**Nanooptics and photonics**

**Exciton and biexciton states in nanosystems from quantum dots**

**Pokutnyi S.I.1**

*1 Theoretical Physics Department, Chuiko Institute of Surface Chemistry of the NAS of Ukraine. General Naumov str., 17, Kyiv-03164, Ukraine.*

*E-mail: pokutnyi.serg@gmail.com*

The Ge/Si heterostructures promising to create new elements silicon infrared optoelectronics are self-assembled structures with Ge/Si nanoislands. Ge/Si heterostructures with quantum dots (QDs) of Ge are heterostructures II type. In this nanosystem the lowest electronic level is in matrix, and the lowest hole level is within volume of QD. A large shift of the valence band (610 meV) generates the localization of holes in the volume of QD. A significant shift of the conduction band (about 340 meV) is a potential barrier for electrons. The electrons move in the matrix and do not penetrate in the volume of QD [1].

In [2], the theory of an exciton formed by spatially separated electron and hole is developed (the hole moves in the bulk of a Ge QD and the electron is localized above the spherical interface between the QD and the Si matrix). It was found that the binding energy of an exciton in such nanosystem is much higner (almost an order of magnitude) than the binding energy of an exciton in a Si single crystal.

In [3] we show that the biexciton formation in a nanoheterosystems made up of aluminum oxide QDS synthesized in a dielectric matrix is of threshold character and can occur in a nanosystem where the distance *D* between the surfaces of QD is given by the condition . We also demonstrate that in such nanoheterosystems acting as “exciton molecules” (or biexciton) are the quantum dots of aluminum oxide with excitons localizing over their surfaces. The position of the biexciton state energy band is shown to depend both on the mean radius of quantum dots, and the distance between their surfaces, which enables one to purposefully control it by varying these parameters of the nanoheterosystems. It is established that at constant concentrations of biexcitons at temperatures *T* below a certain critical temperature *Tc* due to the radiative annihilation of one of the excitons forming a biexciton one can expect a new spectral band of luminescence shifted relative to the exciton band by the biexciton binding energy . This new luminescence band disappears at temperatures above *Tc.* At a constant temperature *Т* < *Tc*  the growth of exciton concentration brings about weakening of the exciton band and strengthening of the biexciton band of luminescence. As follows form the results of the variational calculations, the major contribution to the biexciton binding energy is from the energy of exchange interaction of electrons and holes, which by far surpasses that from their Coulomb interaction (i.e. the ratio 0.11).

1. *Yakimov A.I., Dvurechensky A.V.* Spatial separation of electrons and holes of quantum dots Ge/Si // JETP Lett.-2001.**-73. -**P. 529-531.

*2. Pokutnyi S.I.* Excitons based on spatially separated electrons and holes in Ge/Si heterostructures with Ge

quantum dots // Low Temperature Physics, -2016. **- 42. -**P. 1151-1154.

3. *Pokutnyi S.I.* Biexcitons in nanoheterostructures of Ge quantum dots // Opt. Eng. -2017. **-56. -**P. 067104.