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In recent years, excitonic behaviors in semiconductor nanocrystals (NCs) have attracted much interest because of unique optical properties and of the potential for applications. The optical properties in NCs are mainly characterized by the effects of quantum size confinement and photo-ionization. Even though much effort has been made, there still exist following two questions even at present.

1. Kayanuma[1] calculated a quantum size effect in spherical NCs by a variational method, and succeeded in the explanation of the quantum size effects that were observed in most of representative semiconductor NCs. The quantum size effect of CuBr NCs, however, has not been explained exceptionally.

2. Photo-induced on/off behaviors[2] and photodarkening effects[3] are the common phenomena observed in NCs. Both the phenomena are interpreted to be originated from the photo-ionization of the NCs. Nevertheless the "photo-ionization process of the NCs" has not been confirmed yet.

I have studied on the behaviors of photo-excited carriers in NCs to understand the optical properties of NCs, and above two questions are resolved in my thesis obviously.

At first, I took TEM pictures of CuBr NCs embedded in PMMA, and measured absorption and photoluminescence (PL) spectra. Both the absorption and PL bands due

to $Z_{1,2}$ excitons show an abnormal blue-shift by changing the size of the NCs. According to Cho's **k**-linear theory[4], the energy levels of the $Z_{1,2}$ exciton state split into eight levels at a finite wave vector **k**. Such abnormal blue-shifts can be interpreted by application of size quantization for the exciton dispersion on the basis of the **k**-linear theory. The multiplicity and the **k**-dependent mixing of $Z_{1,2}$ exciton states cause the abnormal blue-shifts in CuBr NCs.

Next, I measured the temperature dependences of the photocurrent (PC) and the PL intensity in CdTe NCs embedded in TOPO ($(n\text{-}C_8H_{17})_3P=O$) matrix to clarify the trapping process of photo-excited carriers emitted from the NCs. The TOPO is a suitable matrix for measuring the PC, compared to PMMA or glass, because of the large movility of charged carriers. Phase transition of the TOPO matrix from amorphous solid to liquid causes a steep rise in the temperature dependences of both the PC and PL intensity. The existence of the large PC means that the photo-generated charged carriers are emitted from NCs to the matrix. The steep rise of PC and PL intensity strongly suggests that the emitted carriers are trapped in the amorphous phase, but they are not in liquid. Hence, such abrupt changes in the temperature dependences of the PC and the PL intensity are direct evidence for an escape of a photo-excited carrier from the NC.

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[3] D. I. Chepic et al., J. Lumin. **47**, 113 (1990).

[4] K. Cho, Phys. Rev. **B14**, 4463 (1976).