

# Photoluminescence from CdS Nanocrystals Fabricated by Sequential Ion Implantation

**Y. Kanemitsu,<sup>a</sup> D. Matsuura,<sup>a</sup> M. Ando,<sup>a</sup> T. Kushida,<sup>a</sup> and C. W. White<sup>b</sup>**

<sup>a</sup> *Nara Institute of Science and Technology, Ikoma, Nara 630-0101, Japan*

<sup>b</sup> *Oak Ridge National Laboratory, Oak Ridge, Tennessee 37831, USA*

Recently, there have been many extensive studies for the fabrication and optical characterization of semiconductor nanocrystals. One of the most versatile techniques for compound nanocrystal fabrication is high-dose ion implantation followed by thermal annealing, because compound nanocrystals can be simply fabricated by sequential ion implantation of the elements forming the compound. In this work, we have fabricated CdS nanocrystals by means of Cd<sup>+</sup> and S<sup>+</sup> implantation into Al<sub>2</sub>O<sub>3</sub> and studied photoluminescence (PL) properties of CdS nanocrystals.

Equal doses ( $4.3 \times 10^{16}$  /cm<sup>2</sup>) of Cd<sup>+</sup> (450 keV) and S<sup>+</sup> (164 keV) were implanted into Al<sub>2</sub>O<sub>3</sub> at 600 C. Samples annealed at 1000 C show efficient PL. The transmission electron microscopy and x-ray diffraction examinations indicated that the average diameter of CdS nanocrystals in Al<sub>2</sub>O<sub>3</sub> is 17 nm and the CdS nanocrystals have the wurtzite structure. The absorption spectrum shows two excitonic peaks at 2.61 and 2.67 eV at 10 K. These peaks are due to the splitting of the excitonic states in wurtzite CdS nanocrystals. Under picosecond laser excitation, the PL spectrum appears near the optical absorption edge. The PL spectrum shows two peaks at 2.58 and 2.50 eV at 10 K. The PL lifetimes at 2.58 and 2.50 eV are 100 ps and 1 ns, respectively. With an increase of the measurement temperature, the intensity of the high-energy PL band increases. This is because excitons trapped at shallow localized states are thermally excited to the high-energy state. The observed PL bands are ascribed to free excitons and excitons trapped at shallow localized states. In addition, the PL spectrum of single nanocrystals has been studied by a low-temperature scanning near-field microscope. The bandwidths of the free exciton and localized exciton emissions are very narrow in single nanocrystals. We will discuss radiative recombination processes of free and localized excitons in CdS nanocrystals.

Oak Ridge National Laboratory is managed by UT-Battelle, LLC for the U.S. Department of Energy under contract DE-AC05-00OR22725.

Corresponding Author: Y. Kanemitsu

Address: Graduate School of Materials Science, Nara Institute of Science and Technology, Takayama 8916-5, Ikoma, Nara 630-0101, Japan

Phone & Fax: +81-743-72-6011, E-mail:sunyu@ms.aist-nara.ac.jp

Topics: VIII, Presentation: Oral

"The submitted manuscript has been authored by a contractor of the U.S. Government under contract No. DE-AC05-00OR22725. Accordingly, the U.S. Government retains a nonexclusive, royalty-free license to publish or reproduce the published form of this contribution, or allow others to do so, for U.S. Government purposes."

