Field-induced Domain Wall Motion of Amorphous [CoSiB/Pt]N Multilayers with Perpendicular Magnetic Anisotropy

M. H. Jung[1], Y. H. Choi[1], K. J. Lee[1], Y. Yoshimura[2], K.-J. Kim[2], T.Ono[2], T. W. Kim[3], C.-Y. You[4]*

[1]Department of Physics, Sogang University, Seoul 121-742, Korea

[2]Institute for Chemical Research, Kyoto University, Gokasho, Uji, Kyoto 611-0011, Japan

[3]Department of Advanced Materials Engineering, Sejong University, Seoul 143-747, Korea

[4]Department of Physics, Inha University, Incheon 402-751, Korea

Perpendicular magnetic anisotropy (PMA) materials are of great interest because of their potential applications to realize next-generation high-density non-volatile memory such as spin-transfer-torque magnetic random access memory (STT-MRAM) with low current density and high thermal stability. Important issue for high-density storage is a further reduction in the lateral dimension, which attain serious thermal heating for current-induced magnetization switching. To overcome the thermal stability problem, materials with strong PMA are required. Strong PMA properties have been investigated in periodically altered ferromagnetic (FM)/nonmagnetic (NM) crystalline multilayers such as Co/Pd, Co/Pt, Co/Au, and Fe/Au. Apart from studies of crystalline PMA materials, considerable work has been done on amorphous systems, because they are expected to have lower pinning density as well as smooth interface. We have previously reported the PMA properties in amorphous multilayers of $[CoSiB/Pt]_N$, where the magnetization reversal process is dominated by the domain wall (DW) motion rather than the nucleation. Thus, the amorphous $[CoSiB/Pt]_N$ multilayer is believed to be one of leading PMA materials to achieve smooth DW motion.

In this study, we report the DW dynamics in amorphous $[CoSiB/Pt]_N$ multilayers with symmetric structure Pt(14 Å)/CoSiB(6 Å)/Pt(14 Å) and the repeated number of layers N = 3, 6, and 9. We used the symmetric structure in order to prevent the inhomogeneous pinning effect introduced by the asymmetric structure, and we chose the N = 3, 6, and 9 multilayers with high squareness. The effective anisotropy constant is 1.5×10^6 erg/cm^3 for all the samples and the coercive field H_c linearly increases with N. In the case of high initial field, where the magnetization is fully saturated by a large magnetic field ($H \gg H_c$), the wall-motion process is dominant. In the case of low initial field ($H \geq H_c$), the dendrite-like process is dominant because unreversed spots act as nucleation sites during the reversal process. For the high initial field configuration, we investigated the DW speed in the creep regime. The field dependence of magneto-optical Kerr effect (MOKE) images shows that the creep exponent μ is scaled 1/4 for all the N values, and the measurements of anomalous Hall resistance in patterned nanowires demonstrate that the DW speed is strongly affected by the pinning strength.