NEIGHBOURING LEVELS STATISTIC FOR Si/SiO_2 QUANTUM DOTS

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We model the Si quantum dots (QDs) embedded into the SiO2 substrate. Single sub-band effective mass approach is used to calculate energy levels of electrons and heavy holes. For weak confinement regime (QD size D>10 nm), when number of confinement levels is limited by several hundred, we considered statistical properties of the electron confinement. In particularly to determine type of the nearest neighbor spacing (NNS) statistics, the distribution function is calculated. The influence of the QD shape on the NNS distribution is investigated (see Fig. 1). The conditions for changing of type statistics are determined. The Brody formula [1] is applied. Variations of the Brody parameter (beta in Fig. 1) for different QD shapes are evaluated. To test the model, which we using, the comparison with available experimental PL exciton data (see [2] for instant) is done. Calculations of low-lying single electron and hole energy levels are performed for spherical shaped QD with diameter D< 6nm. For this QD the number of energy levels is restricted to several levels. The energy dependence of electron effective mass is applied [3] to take into account non-parabolic effect of conduction band, which became important for small size QDs. The first order of the perturbation theory is used to calculate neutral exciton recombination energy taking into account the Coulomb force between electron and heavy hole. The experimental data are reproduced well by our model calculations. This work is supported by NSF CREST award, HRD-0833184 and NASA award NNX09AV07A.

References

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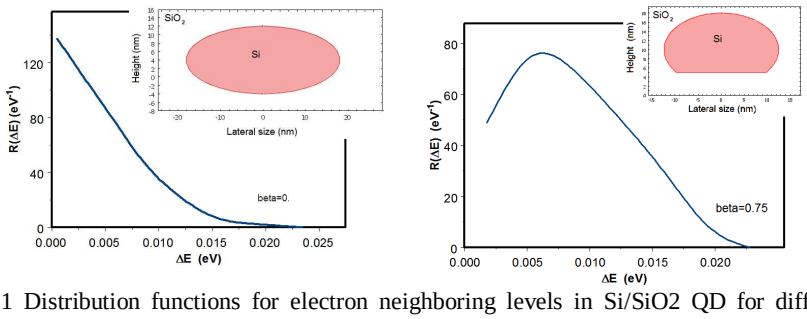

Fig. 1 Distribution functions for electron neighboring levels in Si/SiO2 QD for different shapes.