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Magnetic Properties of Co/Pt-Pd Multilayer Thin Film Media

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Co/Pt and Co/Pd multilayer thin films have been recently investigated for perpendicular magnetic recording media, because of their large perpendicular magnetic anisotropy energy K_p. However, the difference between the role of Pt and that of Pd in the magnetic properties is not clear. In this study, we investigated the dependence of the perpendicular magneto anisotropy for the Co/Pt-Pd multilayer thin films on the concentration in the Pt-Pd alloy layers.

$[Co(t = 0.2 \sim 2.0\ nm)/Pt_{(100-x)}Pd_x(1.4\ nm)]_{12}$ multilayer specimens were prepared on glass substrates through 50nm-thick $Pt_{(100-x)}Pd_x$ underlayers by using a rf magnetron sputtering system. The perpendicular magnetic anisotropy constant K_p and magnetization curves of these specimens were measured in a temperature range from 290 K to 470 K by using a torque magnetometer and a vibrating sample magnetometer, respectively. The film structure was investigated by an x-ray diffraction analysis.

Fig. 1 shows the variation of K_p for Co/Pt, $Co/Pt_{49}Pd_{51}$, and $Co/Pt_{31}Pd_{69}$ specimens on t. The K_p of the Co/Pt specimens increases with increase of t, and the K_p of the specimen with $t = 0.6$ nm has a maximum value of 3.1×10^6 erg/cm^3. When the Pd concentration increases in the Pt-Pd layer, the Co layer thickness of the Co/Pt-Pd specimens, of which the K_p has the maximum value, decreases. The $Pt_{31}Pd_{69}$ specimen has the maximum K_p value of 1.7×10^6 erg/cm^3 at the Co layer thickness of 0.3 nm. Interface anisotropy energy K_s was estimated by using the relation of $K_p = K_v + K_s/t$, where K_v is the bulk contribution. The K_s value of the $Co/Pt_{31}Pd_{69}$ specimens were estimated to be 0.08 erg/cm^2, which is about a half of that of Co/Pt specimens. Fig. 2 shows the temperature dependence of M_s for the Co/Pt, $Co/Pt_{49}Pd_{51}$, and $Co/Pt_{31}Pd_{69}$ with $t = 0.4$ nm. Both the K_p and the M_s values for all the specimens monotonically decreased, with increasing temperature. The decrease rate of the K_p and the M_s with a variation of the temperature is enhanced with decreasing the Pd content in the Pt-Pd layer, although the Co layer thickness for these specimens are same. The Curie temperature of these specimens were roughly estimated from the Weiss theory using Brillouin function to be 476 k (Co/Pt), 504 K ($Co/Pt_{49}Pd_{51}$), and 580 K ($Co/Pt_{31}Pd_{69}$), respectively. These results may indicate that the lattice distortion of the Co layer caused by the interface from the Pt-Pd layer become smaller, since the lattice misfit between the Pt-Pd and the Co decreases with increasing the Pd concentration.

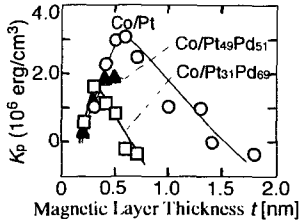

Fig. 1. Dependence of K_u on the Co layer thickness.

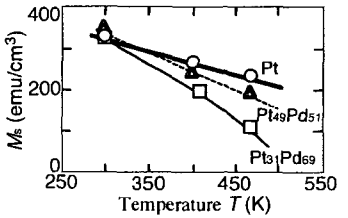

Fig. 2. Temperature dependence of M.

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Astudy on [CoFe/Pt] Multilayer Films with a Perpendicular Magnetic Anisotropy

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Magnetic multilayer films with perpendicular magnetic anisotropy have been widely studied as magnetic recording or magneto-optical recording media. As individual layers in a multilayer stack become thinner, the role of interfaces and surfaces may dominate that of the bulk. Thus, a perpendicular interface contribution to the magnetic anisotropy is capable rotating the easy magnetization direction from in the film plane to perpedicular to the film plane [1]. In this study, we have investigated magnetic properties of [CoFe/Pt] multilayer films.

The magnetic multilayer films consists of Ta/ (Pt or Ru ; buffer layer)/ [CoFe(0.3 nm)/ Pt(0.8 nm)] × N times , which were prepared by r.f. sputtering method on SiO_2/Si (100) wafers at room temperature. The base pressure was 7×10^{-8} Torr and the working pressure was 5mTorr. Ther magnetic properties of [CoFe/Pt] multilayer films were measured using a vibrating sample magnetometer.

As the number of CoFe/Pt bilayers increases, the coercive field increases and the squareness decreases. Especially, the sample [CoFe/Pt] × 25 shows a bow-tie shaped easy-axis loops(Fig. 1). According to the MFM study, the film shows multidomain structure, which has been well-understood as a result of the competition between domain wall energy and magnetostatic energy [2]. To explain this, we have investigated the structural property of thin films using TEM and XRR study.

We have found the difference of grain size and roughness between [CoFe/Pt]x10 and [CoFe/Pt]x25 thin films.

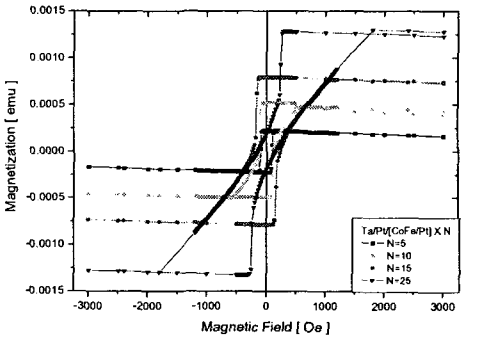

Fig. 1. Hysteresis loop of [CoFe(0.5 nm)/Pt(1.5 nm)] x N perpendicular thin films with N = 5,10,15 and 25.

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