Effect of the electric field on the energy states of the acceptor impurity in the GaAs/$Al_xGa_{1-x}As$ quantum dot

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In the field of modern nanotechnology, it is very important to control different properties of nanoonbects with high precision. Ways to solve this range of problems are to change their size, doping and applying external fields.

Different properties (especially optical properties) depend on the impurity position and external fields. The changing of the external field caused changing the probability density of electron location in different shells.

In this work, we study the effect of electric field and acceptor position on the optical properties of $GaAs/Al_xGa_{1-x}As$ quantum dots. The impurity displacement from the spherical quantum dot (QD) center causes splitting electron levels (for excited states). Those impurity displacement also causes the shift of the absorption band into the low-energy region.

For the hole and acceptor states the multiband effective mass models should be used. For considered nanosystem $GaAs/Al_xGa_{1-x}As$ the Luttinger model with spherical approximation comfortably can be used.

In the heterostructure $GaAs/Al_xGa_{1-x}As$, the band gap Eg and the spin-orbit interaction Δ_{so} are large. Therefore, for hole and acceptor states multiband models of effective masses should be used. And for $GaAs/Al_xGa_{1-x}As$ heterosystem it is convenient to use the Luttinger model with spherical approximation.

We place the hydrogen impurity at a distance D from the center of the QD. The external electric field F_{el} is applied to the heterosystem and we considered three cases of electric field directions.

As a result of research the spectrum of holes in a multiband model in an electric field is determined. The dependence of the hole energy spectrum on the radius of the quantum dot and the location of the impurity from the center of the quantum dot is shown. The dependence of the energy spectrum of central and non-central acceptor impurity in the electric field and without it is obtained.