MICROSTRUCTURE, MAGNETIC PROPERTY RELATIONSHIPS IN SPUTTERED Pt/Co MULTILAYERS

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Introduction

Pt/Co multilayers (ML) are a candidate for a new magneto-optical (MO) recording medium [1,2], especially because of their large polar Kerr effect at shorter wavelengths, where ultra-high density recording is possible. Many of the properties required for a MO recording medium, such as perpendicular magnetic anisotropy, large coercivity, and low optical noise, depend sensitively on the synthesis conditions and microstructure [3] of the multilayer. In this study we used HREM to relate the microstructure of sputtered Pt/Co ML to their synthesis conditions and magnetic properties.

Experimental

Pt/Co ML were dc-magnetron sputtered with Ne, Ar, Kr, or Xe gas at pressures between 5 and 30 mTorr. Before sputtering the multilayer, some substrates were sputter-etched with -50V or -100V rf bias for 5 or 10 minutes. We measured magnetic hysteresis loops and anisotropy energy with magnetometers. Samples for electron microscopy were thinned using conventional methods [3], and observations of microstructure were made with JEM 4000 EX and JEM 2000 FX microscopes.

Results and Discussion

Pt/Co ML sputtered with a heavy mass gas (Xe) had a larger perpendicular magnetic anisotropy and coercivity than multilayers sputtered with a light gas (Ar) (Fig. 1). Energetic bombardment [4] by the lighter (Ar), reflected gas neutrals reduced (111)-fcc texture, crucial for a perpendicular easy-axis of magnetization; multilayers sputtered with a heavy gas (Xe) suffered less damaging bombardment, and they had superior (111) texture and sharper column boundaries, which contributed to a larger coercivity.

When Pt/Co ML were sputtered at higher gas pressure (> 15 mTorr), they had a smaller anisotropy but large coercivity. The microstructure of 'high pressure' ML consisted of a low density of columns, with only modest (111) texture (Fig. 2). We attributed the large coercivity to the isolated, columnar structure.

ML deposited on dielectric surfaces that were first sputter-etched also had better (111) texture and consequently larger anisotropy energy (Fig. 3). Sputter-etching increased the nucleation density for, and enhanced surface diffusion of subsequently sputtered Pt and Co atoms.

The (111)-fcc planes of Pt are a good match (1.6%) to the (002)-hcp planes of ZnO, and therefore a ZnO underlayer [5] promoted highly textured growth (Fig. 4) of Pt/Co ML with large perpendicular magnetic anisotropy. Because ZnO is transparent and has a large index of refraction, it can also be used as the Kerr enhancement layer in a practical disk structure.

References

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Fig. 1 Magnetic hysteresis loops for Ar- and Xe-sputtered Pt/Co ML. $K_{\text{eff}}=6.5$ erg/cm³-Co (Xe) and 3.5 erg/cm³-Co(Ar).

Fig. 2 Microstructure and SAED of Pt/Co ML, 10x(4Å Co+13Å Pt), Xe-sputtered at 15 mTorr. Arrows indicate voids.

Fig. 3 Effect of sputter-etching ZnO (O), AlN (□), and In₂O₃(Δ) surfaces on anisotropy energy of Kr-sputtered Pt/Co ML.

Fig. 4 HREM image of Pt/Co grown on ZnO. Lattices fringes in Pt/Co are (111) atomic planes.