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Effect of Buffer Layer on Perpendicular Anisotropy for Co-Pt Alloy Thin Films

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Co-Pt and Fe-Pt alloy for use as a perpendicular recoding media and patterned media in hard disk may be tuned to possess very high K_u with higher coercivity [1-3]. Among these materials, Co_3Pt has been a promising material for high density magnetic recording media due to the high magnetic anisotropy and high coercivity without high deposition temperature or post annealing.

In this study, Co-Pt alloy films were fabricated by using DCmagnetron sputtering at room temperature and magnetic field was not applied during deposition.

The films structure was Si (100)/Ta (5 nm)/NiFeMo (10 nm)/Ru (x nm)/Co-Pt (50 nm)/Ta (5 nm). Co-Pt films were sputtered by using Pt chip on Co target. In order to enhance perpendicular magnetic anisotropy, Co-Pt alloy films were optimized composition, buffer layer and process condition and were analyzed with VSM, torque magnetometer, EDS and XRD. Fig. 1 shows dependence of out-of-plane coercivity and squareness on the thickness of Ru. The inserting of Ru layer enhanced out-of-plane coercivity and squareness significantly. However the thicker Ruthan 60nm did not enhance the magnetic properties any more. Out-of-plan coercivity was 3758 Oe and squareness of Co-Pt alloy thin film was 0.94 at thickness of Ru layer 60 nm. From XRD results, Inserting NiFeMo layer and Ru layer, the peak intensity of Co_3Pt (0002) increased. This results present that NiFeMo (111) and Ru (0002) of buffer layer enhanced Co_3Pt (0002) preferred orientation and perpendicular anisotropy.

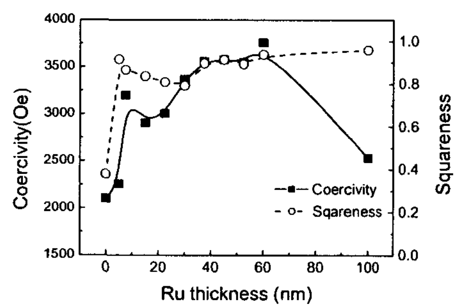

Fig. 1. Dependence of coercivity and squareness on the thickness of Ru.

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Grain Size Reduction of Ru Intermediate Layer by Boundary Oxidation in CoCrPt-SiO₂ Perpendicular Recording Media

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Small grain size and narrow size distribution of recording layer are the most critical requirements for ultra-high recording density in perpendicular magnetic recording (PMR) media. There have been a lot of efforts towards grain size reduction of recording layer by means of increased oxygen and/or oxide content during the recording layer sputtering process [1]. This method doesn't appear to be a proper approach in dual-Ru intermediate layer (IML) PMR where top Ru grains are physically separated, because the enhanced oxygen content will result in small CoCrPt grains with low packing ratio or irregular grain size. Recently, Piramanayagam *et al.* proposed oxide-based IML to reduce the grain size [2]. In this work, we succeeded reducing the Ru grain size by oxygen reactive sputtering with Ru-Cr target. Ru grain size was reduced to 6.1 nm and Ru grains were surrounded by Cr oxide networks. The Cr oxide formation was confirmed by XPS analysis and SAD ring pattern of TEM. Ta/Ru/RuCr/CoCrPt-SiO_2 films were deposited on thermally oxidized Si wafers by magnetron sputtering. Oxygen gas (0 ~ 4.4%) mixed with Ar was used for reactive sputtering gas only for RuCr layer deposition. The thickness of Ru and RuCr was 10 nm each and that of CoCrPt-SiO_2 was 15 nm. The bottom Ru layer was deposited at low Ar pressure in order to keep good (0002) texture and RuCr layer was deposited at high pressure for grain separation. Bright-field TEM images of RuCr-O shows that the grain size of top IML gradually decreases with increasing oxygen partial ratio. In addition, the grain boundaries of RuCr became wider as the oxygen content increases, which suggests that the oxidation occurs mainly at the grain boundaries. The grain size and morphology of recording layer deposited on those IML has the same trend as the RuCr-oxide IML because there is one-to-one grain relationship between the IML and recording layer in dual-Ru PMR. Grain size of recording layer was reduced from 6.3 nm to 5.6 nm by adding 4.4% of oxygen during the RuCr deposition but grain size distribution didn't change noticeably. Coercivity (H_c) measured by a VSM decreased from 3.8 kOe to 2.9 kOe with 4.4% oxygen ratio. This Hc behaviour is related with the grain size reduction because the reduced grain volume makes the film thermally unstable. It is also supported by nucleation field reduction in the samples with the oxide-IML. XPS analysis indicates that the Cr-O to metallic Cr ratio and Ru-O to metallic Ru ratio abruptly increase when more than 2.8% of oxygen is involved. Diffraction ring patterns of Ru/RuCr-O clearly show the existence of Cr oxide in the forms of CrO, CrO_2, Cr_2O_3, and Cr_3O_4. Even though these oxides seem to be helpful in making smaller grains, more than 2.8% oxygen addition can lead to degraded $\Delta\theta_{50}$ of hcp (0002) texture of the IML due to Ru oxidation.

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