Nanooptics and photonics

Change of the spatial character of the Wannier exciton ground state in wide type II semiconductor quantum wells

G.V. Vertsimakha

Institute for Nuclear Research, Natl. Acad. of Sci. of Ukraine. Prospect Nauki, 47, Kiev-03680, Ukraine.
E-mail: avertsim@kinr.kiev.ua

Calculations of exciton spectra and wave functions are important for study of optical properties of semiconductor heterostructures. Type II single quantum wells like $Si/Si_{1-x}Ge_x/Si$ or ZnS/ZnSe/ZnS arouse particular interest. In such systems the structure of the conduction and valence bands leads to forming of spatially indirect excitons with the electron and the hole confined in different layers of the crystal. Such structures are used for investigation of collective excitonic effects because spatially indirect excitons have a long lifetime, can be created without application of electric field and have wide spectrum of states which can be changed using proper well widths and compound concentrations [1].

In studied type II single quantum wells a hole is confined in the internal layer of the structure whereas an electron is confined in the external layers only due to the Coulomb interaction with the hole. How strongly the electron wave function is localized and how deeply it penetrates into the internal level substantially depend on the system parameters. If the barrier layer is wide enough and the Coulomb interaction is strong enough, it can be energetically favorable for the hole to shift from the center of the quantum well towards barriers in order to reduce the distance with the electron. That corresponds to the change of the state of the exciton – the central position of the hole will not be the most probable one.

The energy of the ground state of an exciton in a type II single quantum well on the base of ZnO crystals was calculated variationally. It was shown that for rather wide quantum wells the state with the non-central position of the hole can be energetically favorable that can change optical spectra of such systems.

1. *Burbaev T. M., Bagaev V. S., Bobrik E. A., Kurbatov V.A., Novikov A.V., Rzaev M.M., Sibeldin N.N., Schäffler F., Tsvetkov V.A., Tarakanov A.G., Zaitsev V.V. Exciton condensation in compressively strained SiGe layers of Si/SiGe/Si heterostructure* // Thin Solid Films.-2008.-517.-P.55-56.