Temperature Changes of Exciton Absorption Spectra in Semiconductor-Based Flat Nanofilms

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In the approximation of a dielectric continuum for phonons, the model of rectangular potential well and approximation of effective masses – for electrons, theoretical studies of the temperature changes of the shape of the exciton absorption band in semiconductor-based nanofilms were carried out by the Green's function method [1]. An evident form of the connection function of the ground excitonic state with confined phonons in the flat nanofilm was obtained.

The mass operator of the exciton-phonon system has been built based on this connection function. Its real (Δ) and imaginary (Γ) parts defines the spectral and temperature dependence of the exciton absorption band shape function

$$S(\omega,T)=\frac{\Gamma(\omega,T)}{[\hbar\omega-E-\Delta(\omega,T)]^2+\Gamma^2(\omega,T)}.$$

Here E is the energy of transition to the ground exciton state.

Numerical calculations has been made by the examples of a plane double nanoheterostructures $Al_xGa_{1-x}As/GaAs$ with different concentration of aluminum atoms in barrier material ($x = 0.2 \ldots 0.4$), and β-HgS/β-CdS. If the film thickness exceeds 70 nm, the main contribution to the energy of exciton-phonon system in such nanostructures makes the interaction with optical phonons of the confined mode [2].

Spectral dependences of the absorption coefficient by the mechanism of direct transition to the ground exciton state were computed for named types of nanofilms as a convolution

$$\alpha(\omega,T)=2\pi D_0^2\int S(\omega-\omega',T)g(\omega')d\omega'$$

of $S(\omega,T)$ and Gaussian function $g(\omega)$, which takes into account inhomogeneity of the film thickness [3]. The changes in contour of exciton absorption band due to temperature changes in films of both types and composition of the barrier material in $Al_xGa_{1-x}As$ were investigated.

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