The 8th Joint MMM-Intermag Conference

ABSTRACTS

SAN ANTONIO, TEXAS ▪ JANUARY 7-11, 2001

MONDAY AFTERNOON, 8 JANUARY 2001 SALON C, 1:00 TO 5:00

Session BP
STRUCTURAL, MAGNETIC, AND OPTIMAL PROPERTIES OF GARNETS (POSTER SESSION)

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Contributed Papers

BP-01. Prototyping a Fully-Integrated Mach-Zehnder Magneto-Optic Isolator. M. Levy (Michigan Technolog. Univ., Phys., Metallurgy & Mater. Eng., 1400 Townsend Ave, Houghton, Michigan, 49931, US), J. Fujita, R.M. Osgood, Jr. (Columbia Univ., Microelectronics Sci. Lab, 530 West 120th St., Mail Code 8903, New York, NY, 10027, US), L. Wilkens, H. Dotsch (Universitat Osnabruck, Phys., Barbarastrasse 7, Osnabruck, Osnabruck, 49069, DE), *C. Gutierrez*, and M. Matheaus (Southwest Texas State Univ., Phys., 601 Univ. Dr., San Marcos, TX, 78666, US)

The development of a fully integrated optical isolator is increasingly important for meeting the needs of the rapidly evolving optical communications systems requiring low cost and compact integrated and hybrid optical systems. Several magneto-optic waveguide-based optical isolators have been demonstrated at 1.55 micron wavelengths with extinction ratios close to 30dB, but these devices are not fully integrated and are difficult to fabricate to acceptable tolerances. We report progress towards realizing the fabrication of the first fully integrated Mach-Zehnder interferometer isolator implementing sputtered thin-film magnets to eliminate these integration and fabrication problems. The fabrication tolerances for the Mach-Zehnder device are easier to meet because it does not require mode conversions between two orthogonal modes. This isolator design also implements a thin film magnet to saturate the magneto-optic waveguide for proper non-reciprocal operation, and to reduce device size. The proposed fully integrated Mach-Zehnder isolator consists of a waveguide Mach-Zehnder interferometer with a biasing thin-film Sm-Fe-Co magnet layer. A bismuth-, lutetium-, and neodymium- iron garnet film, (Bi,Lu,Nd)3(Fe,Al)5O12, is grown by liquid phase epitaxy on a [111] oriented GGG substrate to create the waveguide. The magneto-optic film has in-plane magnetization, absorption of 122dB/cm, and index of 2.2403 for the TM mode. The 0.5 micron-thick slab waveguide is patterned using a direct laser-written mask and subsequent phosphoric-acid wet-etching. The fabrication strategies of the Sm-Co-Fe biasing magnetic film are also reported, because device fabrication requires magnetic film deposition at reduced temperatures for process integration with the (Bi,Lu,Nd)3(Fe,Al)5O12 waveguide. An extinction ratio of 19dB with excess loss of 2dB are obtained for the prototype isolator device at 1.54 micron wavelengths with flat response within 2dB at wavelength of 1.49-1.57 microns.

BP-02. Exchange Interactions in $Y_3Fe_{5-x}Cr_xO_{12}$. *Young Rang Uhm*, Sam Jin Kim, and Chul Sung Kim (Kookmin Univ., Dept. of Phys., Sungbukgu, Seoul, 136-702, KR)

The iron containing garnet $Y_3Fe_{5-x}Cr_xO_{12}$ (x= 0.0, 0.25, 0.5, and 1.0) has been examined, and their exchange interactions and distributions in sub-site were studied by ^{57}Fe Mössbauer spectroscopy and vibrating sample magnetometer(VSM). The lattice constants with cubic structure increased from 12.386 Å for x = 0.25 to 12.392 Å for 1.0. The intersublattice 16(a)-O-24(d), 16(a)-O-16(a) and 24(d)-O-24(d) superexchange interactions for $Y_3Fe_{4.5}Cr_{0.5}O_{12}$ were found to be antiferromagnetic with strength of J_{ad} = -52.23 k_B, J_{aa} = -27.85 k_B and J_{dd} = -39.16 k_B, respectively. These values of parameters become larger, as an amount of Cr decreases in garnet. The results show that the chromium in compounds of the $Y_3Fe_{5-x}Cr_xO_{12}$ (x = 0.0, 0.25, 0.5, and 1.0) occupied at octahedral site. The Néel temperature decreased from 580 K for x = 0.0 to 525 K for x=0.5. The substitution of Fe^{3+} by Cr^{3+} on the octahedral site results in much lowering of magnetic ordering temperature. The Mossbauer spectra can be analyses 3 sets or 4 sets of six Lorentzians with increasing an amount of Cr^{3+}. It results from the distribution($_4C_n$) of Fe^{3+} and Cr^{3+} at octahedral site. The ratios of areas, a, d_1, d_2, d_3, in $Y_3Fe_{4.5}Cr_{0.5}O_{12}$ are 0.33, 0.22, 0.28, 0.14, respectively.

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BP-03. Novel milling process of Bi-YIG nanoparticle dispersed film. *Teruyoshi Hirano* (Toppan Printing, Co. Ltd., TRI, 4-2-3 Takanodai-minami, Sugito, Saitama, 345-8508, JP), Carlos Seiti Kuroda, Tae-Youb Kim, Tomoyasu Taniyama, Yoshitaka Kitamoto, and Yohtaro Yamazaki (Tokyo Inst. of Technol., Dept. of Innovative and Engineered Mater., 4259 Nagatsuta, Midori-ku, Yokohama, Kanagawa, 226-8502, JP)

The 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 nanoparticle and their coating films [T. Hirano *et al.*, *Denki Kagaku*, **64**(4), 307 (1996)]. Throughout the research processes, we developed a new planetary milling machine system for nanoparticle dispersed fluids. In this study, we estimated magnetic and magneto-optical properties of the Bi-YIG nanoparticle dispersed material which made with new milling machine system. $Bi_{1.8}Y_{1.2}Fe_5O_{12}$ particle was prepared by coprecipitation and annealing processes [T. Hirano *et al.*, *IEEE Trans. Magn.*, **31**(6), 3280 (1995)]. The nanoparticle were mixed with an epoxy binder and with a cyclohexanone. Then the mixtures were milled by a planetary milling machine [Y. Yamazaki *et al.*, *J. Phys. IV France*, 7(5), Cooloque C1, C1-543 (1997)]. The magnetic fluid A was prepared with an ordinary milling system, fluid B was prepared with the developed milling system (Toppan Co.). The coating films were made with spin coater on glass substrate. Optical spectra were measured with a spectrophotometer. The Bi-YIG nanoparticle dispersing fluid prepared with system A contains aggregated particle phases. The milled fluids prepared with system B are clear. Figure 1 shows AFM image of the nanoparticle in the fluid B film. The nano-size particle is about 40 nm which is primary size. Figure 2 shows transparent spectra of coating films. The film A shows scattered and low transparency. The fluid B films have high transparency. These results indicate that the fluid A film is made by aggregated Bi-YIG nanoparticle, and the fluid B film is made by the Bi-YIG nanoparticle dispersed material. This developed milling system creates promising magneto-optical material. This work was supported by Research Development Program of University-Industry Alliance-A Matching Funds Approach from Japan Society for the Promotion of science.