Polarization selective element with a new structure for ultra small optical pick-up head

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Over years, read/write optical data storage systems have become intensively significant for data back-up issues due to their outstanding features such as high capacity, rapid access, multi read/write modes, reliance, and so on. These systems fall into one of two technologies: phase-change technology and magneto optical (MO) technology. MO technology has a significant advantage of handling an enormous capacity compared with the phase-change counterpart. Size, speed and price of these systems partially depend on pick-up heads performing read/write functions. The polarization selective elements used to determine polarization state of readout beam throughout the reading process play an important role in the MO pick-up head systems. They must be simple in structure and tolerant towards alignment variations that lead to a high performance and easy fabrication process. In this paper, a new polarization selective element based on holographic volume grating and dove prism wave-guide is proposed. This element has a novel structure that is more simple than those introduced before.[1][2] By using Dupont photopolymer as the recording medium, no complex development process is needed. Thus, it induces a better performance on polarization selective function. Also, the fabrication could be more easily realized. In addition, ultra small size and lightweight are its interests.

The proposed structure includes three sub-elements, which are holographic input coupler (HIC), holographic polarizing beam-splitter (HPBS) and dove coupler as shown in figure 1. For convenience, the HIC is attached on the upper side of the HPBS, which in turn is supported by the dove prism coupler. The HIC serves as a non-polarization element that has the same performance with s- and p-incidences. The reflected laser beam from the MO disk surface normally incident on the holographic input coupler is diffracted at an angle of 45° with respect to the normal. Meanwhile, the HPBS takes responsibility for separating the s-and p-components of the diffraction beam. The HPBS has 90° diffraction angle and requires 45° incident angle that is compatible with the HIC. The output optical signals are coupled out of the HPBS by the dove prism made of BK7 material. The dove prism coupler has dimension of 2.4mm(width) X 27mm(length) X 1mm(thick) and two holographic gratings formed in 38 μm Dupont photopolymer (HRF150-38) are 1mm X 1mm (width X length). The fabrication of the holographic polarization selective element included two stages. First, H-PBS was recorded by use of a setup in figure 2 with the operating wavelength of 532nm. The intensities of the recording beams were $1.23mW/cm^2$ and the exposure energy was $738mJ/cm^2$ corresponding to the index modulation of 0.0049. Then, the HBPS was exposed by UV for 5 minutes to gain the stability. Second, another photosensitive film was attached on the HPBS and the HIC was recorded on it as shown in figure 3. The HIC has an asymmetric structure so that it suffered from the shrinkage effect. It could be overcome by applying an angle-compensation technique in which the recording angles must be deviated from the desired values.

A switching experiment was implemented to check the validity of the element with regard to optical pick-up heads as shown in figure 4. The NEWFOCUS-5542 half-wave plate of 532nm wavelength mounted on a motor works as a polarization modulator, which is capable of turning polarizing orientation of laser beam. By using a motor controller, the half wave plate regularly revolved and so did the laser beams polarizing orientation. The output electrical signal was captured by an oscilloscope and sketched in figure 5. It is evidence that the series of electrical pulses agrees with the periodical polarization state of the readout beam. During the first half of the rotational period in which the s-component of the electric field vector is higher than p-, a positive pulse is created. In the second half, a negative one is induced. The higher voltage was applied to the motor controller, the shorter output signal's period was obtained. As a result, the polarizing selectivity of the element was successfully represented. Also, the positive and negative pulses had a same duration. That means there was no priority over either s- or p-incidences. It is a significant feature that makes our element reliable and accurate. The transmission images for s- and p-incidences were taken and shown in figure 6. In short, our element has many advantages such as small size, lightweight, simple structure, easy alignment, and maximum polarization ratio of about 100 that lead to a possible use in MO pick-up systems.

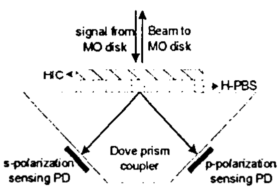


Fig. 1 A new design for holographic polarization selective element (top view)

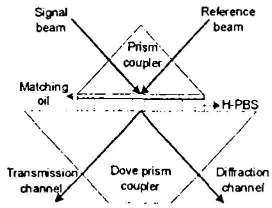


Fig. 2 Recording geometry for HPBS

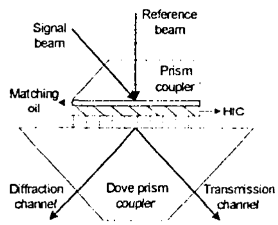


Fig. 3 Recording geometry for HIC

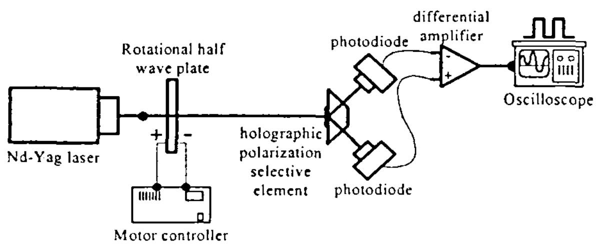
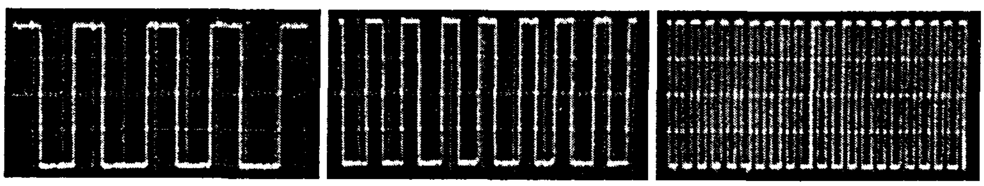
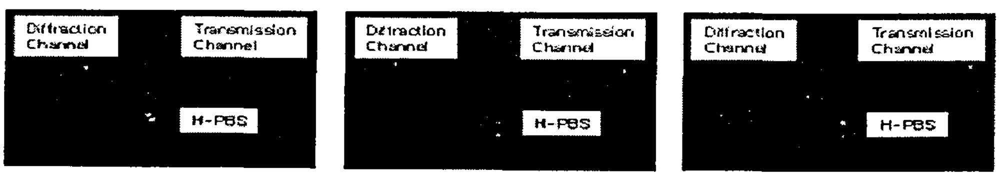


Fig. 4 Differential detector in the switching experiment.



(a) (b) (c)

Fig. 5 The output electrical signals with different applied voltages: (a) 500mV, (b) 700mV, (c) 1500mV.



(a) (b) (c)

Fig. 6 Transmission images in the switching experiment : (a) for s-incidence, (b) for both s- and p-incidences, (c) for p-incidence.

참조 문헌

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2] Yang-Tung Huang, "*Polarization-selective volume holograms: general design,*" Opt. Lett. **33**, 2115 (1994).