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Magnetization Reversal of Co/Pd Multilayers on Si Substrates and AAO Membranes

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Recently, researchers paid attention to the magnetization reversal of magnetic nanostructures because of the developments of spintronic devices and ultra-high density recording. In this study, [Co(0.3 nm)/Pd(1 nm)]$_{15}$ multilayers are deposited on Si(100) substrates and anodic-alumina-oxide membranes (AAO) with an average hole diameter of around 200 nm in an UHV e-beam system. The out-of-plane coercivity of Co/Pd multilayers grown on Si substrates is of around 3000 Oe which is measured by the PMOKE. The magnetization reversal of Co/Pd multilayers is directly imaged by the MFM with a variable perpendicular field up to 4000 Oe. The domain nucleation and the wall motion of Co/Pd multilayers grown on Si are observed as shown in Fig. 1(a). Instead of domain-wall motion, the magnetization reversal in Co/Pd multilayers grown on AAO displays a domain rotation. Small domains are observed in MFM images as shown in Fig. 1(b). In the VSM investigation, we make a plot of coercivity vs. out-of-plane angle for both samples. They suggest a wall motion and a domain rotation for Co/Pd multilayers grown on Si and AAO templates, respectively. In the perpendicular magnetoresistance (PMR) measurements, a large resistivity is observed in the AAO case due to a relatively small cross-sectional channel for electrons to pass. The PMR displays a negative MR behavior for both films as shown in Fig. 1(c). The position of maximum peak is located at 2400 Oe and 1100 Oe for the co/Pd multilayers grown on Si and AAO templates. They indicate that the magnetization reversal take place under a low field and the strength of perpendicular anisotropy is relatively low in the AAO case.

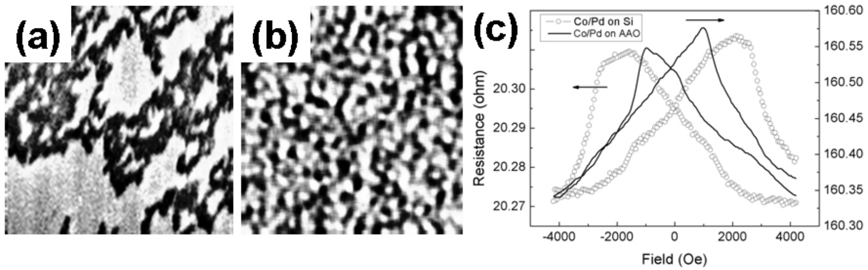

Fig. 1. The MFM images of Co/Pd multilayers on (a) Si substrates and (b) AAO membranes. The perpendicular MR curves of Co/Pd multilayers are shown in Fig. (c).

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Variation of the Switching Field of a Two-layered Magnetic Nanowire

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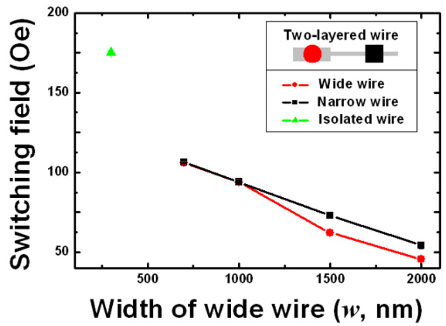
As the width of nanowire decreases, the switching field (H_{sw}) increases. There are reports that H_{sw} of the magnetic nanowire can be decreased by attaching a nucleation pad to it and that, when the two different wires are connected, H_{sw} of the hard magnet is proportional to the difference of the two anisotropy constants [1-3].

We have studied the variation of H_{sw} of the two-layered NiFe nanowires (20 nm thick). They were fabricated by using electron beam lithography and lift-off. The widths of the wide wire (w) are 700~2000 nm and those of the narrow wire are 200~500 nm. The hysteresis loops of the two-layered wire show sharp switching. This suggests that the main mechanism for reversal is the domain wall motion. The domain image of the two-layered wire shows three magnetic contrasts only, i.e. bright at one end, dark at the boundary, and dark at the other end, which confirms that both parts of the wire are in single domain state. The H_{sw} of isolated nanowire shows 1/*w*-dependence [4].

Figure shows the variation of H_{sw} for both parts (300 nm - *w* nm) vs *w*. The difference in H_{sw} is observed when $w \geq$ 1500 nm only. Qualitatively this observation can be understood [3]. Since the anisotropy constant depends on the width of the wire, the difference in anisotropy decreases for fixed 300 nm wire as w decreases. The minimum H_{sw} of the 300 nm wire is ~1/3 of H_{sw} of the isolated wire.

We will also present more detailed results for this study, including magnetic domain images.



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