Abstract

Binding Energy of Hydrogen-Type Impurities in Quantum Well Wires of InSb/GaAs

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The III-V-type semiconductors are widely used for construction of nanostructures. The dispersion law of charge carriers in these semiconductors is essentially nonparabolic and is the same one as the relativistic dispersion law in the two-band approximation. So the binding energy of hydrogen-type impurities in a quantum well wire (QWW) of finite depth is investigated by means of a variational approach as a function of the wire's radius and of the impurity's location [1].

The total energy of the impurity state is determined in the two-band approximation from Kane's analog of the Klein-Gordon equation. The binding energy of hydrogen-type impurity in QWW of InSb semiconductors was investigated in [2] by variational method in the case of the circular cross section and of infinite depth.

The nonparabolicity of dispersion law leads to a considerable increase of the binding energy of the hydrogen-type impurity in InSb/GaAs QWW in comparison with the analogous value in the wire with a standard dispersion law (e.g., GaAs/AlAs [1]).

In present work it is shown that the binding energy is maximal when the impurity center is localized on the wire's axis and it decreases at its deflection from the axis, similar to the parabolic case. The binding energy in nonparabolic semiconductors, in comparison to the standard case, is greater for all values of a shift parameter characterizing the deflection of the impurity center from the axis.

One can consider the vertical interband transitions from the valence band, with nonparabolic dispersion law, to the basic donor level using the analytical expressions for the wave functions and energy spectrum for the finite electron's states as it has been done for InSb QWW in [3].

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