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Co/Pd 다층박막에서의 국소 보자력 변화와 자구 반전 거동간의 정량적 상관관계 연구

한국과학기술원 물리학과 및 스핀정보물질연구단 장혁재*, 최석봉, 신성철

Observation of Quantitative Correlation between Local Coercivity Variation and Magnetization Reversal Behavior in Co/Pd Multilayer Films

Dept. of Physics and CNSM, KAIST Hyuk-Jae Jang*, Sug-Bong Choe, and Sung-Chul Shin

1. Introduction

Magnetization reversal dynamics study in Co/Pd multiplayer films has been considered important for achieving high performance of technological applications as well as for fundamental understanding of the reversal process. Recently, advanced magnetic imaging techniques have provided direct evidence of the contrasting magnetization reversal behavior, wall-motion dominant and nucleation dominant processes in this system. Macroscopic magnetic properties and local magnetic properties variation due to the structural irregularities have been studied as possible origins of the contrasting reversal behavior[1,2]. Among the local magnetic properties, the local coercivity has been considered as one of the most important parameters which contribute to reversal dynamics and recording noise, because fluctuation in the local coercivity may cause an inhomogeneity in domain shape and size. Even though it is imperative to understand how the local coercivity variation affects the magnetization reversal behavior, it is not yet quantitatively investigated. Therefore, we present here the observation of the quantitative correlation between the local coercivity variation and the magnetization reversal dynamics.

2. Experiment

We prepared the multilayered samples of (2-Å Co/11-Å Pd)$_n$ with varying number of bilayer repeats *n* from 3 to 20 on glass substrates by e-beam evaporation under a base pressure of 2.0×10^{-7} Torr at ambient temperature. The individual bilayer thickness was kept constant to prevent the substantial changes of the macroscopic magnetic properties. The structural irregularities were expected to increase with increasing *n*, which in turn, sensitively affected the local coercivity variation. Using a MOMM system[2], the local hysteresis loops were measured simultaneously for every local region of 0.98×0.98 μm^2 at ambient temperature under an identical condition of the sweeping rate of 10 Oe/s on a 32.0×25.6 μm^2 region of each sample. We obtained the local coercivity from the local hysteresis loops and then, determined the standard deviation ΔH_C of the local coercivity variation. Magnetization reversal dynamics was also investigated via time-resolved observation of domain evolution patterns at *precisely the same* position that the local coercivity was measured. For quantitatively characterizing the magnetization reversal behavior, we determined the reversal ratio V/R, where V and R are the wall-motion speed and the nucleation rate, respectively, with utilizing an analysis method proposed by Choe and Shin[3].

3. Results and Discussion

Figure 1 illustrates the plot of ΔH_C with respect to n. It is clearly seen in the figure that ΔH_C sensitively increased with increasing n. A lager coercivity variation of the thicker film could be considered as the result from a larger density of the microstructural irregularities with increasing the number of repeats n. Magnetization reversal behavior in these samples was found to sensitively change from wall-motion dominant to nucleation dominant with increasing n. As expected in the reversal behaviors of the samples, the reversal ratio V/R decreased with increasing n as shown in Figure 2. For a quantitative analysis of the correlation, we plot V/R versus ΔH_C for our (2-Å Co/11-Å Pd)$_n$ samples in Figure 3, where the x-axis is ΔH_C in logarithmic scale and the y-axis is V/R in logarithmic scale. A sample having a small ΔH_C revealed wall-motion dominant reversal with a large V/R, while a sample having a large ΔH_C exhibited nucleation dominant reversal with a small V/R. This could be understood because larger ΔH_C caused more spatial irregularities, which in turn, impeded the wall-motion process more and also, larger ΔH_C made the nucleation process take place more easily at a region having a smaller local coercivity. Interestingly, we see that V/R was truly correlated with ΔH_C and the correlation could be well fitted by a simple analytic function given by

$$Log(V/R) = \alpha Log(\Delta H_C) + \beta \quad , \qquad (1)$$

where α and β are the fitting parameters and those values were determined to be –2.25±0.12 and 3.48±0.17, respectively.

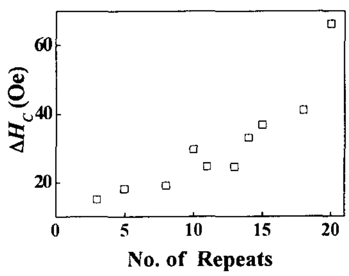

Fig. 1 The standard deviation ΔH_C of the local coercivity variation of (2-Å Co/11-Å Pd)$_n$ samples

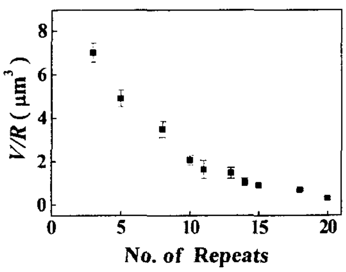

Fig. 2 The reversal ratio V/R *versus* number of repeats n of (2-Å Co/11-Å Pd)$_n$ samples

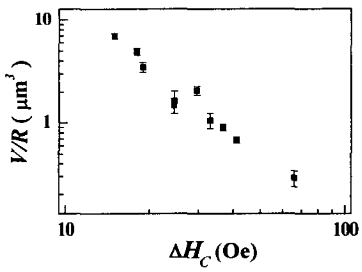

Fig. 3 The correlation between V/R and ΔH_C. The solid line is the best fit for the correlation

4. Conclusion

Quantitative correlation between the magnetization reversal behavior and spatial variation of the local coercivity in Co/Pd multilayer films was observed in the form of the linear relationship between $Log(V/R)$ and $Log(\Delta H_C)$.

Acknowledgments

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References

[1] R. D. Kirby, J. X. Shen, R. J. Hardy, and D. J. Sellmyer, Phys. Rev. B. **49**, 10810 (1994).

[2] S.-B. Choe and S.-C. Shin, Phys. Rev. B. **62**, 8646 (2000).

[3] S.-B. Choe and S.-C. Shin, Appl. Phys. Lett. **70**, 3612 (1997).