Photoluminescence characterization of individual CdS nanocrystals embedded in dielectric matrices

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Recently, there are extensive studies of photoluminescence (PL) properties of individual nanostructures. The PL spectrum of individual nanostructures provides intrinsic information about their electronic structures. Semiconductor nanocrystals embedded in dielectric matrices are one class of the unique nanostructures, because carriers and/or excitons are strongly confined in nanocrystals by dielectric matrices with large band gap energies.[1, 2] In this work, we report PL properties of embedded CdS nanocrystals in Al_2O_3 matrices under high spatial resolution by a scanning near-field optical microscope (SNOM).

The samples of CdS nanocrystals in *c*-axis oriented α-Al_2O_3 single crystals were fabricated by sequential ion implantation followed by thermal annealing.[1] Equal doses of Cd^+ and S^+ were implanted into the substrate, and the samples were annealed at 1000 °C for 60 min in flowing Ar + H_2 atmosphere. From TEM observations, the averaged diameter of CdS nanocrystal was estimated to be 17 nm. The x-ray diffraction date showed that the CdS nanocrystals have the wurtzite structure.

Figure 1 (a) shows the spatial profile of the PL intensity measured by SNOM in the CdS nanocrystals at 8 K. The individual bright spots correspond to the CdS nanocrystals showing efficient PL. Figure 1 (b) shows the surface topographic image obtained by shear force in the same scanning area in Fig. 1(a). No remarkable structures were observed in the topographic measurement, while there exist the bright spots in the PL image in the same area. This result suggests that the optical measurement by SNOM is a powerful method for the spatial characterization of nanocrystals embedded in transparent substrates. Further, the SNOM-PL spectra consist of the sharp PL bands near the energy of band edge at 2.58-2.59 eV.[2] These sharp PL bands attribute to the radiative recombination of excitons in individual CdS nanocrystals. The origin of these PL bands will be discussed.

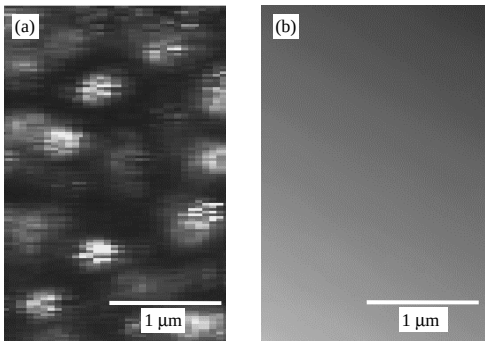

Figure 1
(a) SNOM PL image of the sample.
(b) Shear-force image of the surface.

Part of this work at Nara was supported by a Grant-in-Aid from Scientific Research from The Ministry of Education, Science, Sports and Culture of Japan. Oak Ridged National Laboratory is managed by UT-Battelle, LLC, for the U.S. department of Energy under Contract No. DE-AC05-00OR22725.

References

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