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ANALYSIS OF LPE GROWN GARNET FILM FOR FARADAY ROTATOR

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Abstract - LPE growth experiment were carried out to make garnet crystal for Faraday rotator and we have evaluated the characteristics of Faraday rotator by a measurement system which is consist of electromagnet and optical components, also done Laue pattern analysis. The thickness of garnet film was 180 μm and the Faraday rotation of this film was 388 deg/Cm at wavelength 1.55 μm, room temperature.

Ⅰ.INTRODUCTION

A serious problem in optical communication system is noise caused by reflected light from optical device. In order to circumbent this problem, optical isolator is incerted to optical transmission system. The function of optical isolator which is shown in Fig.1 is to transfer optical signals only in forward direction by cutting off backward direction signals. The 45 degree Faraday rotator, whick is oprerated in nonreciprocal rotation of polarization plane, is the most important component in optical isolator and mainly determines the performance of isolator[1].

Magnetic garnet material has been widely used as a Faraday rotator at the wavelength of optical communication. We have grown Bi substituted rare-earth iron garnet by liquid phase epitaxy (LPE) method, acquired Laue back-reflection pattern to identify whether grown film is single crystal or not and measured Faraday rotating angle at wavelength 1.55 μm.

Ⅱ..EXPERIMENT RESULTS AND DISCUSSION

A. Garnet Film Growth.

Experimental procedure of fabrication of Faraday rotator are shown in Fig. 2. Fig. 3 shows experiemntal apparatus for garnet film. Garnet film was grown by LPE on to (111) oriented garnet substrates with lattice

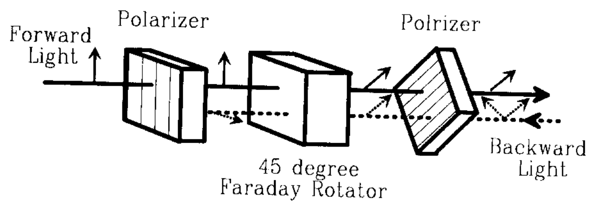


Fig. 1 Principle of optical isolator

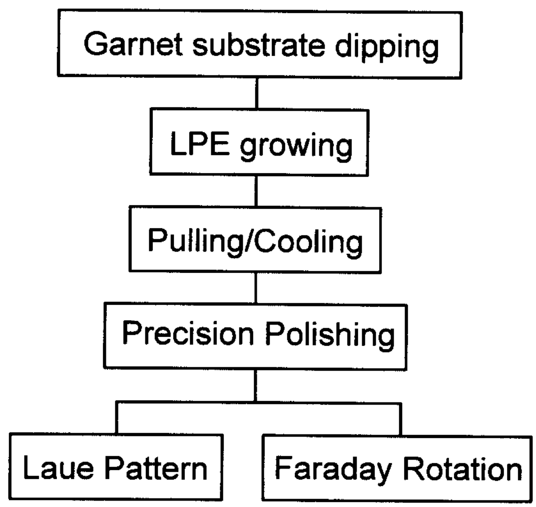


Fig. 2 Fabrication process of Faraday rotator

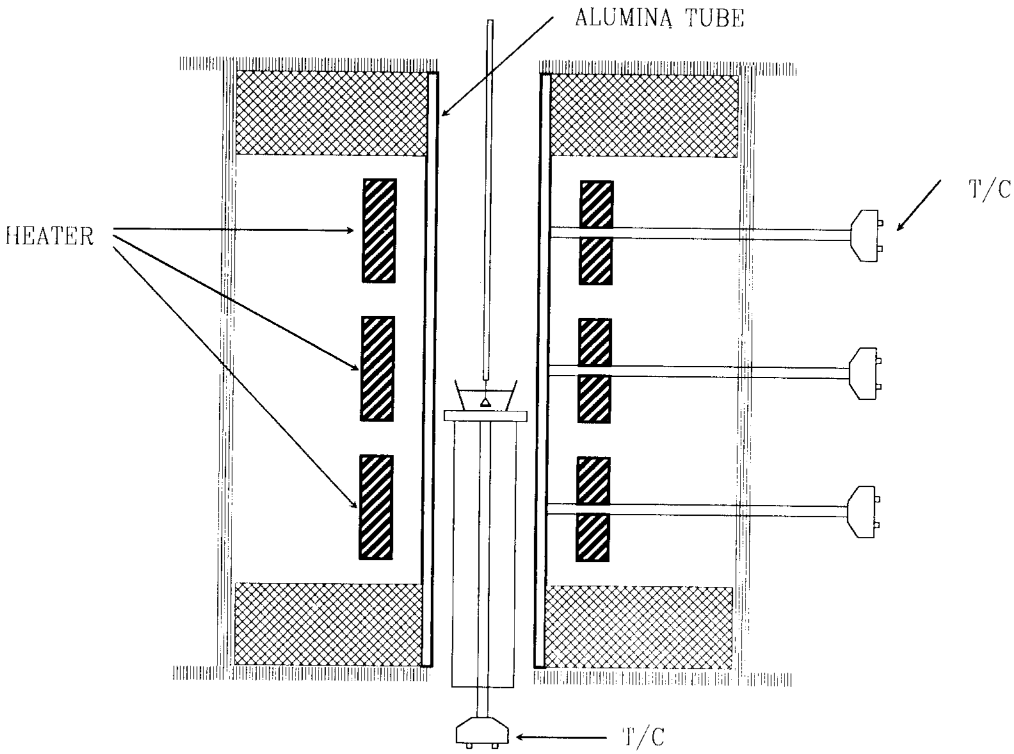


Fig. 3 Schematic diagram of LPE furnace

constant 12.496 Å at 25℃. The film was grown from $PbO\text{-}Bi_2O_3\text{-}B_2O_3$ flux using horizontal dipping and 100 rpm. The growth temperature is 800℃. The thickness of garnet film was 180 μm at growth time 48 hours.

B. Back-Reflection Laue Pattern

Photo. 1 is a Back-Reflection Laue pattern of a garnet crystal. Incident beam is perpendicular to epitaxial film surface. Tungsten radiation, 30 kV, 18 mA, 10 hours exposure 3 cm film-to-specimen distance were experimental conditions. The spots are seen to lie on certain curves, hypobolas, as shown above photo.1. The spots lying on any one curveare reflections from planes belonging to one zone as well known fact [2]. Fig. 4 is a Wulff net positioned 5 spots on a hypobola to determine Miller indices of that planes. Fig. 5 is a rectangular film redrawn by selecting only 6 spots from photo. 1. Resulting from analysis, 5 plane indices was found as shown Fig. 5. From this result, we have concluded that the grown film was identified as a single crystal.

C. Faraday Rotation of Grown Film.

We have constructed Faraday roatation angle measurment system shown in Fig. 6. The magnetic field of electromagnet is available up to 3000 Oe. The light from laser diode is polarized by linear polarizer P and polarization plane rotates on the way through garnet film

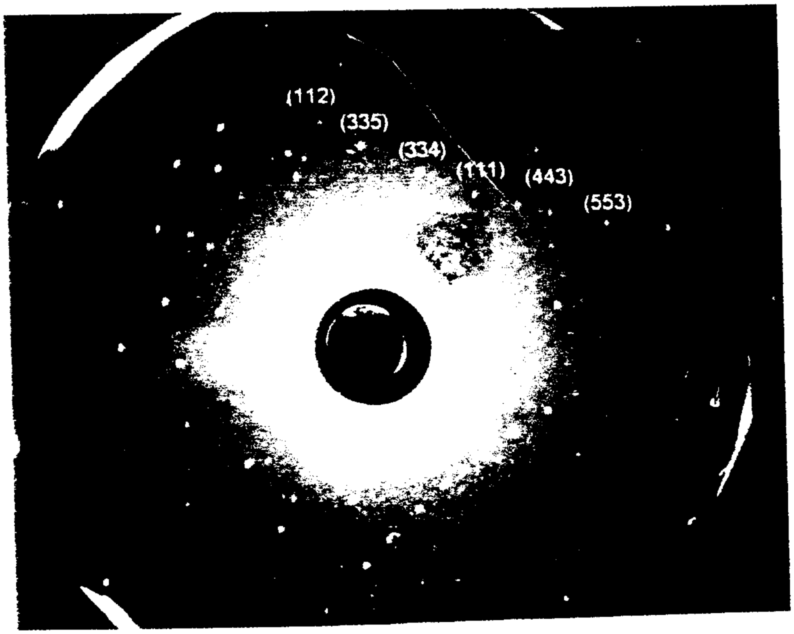


Photo. 1 Back-reflection Laue pattern of a garnet crystal

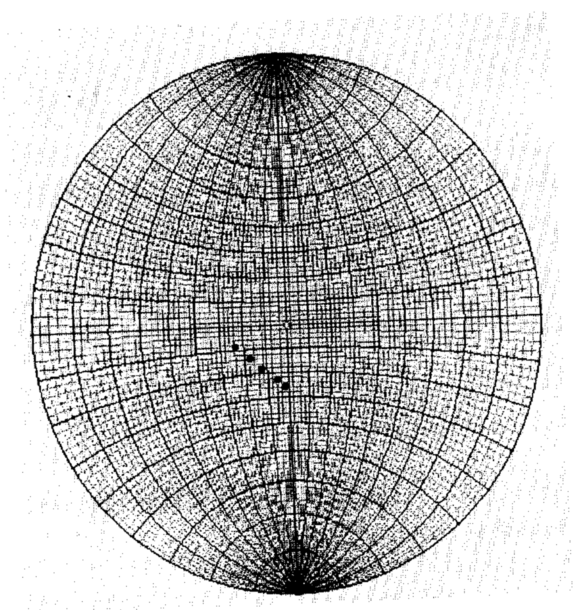


Fig. 4 Wulff net showing experimental 6 spots selected from Photo. 1

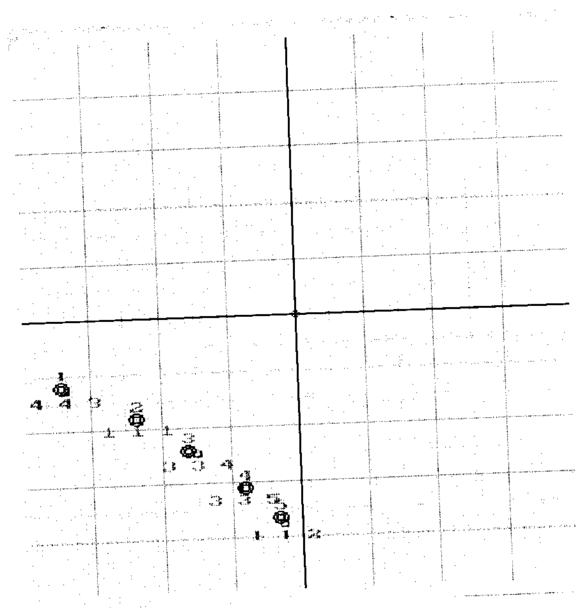
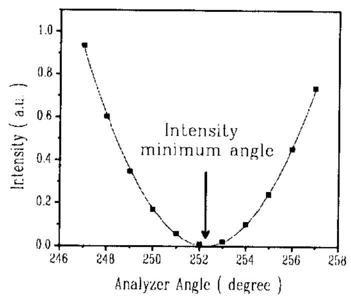
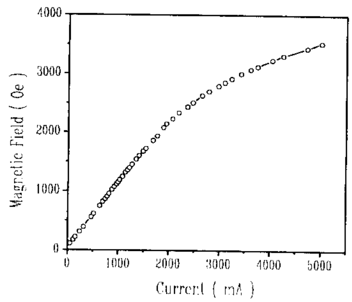


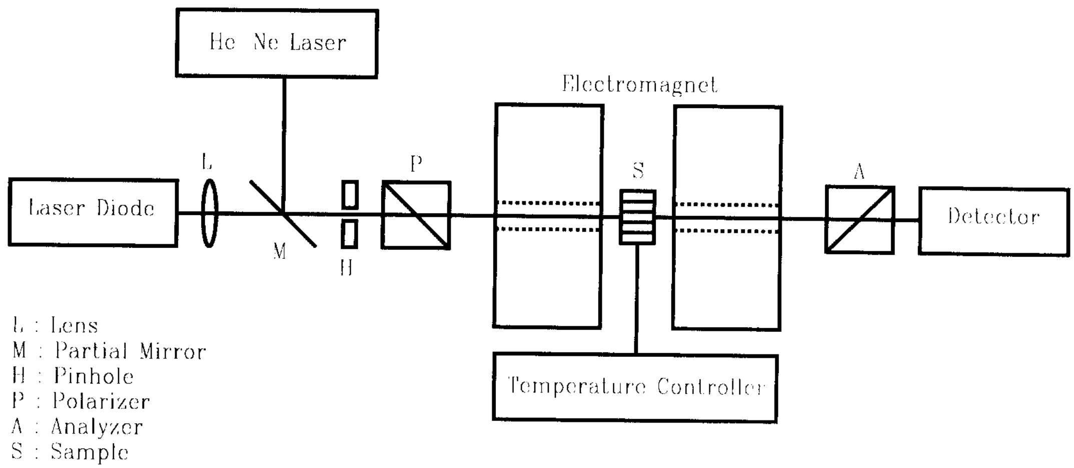
Fig. 5 Miller indices from Laue pattern analysis



(b)



(c)



(a)

Fig. 6 (a) Experimental setup Faraday rotation measurement system
(b) Method of measuring Faraday rotation by the way intensity minimum angle
(c) Magnetic field of electromagnet vs. current

S. We have measured the transmitted intensity of light with varying analyzer angle and found minimum intensity angle. This minimum intensity angle is compared with the case of no garnet film. The difference of this two minimum intensity angle gives Faraday rotation angle of garnet film. In this way, Faraday rotation angle of garnet film was measured with varying magnetic field up to saturation field. Error range of measurment system is 0.5 degree.

The data of Faraday rotation angle are shown in Fig. 7 vs. applied magnetic field at room temperature. The magnetic field necessary for saturation was about 150 Oe and saturation Faraday rotation is 388 deg/Cm.

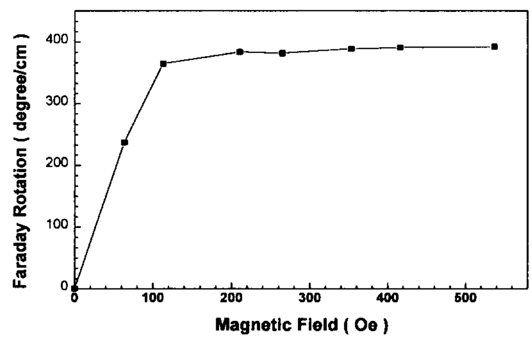


Fig. 7 Faraday rotation of garnet film

Ⅲ.CONCLUSIONS

Bi substituted rare earth iron garnet film used to Faraday rotator for optical isolator was grown by LPE method. Analyzing back-reflection Laue pattern confirmed that grown film is garnet single crystal. Faraday rotation angle is 388 deg/Cm at room temperature. Further research will be continued to enhance Faraday rotation angle of garnet film.

REFERENCE

[1] H. S. Park, W. G. Lee et al, Proceedings of Material Research Society of Korea, B 31 (1994, 11).
[2] B. D. Cullity. Elements of x-ray diffraction. 2ed. (Addison Wesley, 1978).