MAGNETIC AND MAGNETO-OPTICAL PROPERTIES OF Co-CONTAINING Bi-DyIG PARTICLES DISPERSED IN A PLASTIC BINDER

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Abstract **--- Nano-size Co_x:$BiDy_2Al_{0.8}Fe_{4.2}O_{12}$ ($0 \le x \le 2.0$) particles were prepared with a coprecipitation method. The coating films of the particles were prepared with a coating technique. The magnetic and magneto-optical properties of the particles and films were investigated. The M_S and H_C of the particles and films increased with the Co content x. The Faraday rotation dropped with x. The Co content $x = 0.5$ film has high H_C about 450 Oe, and the figure of merit at 520 nm is about 0.63. The particle size in the film was about 50~100 nm which is smaller than the wavelengths of the read and write laser example 633 nm. These results show that the coating Co_x:$BiDy_2Al_{0.8}Fe_{4.2}O_{12}$ film is one of the candidate materials to a new economical magneto-optical storage medium.**

I. Introduction

We have been studying the preparation process and applications of coating magneto-optical films [1][2]. Nano size particles of Bi-YIG have been dispersed in the plastic binders on the base films. The increase in the coercive force of the particles has been one of the major tasks, in order to apply the films to recording media. The fine particles of garnet, however, require more effort to increase the coercive force than the thin films, because of the low internal stresses [3][4].

Some high coercive force films have been prepared by dry processes [5][6] with a substrate temperature of more than about 500°C. Inexpensive plastic sheets can not be used as substrates. We can solve this thermal problem by employing the coating technique in film preparation processes.

In this paper, the magnetic and magneto-optical properties of Co-containing Bi-DyIG (Co_x:$BiDy_2Al_{0.8}Fe_{4.2}O_{12}$) particles and its coated films were investigated to develop high coercive force films.

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II. Experimental

A. Preparation of the Co-containing Bi-DyIG particles

Co-containing Bi-DyIG particles were prepared by coprecipitation and annealing processes [7]. Aqueous solutions of nitrates of Bi, Dy, Al and Fe were mixed where the ratio of the cations corresponded to the composition of $BiDy_2Al_{0.8}Fe_{4.2}O_{12}$. Then an aqueous solution of Co nitrate was added. The concentrations of Co in the samples were from $x = 0.0$ to 2.0 in the Co_x:$BiDy_2Al_{0.8}Fe_{4.2}O_{12}$. The solution was mixed with a NaOH solution with stirring at room temperature. After the coprecipitation reaction, the pH of the solution was 12 ~ 13. The obtained slurry was washed, filtered and dried at 300°C for 1.5h. Then the coprecipitate was heated in air at 700°C for 4h.

The crystal phases of the particles were examined by x-ray diffraction analysis.

B. Preparation of the coating films

The particles were mixed with an epoxy binder (Epo-tek 396;Epoxytechnology) solved by a cyclohexanone and milled with a planetary milling machine (Pulverisette 7;Fritsch) for 30h, then were coated by a spin coater on Corning 7059 glass. The thickness of the films was about 2μm. It was controlled by the viscosity of the ink. The films were dried at 80°C for 1h in an oven. The volume contents of the particles in the coating films was about 0.5.

The particles in the films were observed with an Atomic Force Microscope (AFM). The magnetic properties of the films were measured with a VSM. Faraday rotation θ_F was measured by the polarization modulation method. The absorption coefficient α was measured with a spectrophotometer.

III. Results

A. Properties of the particles

Figure 1 shows the saturation magnetization M_S and coer-

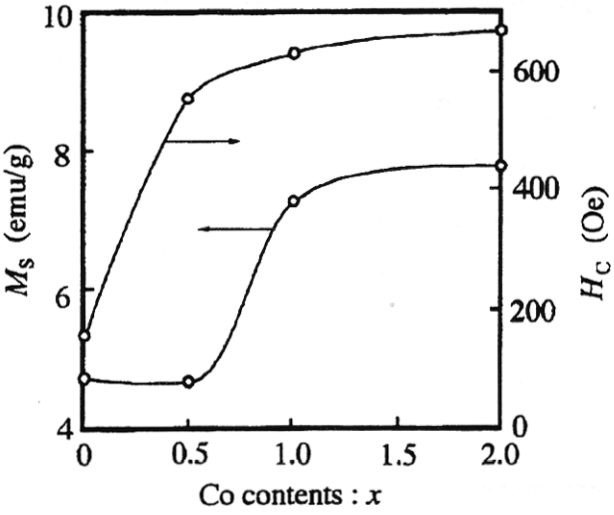

Fig.1 Saturation magnetization M_S and coercive force H_C of the Co-containing $BiDy_2Al_{0.8}Fe_{4.2}O_{12}$ particles.

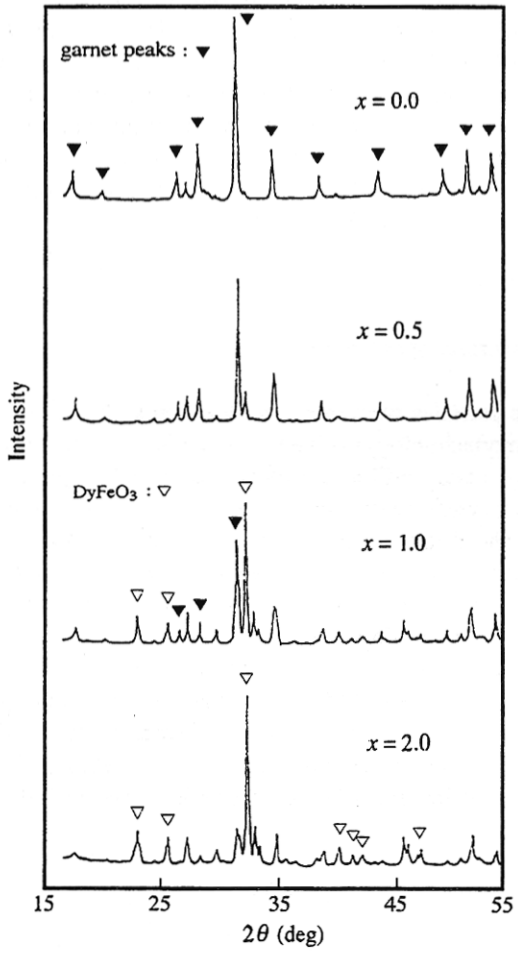

Fig.2 X-ray diffraction patterns of the Co-containing $BiDy_2Al_{0.8}Fe_{4.2}O_{12}$ particles.

cive force H_C of the Co-containing Bi-DyIG particles. The M_S and H_C of the particles increase with the x. The particle x = 0.5 has a high coercive force which is about 600 Oe, the value was slightly smaller than the 800 Oe which had been reported [3][4]. In the region from x = 1.0 to 2.0, the particles have large M_S about 7.5 emu/g and high H_C about 600 Oe.

Figure 2 shows x-ray diffraction patterns of the Co-containing Bi-DyIG particles. The main phase of the particles from x = 0.0 to 0.5 is garnet. In the region from x = 1.0 to 2.0, the particles have high H_C and M_S but didn't have diffraction peaks with garnet. We investigated the x-ray diffraction patterns with information from the JCPDS, the patterns were identified to $DyFeO_3$ and unknown crystals. Those figures indicated that the magnetic properties of the particles in the region of x = 1.0 to 2.0 were caused by the $DyFeO_3$ phase.

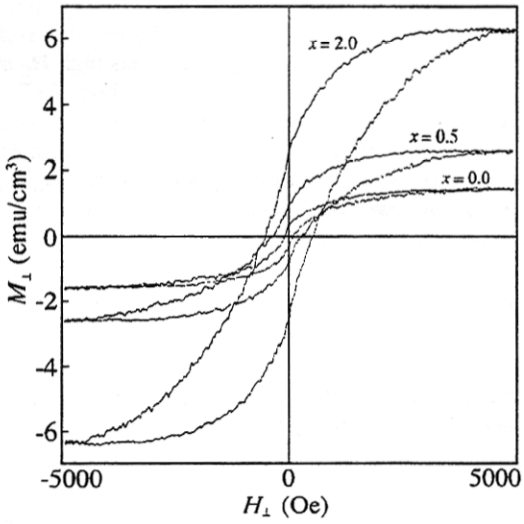

Fig.3 The M-H curves of the coating $BiDy_2Al_{0.8}Fe_{4.2}O_{12}$ films.

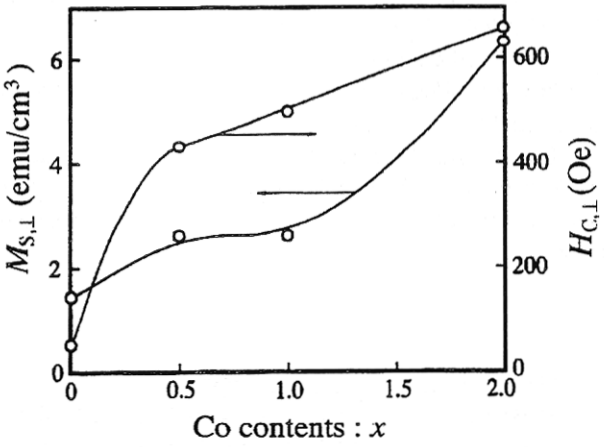

Fig.4 Magnetic properties of the Co-containing $BiDy_2Al_{0.8}Fe_{4.2}O_{12}$ coating films.

B. Properties of the coating films

Figure 3 shows the *M-H* curves of the coating Co-containing Bi-DyIG films in the perpendicular configuration. The coating films indicate the high value H_C which is almost the same as the aforementioned particles.

Figure 4 shows the magnetic properties of the coating films. The perpendicular coercive force H_C of the films of x = 0.5 to 2.0 are over 450 Oe. The M_S of the coating films increase with x, so this tendency is the same with the particles.

Figure 5 shows the magneto-optical properties and absorption coefficients α of the coating films. The Faraday rotation θ_F decreased with increasing x. In the region from x = 1.0 to 2.0, θ_F was zero. This is because the garnet phase in the particles disappeared with increasing x. The $2\theta_F$ of the film with x = 0.5 was about 600 deg/cm, and the relatively high H_C of 450 Oe was obtained. The figure of merit $2\theta_F/\alpha$ of the film at 520 nm is about 0.63. These results indicate that the coating films have the potential to develop a new economical magneto-optical recording system.

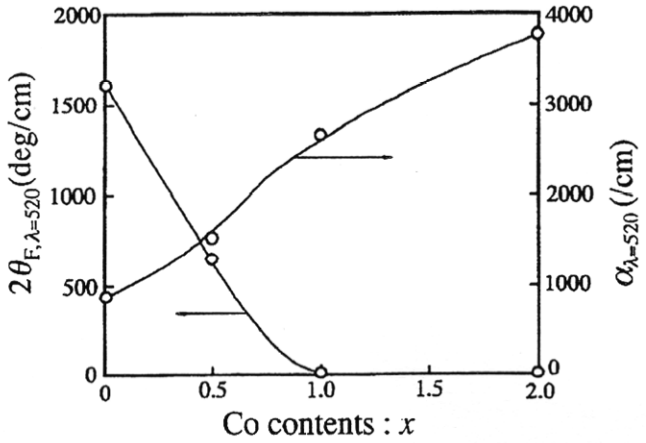

Fig.5 Magneto-optical properties of the Co-containing $BiDy_2Al_{0.8}Fe_{4.2}O_{12}$ coating films.

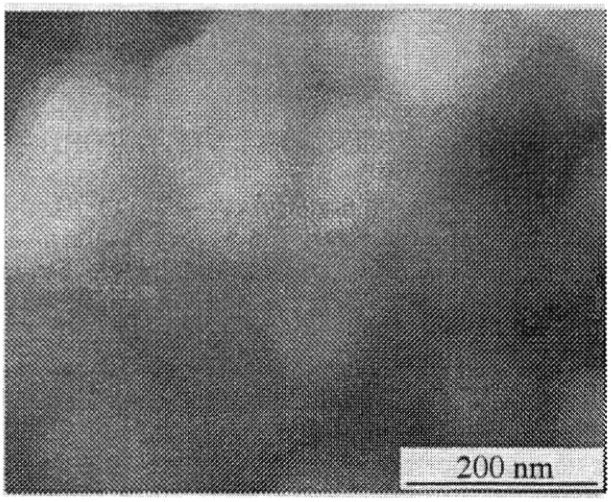

Fig.6 The AFM image of the Co-containing $BiDy_2Al_{0.8}Fe_{4.2}O_{12}$ particle (x = 0.5) in the coating film.

Figure 6 shows an AFM image of the Co-containing Bi-DyIG particles which have x = 0.5 in the coating films. No aggregate of the particles was observed. The primary size of the particles is about 50 ~ 100 nm. The size is small enough for the wavelengths of the read and write lasers for current, and near future, magneto-optical storage systems.

IV. Conclusions

Nano-size Co-containing Bi-DyIG particles were synthesized. Thin films were prepared by coating the particles milled for 30 h. Magnetic and magneto-optical properties of the particles and films were measured.

The $2\theta_F$ of the film with x = 0.5 was about 600 deg/cm, and the relatively high H_C of 450 Oe was obtained. The figure of merit $2\theta_F/\alpha$ at 520 nm is about 0.63. The size of the observed particles was about 50~100 nm in the films which is small enough for the wavelengths of read and write lasers.

These results show that the coating Co-containing Bi-DyIG film is one of the candidate materials to a new economical magneto-optical storage medium.

References

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