OPTICAL SPECTROSCOPY OF EXCITONS WITH SPATIALLY SEPARATED ELECTRONS AND HOLES IN NANOHETEROSTRUCTURES WITH SEMICONDUCTOR AND DIELECTRIC QUANTUM DOTS

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In [1, 2] study, we find that the binding energy of an exciton formed from an electron and a hole spatially separated from each other (the hole is moving within a quantum dot (QD), and the electron is localized above the spherical QD – matrix interface) in a nanosystem containing semiconductor (germanium) and insulating aluminium oxide QDs is substantially increased (by nearly two orders of magnitude) compared to the exciton binding energy in an silicon and aluminium oxide single crystal. It is established that, in the band gap of an germanium and aluminium oxide QDs, there is a band of exciton states (formed from a spatially separated electron and hole). It is shown that there exists the possibility of experimentally detecting the ground and excited exciton states in the band gap of an germanium and aluminium oxide QDs at room temperature from the absorption and transmittance spectra of the nanosystem. The effect of a substantial increase in the exciton binding energy offers considerable scope for the use of insulating nanoheterostructures as the active region of nanolasers operating at excitonic transitions [1, 2].

The theory of excitons from spatially separated electrons and holes (the hole moves in volume QD, and the electron is localized over the spherical surface boundary of (QD/matrix)), developed in [3, 4], for the case in which centrifugal energy of the electron is considered in the potential energy of the exciton. It has been shown that the taking into consideration centrifugal energy in the potential energy of the exciton leads to the occurrence of the quasi-stationary states in the band of the surface exciton states, which with the increase of QD radius transfers into stationary state. It is established that the light spectrum of the interband absorption (emission) of nanosystems consisting of the energy bands which are formed by the electron between quasi-stationary and stationary states, and intraband absorption spectra – from the bands caused by electron transitions between stationary states [3, 4].

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