanism of enhanced coercivity associated with morphological corrugations, and measured results have been compared with the calculation on the 2-dimensional distribution of coercivity and exchange coupling field.

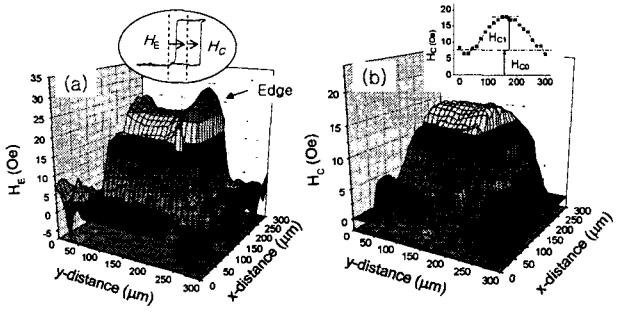

Fig. 1. Two-dimensional distribution of (a) exchange bias field H_E, and (b) coercivity H_C in 200°C-annealed sample (x-axis: along free-layer, y-axis: along pinned layer directions). In the inset of (a) MOKE hysteresis loop for the place located at the center of junction. In the inset of (b), the variation of H_C, where H_{C0} and H_{C1} denote the intrinsic and enhanced components of coercivity, respectively.