EXITON DYNAMICS OF SEMICONDUCTOR NANOCRYSTALS AND MULTI-COLOR OPTICAL SWITCHING OF EXCITON LUMINESCENCE

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Semiconductor nanocrystals (SNCs) show specific photophysical properties such as muti-exciton generation induced by one photon absorption, Auger recombination, and hot carrier transfer from higher excited electronic states. These properties are mainly originated from the relaxation of momentum conservation in SNCs. We have prepared several kinds of SNCs with controlled quantum confinement dimensionality such as quantum dots (QDs), nanorods (NRs), and nanoplatelets (NPLs), and examined elementary relaxation processes of excitons by time-resolved spectroscopy and single particle spectroscopy to reveal the relationship between structure and elementary exciton relaxation and carrier transfer processes. In addition, hybrid nanostructures (HNs) of SNCs with metal nanoparticles such as Au and Pt and acceptor molecules were prepared as model systems to extract carriers for efficient utilization of photon energy.[1-6]

SNCs are also expected to play an important role in luminescence materials because of their characteristics like high absorption coefficient, wide absorption band and narrow emission band. On the other hand, photochromic molecules such as diarylethene (DAE) exhibits reversible optical switching of molecular structures. Novel photoresponsive properties such as reversible switching of optical properties of SNPs will be expected for SNCs-DAE systems. We synthesized various CdTe QDs (3.3 ~ 4.1 nm) by a colloidal synthetic method and DAE derivatives were adsorbed on CdTe QDs to prepare hybrid nanostructures (HNs). We observed very efficient luminescence quenching of CdTe QDs with the closed form of DAE (DAEC, ~10^{-6} M), although the open form (DAEO) does not show luminescence quenching. Photochromic reaction of DAE is repeatable, so that the continuous switching of luminescence property of CdTe QDs is expected. A large spectral overlap of absorption of DAEC (acceptor) and luminescence of CdTe QDs (donor) indicates that the mechanism of luminescence quenching is probably Förster-type resonance energy transfer. Based on the luminescence decay dynamics, the detail mechanism of the interaction between CdTe QDs and DAE will be discussed.

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