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Temperature dependence of exchange bias in Co/Ni anti-dot arrays

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Recently, spintronic devices with submicron structures are widely investigated to take advantage of their unique micromagnetic properties. In this work, we study the temperature dependence of exchange bias in bilayer anti-dot arrays made by depositing Co (40 nm)/Ni (5 nm) ferromagnetic bilayer on Si substrate to form anti-dot arrays with a diameter 1 μm. The anti-dot patterning was done only for the upper Co layer, while the Ni underlayer was kept unperforated. The temperature dependences of magnetoresistance (MR) and exchange bias were studied along magnetic easy and hard axes. The in-plane MR measurements were performed using a physical-property measurement system (PPMS ; Quantum Design Inc.) at various temperatures. The standard in-line four-point probe configuration was used for the electrical contacts. As temperature was varied, the MR data were obtained in which in-plane field (H=3 kOe) was applied in the directions along the hard and the easy axes with respect to the lattice plane. The temperature dependences of magnetic anisotropy and exchange bias were also studied along the magnetic easy and hard axes. As temperature decreases, the single peak splits into two peaks. While no exchange bias was observed along the magnetic easy axis, the exchange bias field steadily increased with decreasing temperature along the magnetic hard axis. These results were interpreted in connection with the magnetic anisotropy and the effect of the anti-dots in pinning domain wall motion along the respective direction.

Keywords: Co/Ni anti-dot arrays, magnetic properties, magnetic anisotropy