Influence of Piezoelectric Field on the Confined States in Low-strain and Asymmetric InGaAs Quantum Dots

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Low-indium content $In_{0.3}Ga_{0.7}As$/GaAs self-assembled quantum dots (QDs) are an unique kind of quasi-zero-dimensional nanostructures with large volume and in-plane shape asymmetry in comparison to well-studied epitaxial self-assembled InAs/GaAs QDs. They have been demonstrated to show atypical properties like ultra-small fine structure splitting and low degree of linear polarization of photons emitted from the surface (despite the distinct nanostructure in-plane asymmetry – lateral aspect ratio exceeding 2) [1]. Additionally, influence of quasi-zero-dimensional density of states within the wetting layer has been shown to have influence on the energy transfer in the structure [2].

Hereby, we present theoretical studies of the confined states in low-strain In(Ga)As quantum dots (QDs) of that type. The 8-band **k·p** model together with the continuum elasticity theory and piezoelectric fields were employed to calculate the confinement potential and the confined electron and hole eigenstates. It has been found that the piezoelectric potential affects the total confinement potential to such an extent that the hole eigenstates can get the spatial in-plane orientation orthogonal to the main axis of dot elongation. This influences both, qualitatively and quantitatively, many of the electronic and optical properties. We have obtained that due to the low-strain regime of these dots the second-order piezoelectric field does not change the field distribution significantly, whereas the linear piezoelectric field provides an additional confinement in the perpendicular direction to the elongation axis. This causes unusual polarization of photons emitted from the structure, where the linear polarization axis of light is perpendicular to the elongation direction of the QD, which is contradictory to the case of pure InAs QD case. Eventually, importance of the degree of the shape asymmetry or the dots' size, and differences between the low-strain (low-In-content) QDs and pure InAs dots formed in high strain conditions are discussed [3].

[1] A. Musiał et al., *Phys. Rev. B* **90**, 045430 (2015)
[2] P. Podemski, M. Pieczarka et al., to appear in *Superlattices and Microstructures* (2016)
[3] M. Pieczarka, G. Sęk, to appear in *Physica B: Condensed Matter* (2016)

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