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묽은 자성반도체 $Cd_{1-x-y}Mn_xHg_yTe$ 단결정의 Faraday 회전

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(Faraday Rotation of Diluted Magnetic Semiconductors $Cd_{1-x-y}Mn_xHg_yTe$ Single Crystals)

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Abstract $Cd_{1-x-y}Mn_xHg_yTe$ single crystals were grown by using the vertical Bridgman method. The Verdet constant was evaluated as a function of the photon energy by using the result for the Faraday rotation. The Verdet curve was well fitted by using a single-oscillator method and shifted downward at $y \geq 0$ due to the exchange interaction. The Faraday rotation decreased linearly with increasing magnetic field from 0 KG to 8KG.

1. Introduction The large magneto-optical effects in diluted magnetic semiconductors (DMSs) have been of great interest for many years[1]. DMSs are compounds based on typical semiconductors(CdTe and ZnSe), for which a fraction of nonmagnetic cations has been replaced by magnetic ions (Mn, Fe, Co, and Cr). Among these properties, the strong spin-spin exchange interaction occurring between the *d* electrons of the Mn^{2+} ions and *s*-like conduction-band and *p*-like valence-band electrons profoundly affects all physical phenomena that depend on the Zeeman splitting of the band sublevels. For instance, this spin-spin exchange interaction leads to the well-known gaint Faraday rotation observed at photon energies E near the band-gap resonance[2,3]. The effect has been subsequently studied in various DMSs, in particular, in the optically isotropic CdMnTe and ZnMnTe[4]. In this paper, we investigate the Faraday rotation study on the quaternary CdMnHgTe crystals as a function of Hg compositions and magnetic field.

2. Experimental Procedure The $Cd_{1-x-y}Mn_xHg_yTe$ single crystals were grown by using the vertical Bridgman method. The mole fraction x and y was determined by Electron Probe Microanalyzer (EPMA-1400, SHIMADZU) and X-ray diffraction (XRD) measurements. Faraday rotation was measured by placing the sample in a magnetic field of an electromagnet and between two polaroid sheets set at 45° with respect to each other. Using this apparatus, rotation as small as 0.1° could be easily determined.

3. Results and Discussion Figure 1 shows the change in lattice constant with Hg concentration. This quaternary system crystallizes in the zinc-blende structure in the composition range y = 0.5, and also it is found that the lattice constant decrease with Hg concentration. Figure 2 shows the Verdet constants in $Cd_{1-x-y}Mn_xHg_yTe$ (y=0, 0.01, 0.03, and 0.05) at room temperature plotted as a function of the photon energy in the resonant part of the spectra with an expanded scale (1.2-2.1 eV). Figure 3 shows the magnetic field dependence of the Faraday rotation with increasing magnetic field at λ

=625 nm and 635 nm.

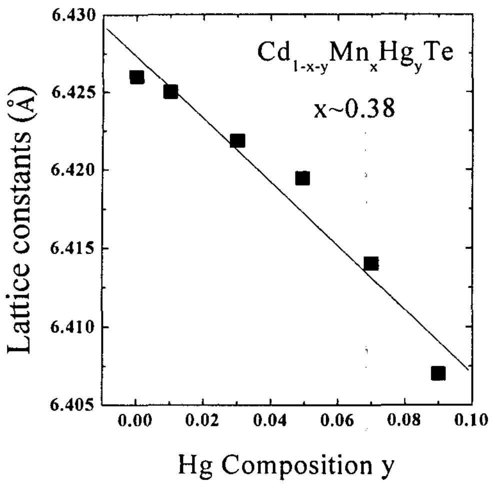

Fig. 1. Lattice constants as a function of Hg mole fraction y

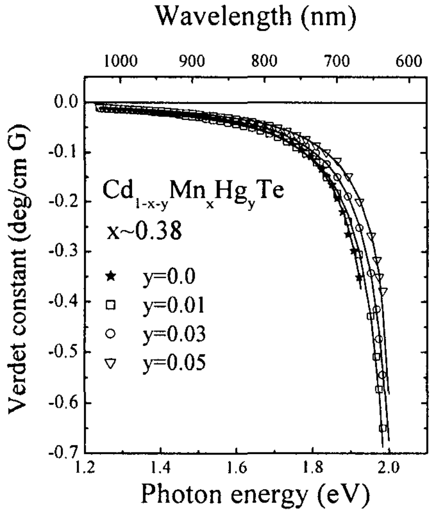

Fig. 2. Verdet constant for CdMnHgTe at R.T. for Hg mole fraction y. Solid line is the fit by single-oscillator model.

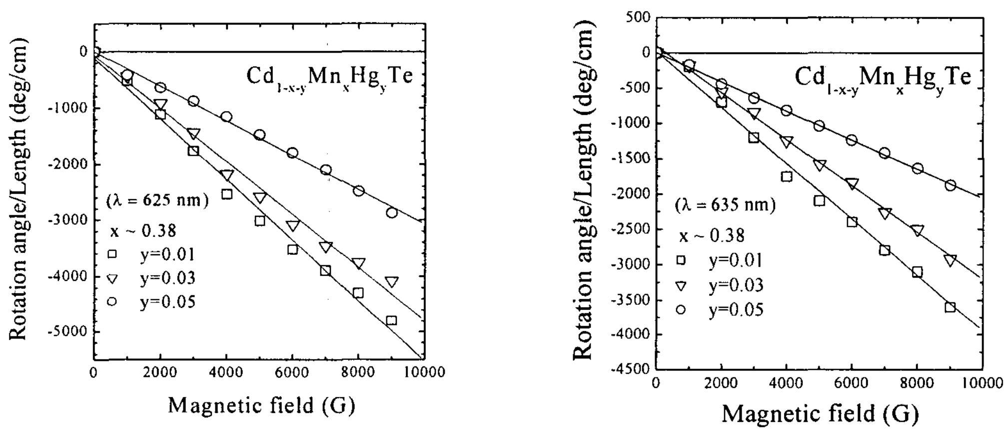

Fig. 3. Magnetic field dependence of the Faraday rotation with increasing magnetic field. The solid line represents a least-squares fit.

4. Summary $Cd_{1-x-y}Mn_xHg_yTe$ single crystals were grown by using the vertical Bridgman method. The Verdet constant was evaluated as a function of the photon energy by using the result for the Faraday rotation. The Verdet curve was well fitted by using a single-oscillator method and shifted downward at $y \geq 0$ due to the exchange interaction. The Faraday rotation decreased linearly with increasing magnetic field from 0 KG to 8KG.

5. References

[1] J. K. Furdyna et al., Semiconductor and Semimetals Academic, Vol. **25**, (1988).

[2] A. V. Komarov, S. M. Ryabchenko, O. V. Terletskii, I. I. Zheru, and R. D. Ivanchuk, Sov. Phys. JEPT **46**, 318 (1977).

[3] J. A. Gaj, R. R. Galazka, and M. Nawrocki, Solid State Commun. **25**, 193 (1978).

[4] D. U. Bartholomew, J. K. Furdyna, and A. K. Ramdas, Phys. Rev. B **34**, 6943 (1986).