Quasi-stationary exciton states in open cylindrical semiconductor nanotube

Makhanets O.M., Kuchak A.I., Voitsekhivska O.M., Iliniuk A.V.

Yuriy Fedkovych Chernivtsi National University, Chernivtsi, Ukraine

The multi-shell semiconductor nanotubes have been recently studied both theoretically and experimentally [1,2]. The unique properties of quasi-particles (electrons, excitons and so on) in such nanostructures allow using them as basic elements for the devices of modern nanoelectronics.

The authors of ref. [1] have been grown the arrays of semiconductor nanotubes consisting of the sequence of $GaAs$ and $Al_x Ga_{1-x} As$ nanoshells using the method of molecular beam epitaxy. This nanostructure was covered by rather thick shell of $GaAs$ in order to avoid $Al_x Ga_{1-x} As$ oxidizing.

The multi-shell nanotube under study is an open one because the potential energy of electron in $GaAs$ is smaller than that in $Al_x Ga_{1-x} As$. In open nanotubes, on the contrary to the closed ones, the quasi-particles can tunnel through the potential barrier into the outer medium, creating an additional channel of energy relaxation for the quasi-particles excited in the quantum well. It is clear that the quasi-particles energy spectra in such nanosystems are quasi-stationary and are characterized by the resonance energies and resonance widths.

The theory of exciton and phonon stationary spectra together with the theory of electron- and exciton-phonon interaction well correlating to the experimental data and general physical considerations is already developed for the closed cylindrical and hexagonal nanotubes [2].

The quasi-stationary spectra of electrons, holes and excitons were theoretically studied for the spherically-symmetric quantum dots and single cylindrical quantum wires [3]. In this work, we present the theoretical study of exciton quasi-stationary spectrum in multi-shell open cylindrical semiconductor nanotube. The dependences of exciton resonance energies and resonance widths on nanotube thickness are obtained and analysed.

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