Magneto-Optical Properties of Bi-YIG Nanoparticle with Poly-Methacrylate Matrix Materials

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INTRODUCTION Bismuth substituted yttrium iron garnet (Bi-YIG) is a very attractive material for magneto-optical applications. We have been studying the preparation process and applications of Bi-YIG nanoparticles and their coating films. The hybrid material is usable to built-in electronic and optical devices. Some kinds of magnetic materials with nanoparticles are reported in resent years. Bulky hybrid materials of Bi-YIG nanoparticle and kinds of plastic matrix are useful for magneto-optical devices because these have easy molding properties for various shapes. In this study, we will introduce hybridized materials constructed by the Bi-YIG nanoparticle and methacrylate (MA) monomer. We estimated the Bi-YIG nanoparticles dispersed properties with some derived MA materials used for plastic optical fiber. The magneto-optical properties of them are measured.

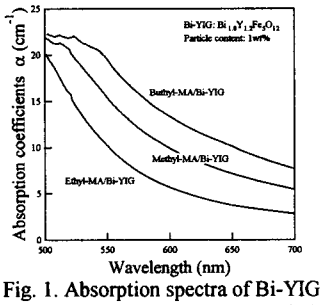

Fig. 1. Absorption spectra of Bi-YIG nanoparticle and R-MA (R = methyl, ethyl, butyl) fluids.

EXPERIMENTS $Bi_{1.8}Y_{1.2}Fe_5O_{12}$ particle was prepared by coprecipitation and annealing processes. The nanoparticles were mixed with R-MA (R = methyl, ethyl, butyl and the others) and poly methyl-MA (PMMA). Then the mixtures were milled by planetary milling machine with 48 h. The methyl-, ethyl- and butyl-MA fluids are stable over 168 h. The solidified the hybrid materials by heat polymerization process under 70°C, 5 h with 0.1 wt% of 2,2'-azobis(isobutylrate) and 1-octanethiol.

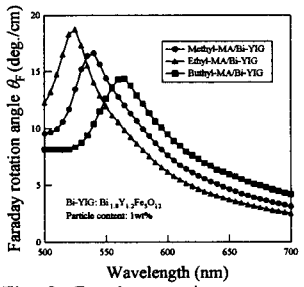

Fig. 2. Faraday rotation spectra of Bi-YIG nanoparticle and R-MA (R = methyl, ethyl, butyl) fluids.

RESULTS AND DISCUSSION Figure 1 shows the absorption spectra of the Bi-YIG fluids. The absorption coefficients α of the ethyl-MA fluid is smaller than them of the others. Figure 2 shows the Faraday rotation spectra of the fluids. The Faraday rotation θ_F of the ethyl-MA fluid is about 19°/cm. The ratio of the θ_F and α at 520 nm are 0.56 (methyl-MA), 1.3 (ethyl-MA) and 0.36 (butyl-MA). The solid of the ethyl-MA is clear and have high transparency. The size of the Bi-YIG nanoparticle measured with TEM is smaller than the 40 nm. We will show new solid phase magneto-optical materials which have high transparency and large Faraday rotation angle. This hybridized material will be able to produce magneto-optical devices with molding mass-production processes.