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$Mn(Sb_{1-x}Pt_x)$ film with NiAs type Structure for the New Magneto-Optical Material.

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1. Introduction

Large value of Kerr rotation angle, θ_K, and high reflectance, R, at short wavelength region (500 nm) are the essential requirements for the magneto-optical (MO) recording media to achieve high density magneto-optical recording.

Recently, the present authors have newly found that MnSbPt film with the concentration of 50at%Mn, 44at%Sb and 6at%Ptannealed at 300°C shows giant θ_K more than 1.0° at short wavelength of λ=500nm [1,2,3]. From the result of structural analysis and of θ_K spectrum, the giant θ_K observed experimentally arises from the NiAs MnSb compound including Pt atom.

In the present study, to make clear the concentration dependence of θ_K more presicely, MnSbPt films with MnSb side (low Pt concentration) were prepared in a concentraion range 44at%<Mn<55at%, 37at%<Sb<44at%, 4at%<Pt<15at%. Dependences of θ_K, magetic Kerr ellipticity, h_K, and reflectance, R, on wavelength will be discussed by referring the result fro PtMnSb film with $C1_b$ structure and MnSb with NiAs structure.

2. Result and Discussion

A. Magneto-optical properties

Fig.1 shows the concentration dependence of θ_K at λ=633nm for various MnSbPt films annealed at 300℃. In this figure, the equi-value lines of θ_K are also shown. As seen in this figure, θ_K decreases from 0.8° at 12at%Pt to 0.6° at around 10at%Pt with decreasing Pt concentration and θ_K recovers again and takes maximum value of more than 0.8° at 6at%Pt with further decreasingPt concentration along the line of $Mn(Sb_{1-x}Pt_x)$ with satisfying stoichiometric concentration of Mn 50at% in NiAs structure. Namely, the magnitude of θ_K is clasified into two groups around the critical Pt concentration of Pt atom about 10at%. From these experimental results, in the MnSbPt system, two concentration regions where θ_K shows more than 0.8° are clearly found. One corresponds to the well-known off-stoichiometric concentration of $C1_b$ PtMnSb compound. Another one corresponds to the concentration of 50at%Mn, 44at%Sb and 6at%Pt recently reported by present authors [1,2,3]

Fig.2 shows the typical θ_K spectra for the present MnSbPt films with different three concentrations. In this figure, θ_K spectra for $C1_b$ type PtMnSb film and NiAs type MnSb film are also shown for comparison. For the present film with the concentration of $Mn_{50.1}Sb_{44.0}Pt_{5.9}$, θ_K increases from 0.3° at λ=1000nm with decreasing

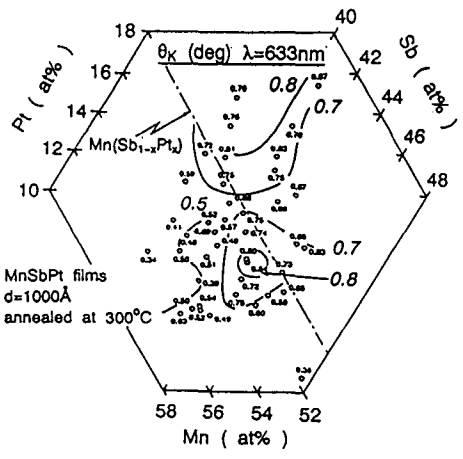

Fig.1 Concentration dependence of θ_K at l=633nm for MnSbPt films annealed at 300°C

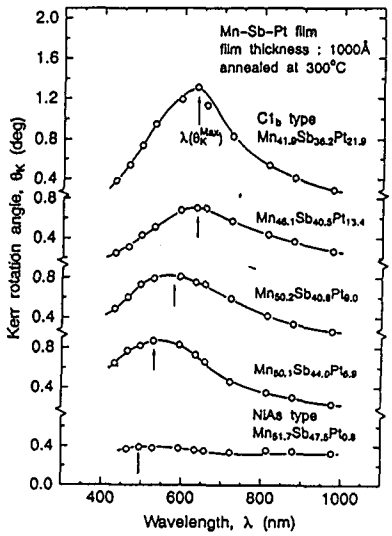

Fig.2 θ_K spectra for MnSbPt films annealed at 300°C

λ and takes maximum of about 0.8° at λ=500nm and with further decreasing λ, θ_K decreases to 0.6° at 400nm For the other films with concentration $Mn_{50.2}Sb_{40.8}Pt_{9.0}$ and $Mn_{46.1}Sb_{40.5}Pt_{13.4}$, similar spectra are also observed, however, the wavelength where θ_K shows maximum, $\lambda(\theta_K^{Max})$, are about 500nm for $Mn_{50.1}Sb_{44.0}Pt_{5.9}$, 580nm for $Mn_{50.2}Sb_{40.8}Pt_{9.0}$ and 630nm for $Mn_{46.1}Sb_{40.5}Pt_{13.4}$, respectively. In other words $\lambda(\theta_K^{Max})$ shifts from relatively longer λ of about 630nm to relatively shorter λ of abpout 500nm with decreasing Pt concentration. These results suggest that MnSbPt films obtained presently are useful material for the high density MO recording system using blue Lasers.

B. Magnetic properties

From the results of concentration dependence of Ms, along the line of $Mn(Sb_{1-x}Pt_x)$ with the stoichiometric concentration of 50at%Mn in NiAs type MnSb compound, Ms decreases from 90 emu/g of MnSb to 50 emu/g of the film including Pt 15ar%. The values of Ms for the present films with $Mn_{50}Sb_{44}Pt_6$ concentration is about 70 emu/g after annealed at 300°C. From the result of temperature dependence of Ms, the Curie temperature of this compound is simply estimated to be about 280°. This value of Tc is suitable for MO disk.

While the hysteresis loops for the present films revealed that macroscopically the easy axis of magnetization lies in film plane. Namely, unfortunately perpendicular magnetic anistropy of the film were not induced in this stydy, because of the c-axis orientation in NiAs structure ((110) preferred orientation in film plane).

In order to investigate the possibility to induce perpendicular magnetic anisotropy in this film, preliminary experiment concernig the magnetocrystalline anisotropy is made using powder samples (annealed at 600°C). In Fig.3, X-ray diffraction patterens for $Mn_{50}Sb_{49}Pt_1$ and $Mn_{50}Sb_{44}Pt_6$ powders and powder alignment samples under rotational and uni-directional magnetic field are shown, respectively. For the sample prepared in rotational and uni-directional magnetic field, XRD measurement was made for the both samples of which surface is parellel (rotational) and perpendicular (unidirectional). For powder samples (random orientation) with the concentration of $Mn_{50}Sb_{49}Pt_1$ and $Mn_{50}Sb_{44}Pt_6$, various diffracted lines from NiAs and $C1_b$ structure are observed.

On the other hand, for powder alignment sample with the concentration of $Mn_{50}Sb_{49}Pt_1$, the drastic change in crtystal orientation took place. Namely, the diffracted lines from (002) and (004) planes of NiAs structure, which are very weak in powder pattern, are clearly observed. This fact suggests that the easy axis of magnetization in NiAs structure with low Pt concentration lies in the c-plane. While, for $Mn_{50}Sb_{44}Pt_6$ prepared in uni-directional magnetic field, diffracted line from (002) and (004) of NiAs structure are also clearly observed. This results suggests that the direction of easy axis of magnetization in NiAs structure is parallel to c-axis.

Based on these results, we can safely conclude that the direction of the easy axis of MnSbPt with NiAs structure is changed from c-plane to c-axis with increasing Pt concentration. Therefore, we can simply expect that the perpendicular magnetic anisotropy in the present films will be possibly induced by changing the preferred grain orientation of c-axis in NiAs structure.

Within the framework of the present paper, the mechanism of giant θ_K for MnSbPt films with NiAs type structure will be discussed by comparing with those of PtMnSb with $C1_b$ structure.

References

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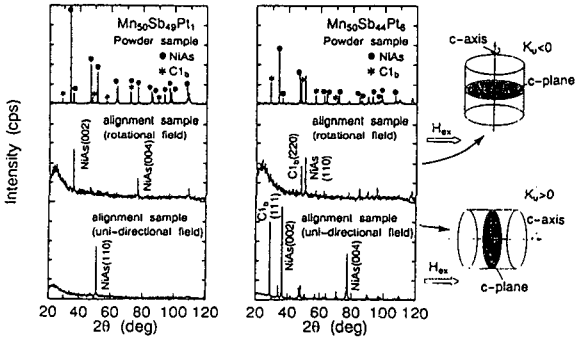

Fig.3 X-ray diffraction patterns MnSbPt powder and powder alignment samples.