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Geometry of epitaxial GaAs/(Al,Ga)As quantum dots as seen by excitonic spectroscopy

Jun-Wei Luo[*]
80401,

Alex Zunger[†]
80309,
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It is shown that exciton and multiexciton emission lines (“spectral barcode”) of a quantum dot conceal nontrivial structural information on the shape and size of the dot, information which can be uncovered by comparison with

leading to the misuse of the FSS to infer shape anisotropy: In the Luttinger Hamiltonian representation, the effective mass of hole is anisotropic in that its value along (100) is different from along (110). Thus, if one ignores the fact that the QDs under consideration are made of atomistically discrete materials, the symmetry of circular based dot in this Hamiltonian is C_{4v}. Despite this, numerous papers[18,31] claimed that circular-based lens shape dot has D_{2d} symmetry. This is because in a continuum approximation the [110] and $[1\bar{1}0]$ directions are equivalent. In such a D_{2d} symmetry, the fourfold degenerate exciton (originating from an electron of $J_z = \pm 1/2$ and a heavy-hole of $J_z = \pm 3/2$) splits into double-degenerate bright state (Γ_5) and two nondegenerate dark states (Γ_1 and Γ_2, respectively). Because Γ_5 is degenerate in this approximation, the FSS is zero for cylindrically symmetric dots under the continuum point of view.

To account for the observed nonzero FSS, the continuum theory assumes that the FSS originates, in its entirety, from deviations from cylindrical symmetry of the overall QD shape, i.e., shape anisotropy of the QDs.[17,19,20,30] This shape anisotropy (e.g., elongation in $[1\bar{1}0]$ direction[17,19,20]) of QD lowers then the D_{2d} symmetry to C_{2v}.[32] The double-degenerate bright Γ_5 further splits into two nondegenerate states (Γ_2 and Γ_4). The lifting of the degeneracy of the two bright exciton states is referred to FSS and is used under the continuum point of view to fit the measured FSS into a geometric shape anisotropy.

In reality, the [110] and $[1\bar{1}0]$ directions are nonequivalent in zincblende crystal. This leads to 91([1)]TJti

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*jun-wei.luo@nrel.gov
†alex.zunger@gmail.com

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