

Perpendicular synthetic antiferromagnetic Co/Pt superlattice for pinned layer of MTJ-based magnetic sensor devices

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Magnetic tunnel junction (MTJ) based magnetic sensor devices have a potential to be replaced for present magnetic sensors because of their high sensitivity, small size and low power consumption. For monitoring current of electric vehicle (EV) battery, very wide dynamic range up to 2 kOe is required. In our previous work, MTJs with perpendicular synthetic antiferromagnetic (p-SAF) pinned layer exhibited a wide dynamic range of 2.7 kOe after annealing at 300°C [1], but improvement of annealing stability up to 400°C is needed for EV applications. Purpose of this work is achievement of large switching field above 2 kOe in p-SAF Co/Pt superlattice after annealing process of 400°C.

Co/Pt superlattices with a structure of SiO₂-sub./Ta(3nm) / Ru(10) / Pt(0.2) / [Co(*t*_{Co})/Pt(0.16)]₆ / cap were fabricated by DC magnetron sputtering. The Co layer thickness, *t*_{Co} was systematically varied. Perpendicular magnetic anisotropy (PMA) in the Co/Pt superlattices was measured by VSM and SQUID. Subsequently, p-SAF films with a structure of Ta(3)/ Ru(10) / Pt(2) / [Co(*t*_{Co})/Pt(0.16)]₅ /Co(*t*_{Co}) / Ru(0.4) / Co(*t*_{Co}) / [Pt(0.16)/Co(*t*_{Co})]₅ / Pt(2) / cap were prepared using optimized conditions and their annealing temperature dependence of switching field (*H*_{ex}) was systematically investigated.

A large magnetic anisotropy energy (*K*_u) above 5 Merg/cc was obtained at *t*_{Co} > 0.24 nm even after annealing at 400°C. The obtained large *K*_u is enough to satisfy the requirement of *K*_u > *J*_{ex}/*t* (*J*_{ex}: exchange coupling energy between Co/Pt superlattices through Ru, *t*: thickness of the Co/Pt superlattices) to realize a wide switching field in p-SAF structure [2]. Fig. 1 shows Co thickness dependences of switching field in the p-SAF films annealed at various temperatures. The largest switching field of 6.9 kOe was observed in the as-deposited film with *t*_{Co}=0.28 nm. Although a switching field gradually decreased with increasing annealing temperature because of intermixing of Ru spacer layer and Co/Pt superlattices, a large switching field above 2 kOe was successfully observed after annealing at 400°C.

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[2] P. J. H. Bloemem *et al.*, Phys. Rev. B, 50, 13505 (1994).

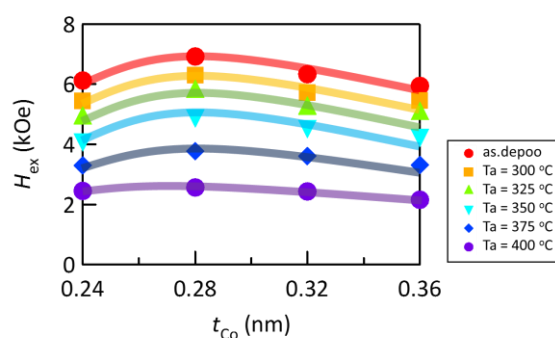


Fig. 1 Co thickness dependence of switching field in P-SAF structure with Co/Pt superlattice