초청강연3

Magneto-optical properties of CdSe-based magnetic semiconductor self-assembled quantum dots

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We have investigated magneto-optical properties of a series of CdSe-based self-assembled quantum dots (QDs) systems involving diluted magnetic semiconductors (DMSs). The QD systems are prepared in the form of single- and double-QD layer geometry. The single-layer magnetic QD structures, consisting of either of CdSe/ZnMnSe or CdMnSe/ZnSe QD layers, were studied by magneto PL measurements. The magnetic QDs exhibit relatively weak PL emission compared to analogous non-DMS system, such as CdSe/ZnSe. However, we observe a dramatic increase in the PL intensity emitted by excitons confined in such QDs when a magnetic field is applied. We discuss this effect in terms of an efficient transfer of excitation between the excitons and the Mn ions. In addition, we discuss on the role that Mn plays in CdSe dot nucleation and providing a new handle for optimization of the growth of the CdSe QDs. The large Zeeman shift of the PL energy and spin polarization of the exciton in QDs, the characteristics of semiconductor quantum systems involving DMSs, were also observed in the presence of magnetic field. We utilize such enhanced magnetic properties of DMS QDs to study inter-dot spin interaction between two QD layers. For observing interlayer exchange interaction, we designed coupled asymmetric two-layer QD structures with different bandgap energies. The double layers were formed either from CdMnSe and CdSe QDs, or from CdSe and CdZnMnSe QD layers, separated by ZnSe barriers. To investigate the spin polarization of carriers in the QDs, we performed polarization-selective magneto-PL experiments by exciting the above structures with unpolarized light, and detecting the PL with either the σ^- or the σ^+ circular polarization. When a magnetic field was applied to the double-QD layers, the intensities of the circularly polarized PL peaks corresponding to the non-magnetic CdSe and CdZnSe layers exhibited significant differences in contrast to the PL observed on single-layer CdSe or CdZnSe QD reference structures. The behavior observed on the double-layer QD structures was interpreted in terms of anti-parallel spin interaction between carriers localized coupled QD pairs.