THICKNESS, CONCENTRATION, AND TEMPERATURE DEPENDENCES OF EXCITON TRANSITION ENERGIES IN $Al_xGa_{1-x}As/GaAs/Al_xGa_{1-x}As$ NANOFILMS

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S u m m a r y

The energy of transition into the ground excitonic state for a quasi-two-dimensional (nanofilm) semiconductor nanoheterostructure with single quantum well and its dependences on the thickness, temperature, and composition of the barrier medium are calculated in the dielectric continuum approximation using the Green's function method. Specific calculations are made for a nanofilm containing a rectangular finite-depth quantum well created by the double heterojunction $GaAs/Al_xGa_{1-x}As$ taken as an example. For the films narrower than 30–40 nm, the transition energy is shown to be mainly governed by the confinement effect and the aluminum content x. In particular, the energy decreases rapidly from 1.55 eV (at $x = 0.2$), 1.62 eV (at $x = 0.3$), or 1.69 eV (at $x = 0.4$) to 1.41 eV for all those x-values, as the film thickness grows. The further increase in the film thickness up to approximately 100 nm is accompanied by a slow growth of the energy to the value characteristic of bulk GaAs, which occurs due to the corresponding reduction in the exciton binding energy. The rate of this growth depends weakly on x. The temperature increase from 0 to 300 K results in a long-wave shift of the exciton band bottom. As a result, the transition energy decreases by a value weakly depending on the film thickness and ranging from 2 meV at $x = 0.2$ to 3 meV at $x = 0.4$. The temperature-induced variations are invoked by the interaction with phonons, which are mostly confined ones in nanofilms thicker than 30–40 nm or interface ones, if nanofilms are thinner.