—Communication—

Preparation of Bi Substituted YIG Particles by Coprecipitation

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1. INTRODUCTION

The development of data processing and telecommunications in the next century will be based on the integrated optical technologies. The thin films of Bi substituted yttrium iron garnet(Bi-YIG) are applicable to magneto-optical disks and magneto-optical display devices. In the preparation of Bi-YIG thin films by sputtering method, ceramic crystal or glass substrates are required because of the high preparation temperature. As the temperature is normally more than 500°C, it is difficult to use the plastic substrates. It is possible to avoid this thermal requirement by adopting the coating method for Bi-YIG fine particles[1].

We prepared Bi-YIG fine particles by coprecipitation method, and the dependence of the magnetic properties and particle size on the preparation conditions were investigated. The prepared particles are classified in order to collect smaller particles, which are necessary to fabricate the transparent magneto-optical coating films.

2. EXPERIMENTAL

Figure1 shows the preparation process of Bi-YIG particles by coprecipitation. First, aqueous solutions of nitrates of Bi, Y and Fe with a metal ratio corresponding to the composition of $Bi_{1.6}Y_{1.4}Fe_5O_{12}$ were prepared and mixed at room temperature with an alkaline solution of NH_4OH. After the coprecipitation reaction, the pH of the solution was 10.7. Then the obtained slurry was washed with water to remove the alkaline ions, and filtered and dried at 100℃ for 1.5 h. Then the coprecipitate was annealed in air at Ta=500~700-℃ for 1 h or 4 h to crystallize.

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Classification of the particles was conducted as follows. Bi-YIG particles(2.0g) annealed at 600℃ for 1 h were dispersed in water(100ml) by using an ultrasonic cleaner for 10 min and then stood for 30 min. After the large particles settled, the fine particles in the water were collected with a magnet.

The composition of the coprecipitates was analyzed by ICP. The shape and the size of the particles were investigated by using a transmission electron microscope(TEM) and the crystal structure of the particles was examined by X-ray diffraction. Magnetic properties were measured using a vibrating sample magnetometer at room temperature.

3. RESULTS AND DISCUSSION

3.1 Magnetic Properties

Figure2 shows the saturation magnetization of the particles as a function of the annealing temperature for both annealing periods. For annealing period of 1 h, Magnetization appeared at Ta=580℃, whereas for 4 h, the magnetization appeared at Ta=570℃.

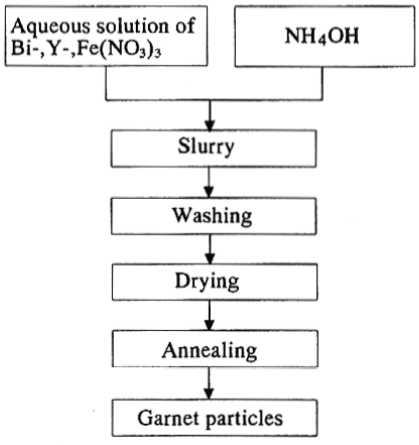

Fig.1 Preparation of garnet fine particles by coprecipitation.

Table1 Effect of classification on magnetization and coercive force

	Before classification	After classification
Magnetization σs [emu/g]	12.23	11.39
Coercivity Hc [Oe]	29.44	15.28

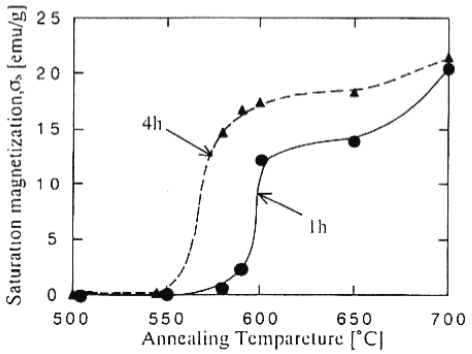

Fig.2 Saturation magnetization of prepared particles vs. annealing temperature for different annealing periods.

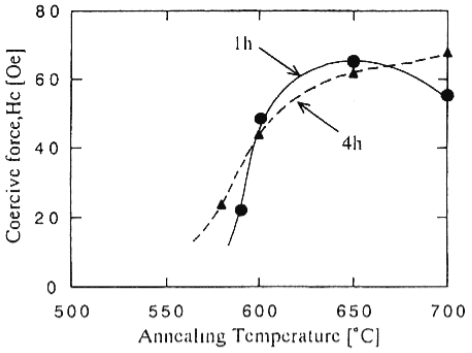

Fig.3 Coercive force of prepared particles vs. annealing temperature.

Figure3 shows the relation between the coercive force of the particles and the annealing temperature. The coercive force was low for the annealing temperature at which the magnetization appeared, and it increased with temperatures the magnetization increased.

Figure4 shows TEM micrographs of the particles annealed for 4 h at various temperatures from 500℃ to 700℃. The magnetization was not detected in the particles annealed at 500℃ and 550℃, the mean particle sizes being about 7nm and 12nm when they were annealed at 500℃ and 550℃,respectively. The size of

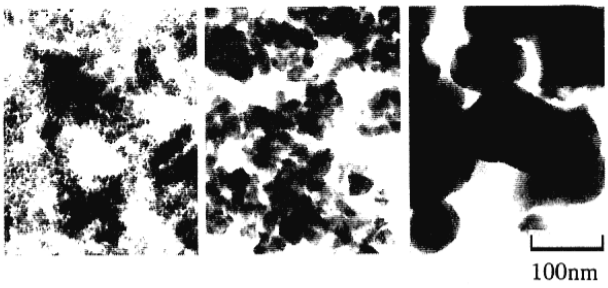

Fig.4 TEM micrographs of annealed Bi-YIG particles.

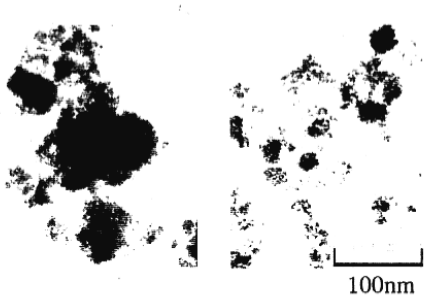

Fig.5 TEM micrographs of annealed Bi-YIG particles, before and after the classification.

the particles increased when they were annealed over 600℃. The particle sizes were 47nm and 200nm when they were annealed at 600℃ and 700℃, respectively.

Some particles, in the powder samples synthesized at 570℃ for 1 h, were found to show considerably large magneto-optical effect.

3.2 Classification

Table 1 shows the effect of the classification process on the saturation magnetization and coercive force of the particles. Although the saturation magnetization hardly changed by the process, the coercive force lowered to half of the initial value after the classification.

Figure5 shows TEM micrographs of the particles before and after classification. The size of small fine particles did not change before and after the classification. However, the aggregated large particles composed of the small particles were removed by the classification process. Which is considered to be the cause of reduction in coercive force after the classification.

REFERENCE

1) T. Fujimoto, Y. Kumura, M. Gomi and M. Abe, J. Magn. Soc. Jpn., **15**, 263 (1991).