

Anisotropic Roughness Effects of Magnetoresistive Hysteresis in Scratched NiO Spin-valves

D. G. Hwang and S. S. Lee
Dept. of Physics, Sangji University,

The low-field and high sensitivity magnetoresistive behaviors of exchange biased spin-valves are advantageous for application in magnetoresistive read heads for high density magnetic recording. One of the outstanding problems in fabricating NiO-biased spin-valves is that hysteresis is observed upon reversal of the unbiased NiFe layer. In this article we report a reduction of hysteresis in the magnetoresistance (MR) of NiO/NiFe/Cu/NiFe spin-valves, using an anisotropic roughness of NiO film. To achieve the anisotropic roughness at NiO/NiFe interfaces, the Corning glass substrates were unidirectionally micro-scratched by means of the diamond paste of $1\ \mu\text{m}$ particles. The average height h and wavelength w of the scribed peak-valley, as shown in figure 1(a), were about $20\ \text{\AA}$ and $0.4\ \mu\text{m}$. During the deposition of the NiO_{300\text{\AA}}}/NiFe_{30\text{\AA}}}/Cu_{20\text{\AA}}}/NiFe_{50\text{\AA}}} spin-valves by rf and dc magnetron sputtering, the uniaxial magnetic field of 320 Oe is applied to perpendicular and parallel direction for the scratching. The exchange biasing fields and coercive fields of the biased NiFe layers in the spin-valve films deposited on the scratched and non-scratched glass substrates have almost the same magnitudes of $H_{\text{ex}} = 180\ \text{Oe}$ and $H_{\text{c}} = 130\ \text{Oe}$, respectively. However, the hysteresis loops of the unbiased NiFe layers for perpendicular and parallel scratching are different as shown in figure 1(b). The H_{c} (unbiased) of perpendicular scratching is reduced to 2 Oe smaller than that of parallel scratching (6 Oe) and non-scratching (5 Oe). The independent exchange biasing effect for the anisotropic roughness due to scratching may be explained that the long-range roughness of $h/w = 1/200$ will not contribute to exchange biasing at NiO/NiFe interfaces¹. The reduction of hysteresis due to

perpendicular scratching may be considered that the magnetic domain of unbiased NiFe layer will be refined by scratching, and the reduced domain size gives rise to the easy displacement of domain wall.

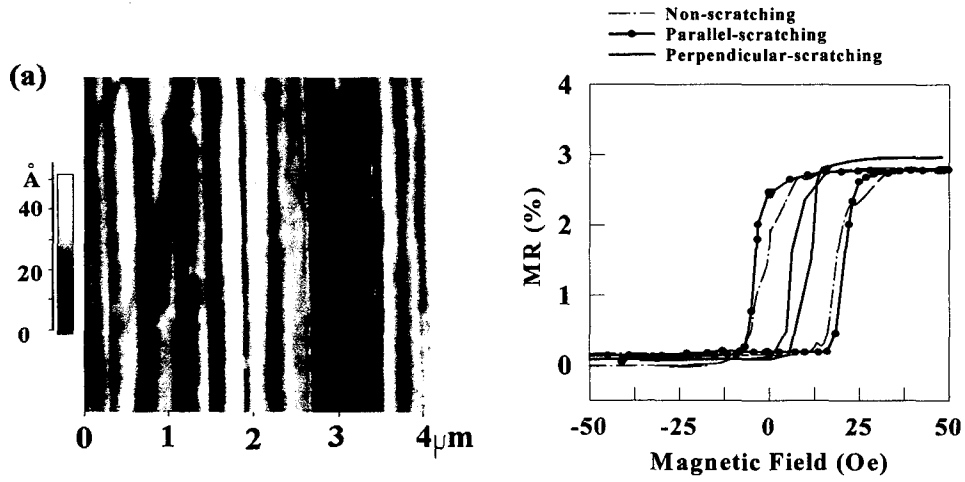


Figure 1. (a) The AFM images of $\text{NiO}_{300\text{Å}}$ /scratched glass and (b) the hysteresis loops of minor MR curves in $\text{NiO}_{300\text{Å}}/\text{NiFe}_{30\text{Å}}/\text{Cu}_{20\text{Å}}/\text{NiFe}_{50\text{Å}}$ spin-valves for scratching and non-scratching.