PHOTOLUMINESCENCE OF Cu AND Al CODOPED ZnS NANOCRYSTALS FABRICATED BY SEQUENTIAL ION IMPLANTATION

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Recently, much interest has been focused on the fabrication and optical properties of semiconductor nanocrystals. Ion implantation is one of the most useful methods for the fabrication of compound nanocrystals. In particular, impurity-doped semiconductor nanocrystals can be simply fabricated by sequential ion implantation of the elements forming compound semiconductors and impurities. In this work, we have fabricated ZnS nanocrystals doped with Cu and Al by ion implantation and studied their photoluminescence properties.

ZnS nanocrystals codoped with Cu and Al were fabricated by sequential ion implantation of Zn^+, S^+, Cu^+, and Al^+ ions into Al_2O_3 followed by thermal annealing. The x-ray diffraction examination indicates that the ZnS nanocrystals are prepared as a mixture of hexagonal and cubic ZnS crystals. The absorption spectrum also shows sharp peaks due to excitons of hexagonal and cubic ZnS nanocrystals at 6 K. Under ultraviolet light excitation, the ZnS:Cu,Al nanocrystal sample exhibits the broad PL band at around 2.40 eV. This PL band in ZnS:Cu,Al nanocrystals is very similar to the donor-acceptor pair (DAP) luminescence of ZnS:Cu,Al bulk crystals. It suggests that the PL spectrum observed in ZnS:Cu,Al nanocrystals is ascribed to the electron-hole recombination after trapping of carriers at donors (Al) and acceptors (Cu) in ZnS. In addition, the spatially resolved PL properties have been studied by a scanning near-field optical microscope (SNOM). In the SNOM image, several bright spots are clearly observed on the sample surface. At each bright point, the bandwidth of the SNOM PL spectrum almost agrees with that of the macroscopic PL spectrum. This observation shows that the spectrum of the DAP luminescence in ZnS:Cu,Al is broadened by the strong electron-phonon interaction.

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