

Study of optical manipulation of ferromagnetism and spin-based photonics

(Hiro Munekata)

Abstract :

An electronic system having itinerant character with moderate carrier concentrations ($10^{15} - 10^{21} \text{ cm}^{-3}$) is an interesting system in that it allows us to study novel aspects of the interaction between charges and spins, with possible access by light and an electric field/current. Among various materials systems, semiconductors-based nanostructures are especially interesting, since they offer opportunities to examine our findings both from fundamental and device-application points of view [1]. In this presentation, we first review experimental results on the optical excitation of the carrier-induced ferromagnetic system $p\text{-(Ga,Mn)As}$, and discuss the possibility of controlling ordered spins by the energy and angular momentum of light. We will review two cases:

- (1) Optical excitation with linearly polarized light pulses and resultant precession of magnetization [2].
- (2) Optical excitation with circularly polarized cw-light and resultant change in surface magnetization [3].

We then discuss the opportunity of utilizing spin-dependent optical transition and spin-dependent carrier transport to fabricate spin-dependent optical devices, e.g., polarized-light detectors and emitters, with some concrete applications in mind. For this topic, we will review the following two topics:

- (3) electrical detection of spin-polarized current in III-V heterostructures and detection of circularly polarized light [4].
- (4) MnSb layers for optical isolators [5] and spin-light emitting diodes

References

- [1] H. Munekata, "Optical Phenomena in Magnetic Semiconductors (Chapter 1)", in *Concepts in Spin Electronics*, edited by S. Maekawa (Oxford Science Publications, Oxford, 2006), p.1-p.42.
- [2] Y. Hashimoto, *et al.*, Phys. Rev. Lett. **100**, to be published on-line Feb. 4th (2008).
- [3] T. Kondo, *et al.*, phys. stat. sol. (c) **3**, 4263 (2006).
- [4] T. Kondo, *et al.*, Jpn. J. Appl. Lett. **45** (Express Lett.), L663 (2006).
- [5] T. Amemiya, *et al.*, Appl. Phys. Express **1**, 022002 (2008).