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Magnetoelastically Induced Perpendicular Magnetic Anisotropy and Perpendicular Exchange Bias of CoO/CoPt Multilayer Films

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Abstract : Recently, perpendicular exchange bias (PEB) is introduced as an active topic attracting continuous efforts. Since its discovery, extrinsic control of PEB has been proposed, due to its scientific significance in spintronic devices and potential application in high density magnetic random access memory with perpendicular magnetic tunneling junction (p-MTJ). To our knowledge, the researches aiming to controlling PEB so far are focused mainly on enhancing the interfacial exchange coupling by adjusting the FM/AFM interface roughness, or optimizing the crystalline structures of FM or AFM layer by employing different seed layers. In present work, the effects of magnetoelastically induced PMA on PEB have been explored in [CoO5nm/CoPt5nm]5 multilayer films. We find the PMA strength of FM layer also plays an important role on PEB at the FM/AFM interface and it is effective to control PEB of [CoO5nm/CoPt5nm]5 multilayer films by changing the magnetoelastically induced PMA of CoPt layer. [CoO5nm/CoPt5nm]5 multilayer films were deposited by magnetron sputtering on fused quartz substrate at room temperature, then annealed at 100°C, 250°C, 300°C and 375°C for 3h, respectively. XRD results reveal that all the samples are well crystallized with preferred fcc CoPt (111) orientation. The continuous multilayer structure with sharp component transition at the CoO5nm/CoPt5nm interface are identified clearly by transmission electron microscopy (TEM), x-ray reflectivity (XRR) and atomic force microscope (AFM). CoPt layer in-plane tensile stress is calculated by sin2φ method, and we find it increases gradually upon annealing from 0.99 GPa (as-deposited) up to 3.02 GPa (300oC-annealed). As to the magnetic property, significant enhancement of PMA is achieved in [CoO5nm/CoPt5nm]5 multilayer films after annealing due to the increase of CoPt layer in-plane tensile stress. With the enhancement of magnetoelastically induced PMA, great improvement of PEB is also achieved in [CoO5nm/CoPt5nm]5 multilayer films, which increases from 130 Oe (as-deposited) up to 1060 Oe (300oC-annealed), showing the same change tendency as PMA and the strong correlation with CoPt layer in-plane tensile stress. We consider it is the increase of CoPt layer in-plane tensile stress that leads to the enhancement of PMA, and thus the enhancement of magnetoelastically induced PMA results in the improvement of PEB in [CoO5nm/CoPt5nm]5 multilayer films.

Keywords : perpendicular exchange bias, magnetoelastically induced perpendicular magnetic anisotropy, CoO5nm/CoPt5nm]5 multilayer film with in-plane stress, perpendicular magnetic tunneling junction
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