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Crystallographic Analysis of CoPtCr-SiO_2 Perpendicular Magnetic Recording Media

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CoPtCr-SiO_2/Ru thin films are known as potential materials for high-density perpendicular recording due to their well-isolated, fine grain structure with high magnetic anisotropy. We reported X-ray diffraction analysis showing the existence of fcc phase in the CoPtCr-SiO_2 film[1]. In this report, we show fcc(111) and hcp(101) diffraction patterns for CoPtCr-SiO_2 films at different levels of Pt content using grazing incidence X-ray diffraction.

A 20-nm-thick CoPtCr-SiO_2 film was deposited on a glass disk by co-sputtering method. Ru (20nm) and Pt (10nm) layers were employed as seed and pre-seed layers, respectively. The composition of the films is expressed as $\{(Co_{90}Cr_{10})_{100-X}Pt_X\}_{89}$-$(SiO_2)_{11}$, where X = 0, 10, 20, and 30at%[2].

We performed 2θ scans at χ-axis angles of 69.5 and 60.2 degrees, where χ is the angle between the surface of the sample and a horizontal plane. The X-ray energy was 10keV (λ = 0.124nm). The grazing incidence angle was 0.20 degrees in the total reflection condition.

Figures 1(a) and 1(b) show X-ray diffraction patterns for fcc(111) and hcp(101) in the CoPtCr-SiO_2 films at different levels of Pt content, respectively. The fcc(111) and the hcp(101) peaks shifted toward lower angles as Pt content increased. Substituting Pt atoms for Co atoms in crystal caused these peak shifts. The diffraction patterns for Pt content below 20 at% included strong hcp(101) and weak fcc(111) peaks, while for Pt content ranging from 20 at% to 30 at%, strong fcc(111) peak appeared and hcp(101) peak decreased in intensity. These results show that an increase of Pt content in the CoPtCr-SiO_2 film causes a formation of fcc lattice.

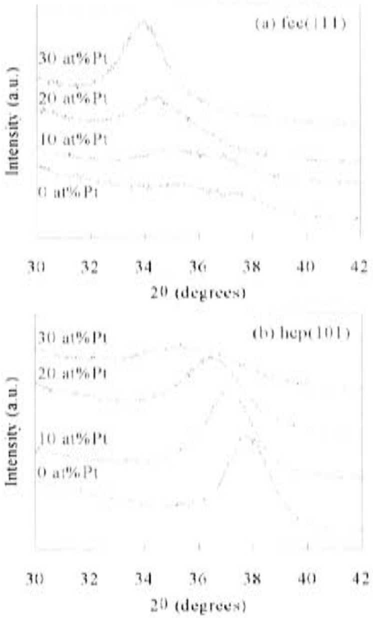

FIG. 1. X-ray diffraction patterns at χ angles of 69.5 and 60.2 degrees for CoPtCr-SiO_2 films at different levels of Pt content. (a) fcc(111) phase, at χ = 69.5 degrees. (b) hcp(101) phase, at χ = 60.2 degrees.

Reference

[1] M. Ohsawa, et al., SPring-8 User Experiment Report No.12, 2003B (July 2004) 270

[2] T. Shimatsu, et al., The 9th Joint MMM/Intermag conference, BC-09 (2004), IEEE Trans. Magn., (2004) in press

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Submicron-Resolved Strain Analysis of Oxide-Patterned Silicon Using Fresnel-Zone-Plate Magnification

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We have developed an image magnification method using a Fresnel zone plate (FZP) to obtain submicron resolution in X-ray diffraction and topography [1-5]. This report describes an FZP method, which was applied to strain analysis of oxide-patterned silicon.

The experiments were performed at BL16XU in SPring-8. The sample used was a 0.63-mm-thick Si{100} wafer upon which an oxide pattern was fabricated (Fig.1A, 1B). The FZP was a phase modulation type, whose zone structure was made of a 2-μm-thick Ta layer on a 2-μm-thick SiN membrane. The diameter was 22 μm, and the outermost zone width Δr_n was 0.2 μm. The theoretical spatial resolution was $1.22\Delta r_n$ = 0.24 μm. Experimental setup was similar to that reported [4]. Si{400} Bragg-case reflection was used at a photon energy of 8.5keV, at which the focal length of the FZP was 31mm. A diffracted X-ray image was expanded 27 times by the FZP (50mm from the sample) and focused on a slit (900mm from the FZP), through which the X-ray intensity was measured.

The topograph shown in Fig.1C was provided by an XY scan of sample positions. Figure 1D shows rocking curves, which were measured at intervals of 0.25 μm along $Y = 0$ and expressed as a contour map. The peak positions ω_P of the rocking curves were estimated by parabola fitting and plotted in Fig.1E. The variation of ω_P corresponds to $\Delta d/d \sim \pm 1\times10^{-5}$, showing that compressive strains were caused under the oxide layers. The spatial resolution was estimated to be less than 0.5 μm.

[1] Ext. Abstracts of the 63rd Autumn Meeting, JSAP, 24p-T-7 (2002)

[2] Ext. Abstracts of the 64th Autumn Meeting, JSAP, 30a-ZK-3 (2003)

[3] SPring-8 User Experimental Report, No.9, 284 (2002)

[4] *ibid.*, No.11, 305 (2003)

[5] *ibid.*, No.12, 274 (2004)

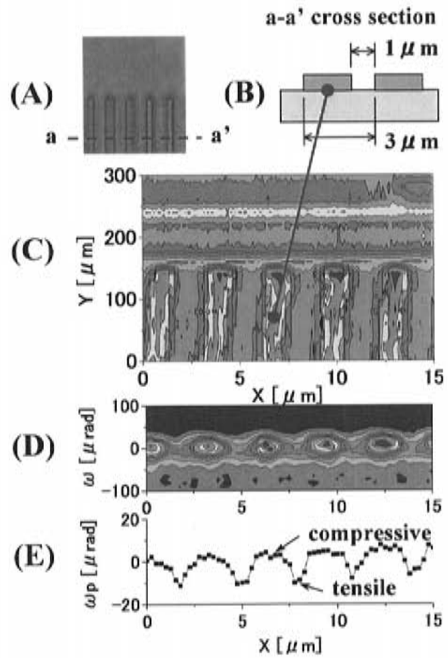

Fig.1. Strain analysis of an oxide-patterned silicon wafer