

Nanooptics and photonics

Nature of recombination processes in PbCdI₂ layered solid solutions

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In our recent studies [1] we have shown that there are PbI₂ nanoclusters (NCLs) which are naturally formed in PbCdI₂ layered semiconductor solid solutions. Earlier, assumption about the presence of these NCLs was based on the analysis of the time resolved photoluminescence (PL) spectra and then it was confirmed by scanning electron microscopy (SEM) methods.

In this study, the temperature dependencies of PL spectra of Pb_{1-X}Cd_XI₂ layered semiconductors with various concentrations of components (X) were investigated. PL excitation was carried out by 395 nm LED. PL spectra were measured in the temperature range of (4.2 -150) K using Ocean Optics MAYA2000 USB spectrometer. Temperature stabilization during the individual measurements was obtained by using UTRECS cryostat system.

Mathematical analysis of obtained spectra particularly spectral decomposition of various bands by fitting those bands by Gaussian peak function was made. It allowed us to study the temperature behavior of individual PL lines and broad bands. Temperature dependencies of peak position, full width at half maximum, and integral intensity of these components, namely, the free and bound exciton lines (~495 nm), donor – acceptor recombination bands (~509 nm and ~515 nm), self-trapped excitonic band (~540-550 nm) and bands associated with the recombination processes involving deep acceptor centers (~605 nm and 650 nm) were investigated.

High temperature blueshifting and thinning of line caused by recombination emission of free excitons in PbI₂ NCLs in Pb_{1-X}Cd_XI₂ solution were found. At the same time, redshifting and thickening of STE band were noted. This confirms the energy transfer between those two processes. We suggested an energy diagram of the optical transitions, which describes the processes outlined above. Also, the low and room temperature PL kinetics of the described bands were measured.

I.Gnatenko, Yu P; Bukivskij, PM; Piryatinski, Yu P; Bukivskii, AP; Skubenko, PA; Gamernyk, RV; Time-resolved photoluminescence spectroscopy of excitons in layered semiconductor PbI₂ nanoclusters, J. Appl. Physics, 112, 9, 093708,(2012).