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Effect of Various Seed-Layers on the Magnetic Properties of Co/Pd Multilayers for Perpendicular Magnetic Anisotropy

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Co/Pd multilayers have been widely investigated for perpendicular recording media and recently for a perpendicular polarizer of a spin-torque devices owing to their high magnetic anisotropy. In our study, we focused our attention on the effect of the texture on the anisotropy since epitaxially grown or strongly textured Co/Pd multilayers have shown coercivity higher than polycrystalline, non-textured Co/Pd multilayers [1]. At first, we deposited Ru, Ta, or Pd as a single metallic seed-layer followed by the deposition of [Co 0.35/Pd 1.015]$_{10}$/Pd 3 (nm). We also used laminated seed-layers, such as MgO 10/Ru 5/Pd 5 (nm) and Ta 5/Pd 10/MgO 10/Ru 5/Pd 5 (nm). The MgO 10/Ru 5/Pd 5 (nm) and Ta 5/Pd 10/MgO 10/Ru 5/Pd 5 (nm) laminated seed-layers were employed to develop [200] and [111], respectively. To reduce the domain coupling in a blanket film, we patterned the as-deposited films into micro-sized square patterns whose size were 2 μm × 2 μm, 5 μm × 5 μm, and 10 μm × 10 μm. We have studied the crystal structure of the multilayers by x-ray diffractometry using a synchrotron source (Pohang Accelerator Laboratory, Korea) and carried out Alternating Gradient Magnetometry to measure the magnetic properties.

We confirmed that our multilayers have preferred growth orientations. All the single metallic seed-layers induced a (111) texture of Co/Pd superlattice as others reported [2, 3]. Among the single metallic seed-layers, the Ta seed-layer produced the strongest Co/Pd (111) texture. However, the coercivity of the as-deposited multilayers was not correlated with the strength of the (111) texture. In the case of the laminated seed-layers, the MgO 10/Ru 5/Pd 5 (nm) developed a weak (200) texture while Ta 5/Pd 10/MgO 10/Ru 5/Pd 5 (nm) did a strong (111) texture as we designed. Those results confirm that the appropriate selection of the seed-layer is indeed important to make an impact on the texture of the multilayers. As for the magnetic properties of the laminated multilayers, the coercivities of the (200) and the (111) Co/Pd multilayers were 1150 and 1450 Oe, respectively. However, after we patterned the multilayers into 2 μm × 2 μm, the coercivities of the (200) and the (111) Co/Pd multilayers were increased by 2~5 times; they were increased to 3000 Oe and 6900 Oe, respectively. Such a result can be attributed to the less magnetic domain interaction. In this presentation, we discuss the effect of various seed-layers on the Co/Pd magnetic properties of blanket films and sqaure-patterned films.

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Spacer Layer Effect and Microstructure on Multilayer [(FePt)$_x$/Os]$_n$ Films

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Spacer layer effect on multilayer [(FePt)$_x$/Os]$_n$ films was investigated. Multilayer [(FePt)$_x$/Os]$_n$ films (x being thickness in nm; Os with a fixed thickness 5 nm; n being the number of layers; total thickness of FePt layers were fixed at 100 nm) have been deposited by sputtering. Spacer layer was found to have substantial effects on the multilayers to exhibit different magnetic properties and microstructure. From the M-H loops, the highest coercivity 11.3 kOe was obtained in [(FePt)$_{20\ nm}$/Os$_{5\ nm}$]$_5$ films as shown in Fig. (a). Coercivity enhancement can be understood from the fact that for a FePt film and Os spacer with fixed thickness, the increasing number of Os spacer will inhibit the grain growth of FePt grains and enriches the grain boundary. Therefore, the layer by layer structure of [(FePt)$_x$/Os]$_n$ film exhibits more good hard magnetic behaviors as shown in Fig. (b). Multilayer FePt films with Os spacers will enhance the coercive force. From a HRTEM cross-sectional observation, the average grain size of the multilayer films can be well controlled by both annealing temperature and thickness of the FePt layer. SAD pattern indicated that the structure of Os spacer was amorphous. The average grain size of [(FePt)$_{20}$/Os]$_5$ films is 18 nm, that is smaller than that of single-layer FePt films (70 nm). In summary, the higher coercivity in multilayer films is attributed to the Os spacers, which due to the reduced grain size that enhances the anisotropy of individual grains.