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Three-dimensional strain distributions due to anisotropic effects in InGaAs semiconductor quantum dots

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ABSTRACT

Semiconductor cubic and wurtzite heterostructures are important materials for optoelectronic applications [1-3]. Previous works address the importance of selfconsistently computing electric-field and strain distributions in quantum-well GaN/AlN wurtzite heterostructures accounting for lattice mismatch, spontaneous polarization, and piezoelectric effects [3-5], and it was shown that unless compensating charges are present at interfaces, huge electric fields emerge in the well material which again lead to significantly modified strain distributions, i.e., differing substantially from those given by lattice mismatch alone. Conclusions from the previous work also suggest the possibility of having significant piezoelectric contributions to the strain in zincblende structures as the piezoelectric tensor elements are of the same order in wurtzite and zincblende.

Recently, we examined the influence of selfconsistent couplings in a two-dimensional model where a wurtzite GaN cylindrical nanostructure is embedded in an AlN matrix [6]. This latter work demonstrates that geometrical effects are important in obtaining the actual strain values and that, particular for smaller nanostructures, deviations between a one-dimensional and two-dimensional analysis appear. In the present work, we consider the important zincblende ternary material compound InGaAs and address three-dimensional nanostructure strain- and electric fields accounting for anisotropy in the stiffness tensor. Results are presented emphasizing the difference in using the isotropic tensor assumption in computing selfconsistent fields as compared to the real case with anisotropy.

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