Size-dependency of energies and recombination rates in strain-induced quantum dots

S. Corni[a], M. Braskén[b], M. Lindberg[c], D. Sundholm[d] and J. Olsen[e]

[a] Scuola Normale Superiore, P.zza dei Cavallieri, 7, 56126 Pisa, Italy. email corni@sns.it
[b] Optoelectronics Laboratory, Helsinki Univ. of Tech., FIN-02015 HUT, Finland
[c] Department of Physics, Åbo Akademi University, FIN-20500 Turku, Finland
[d] Department of Chemistry, University of Helsinki, FIN-00014 Helsinki, Finland
[e] Department of Chemistry, University of Aarhus, DK-8000 Aarhus, Denmark

The energies and radiative recombination rates of ground and excited states of excitons and biexcitons confined in a strain-induced quantum dot have been studied as functions of the dot size. The two-bands effective mass Schrödinger equation for the interacting electrons-holes system has been solved at the Full Configuration Interaction (FCI) level, by expanding the electron and hole single-particle orbitals in an anisotropic Gaussian basis set. The dot has been assumed to be cylindrically symmetric. The confining potentials for both the holes and the electrons have been modelled as a truncated two-dimensional parabola. A comparison with a confining potential, numerically derived from strain calculations, is also given. Parameters such as effective mass, dielectric constant, band gap energy, deformation potential constants suitable for a InGaAs dot induced in a GaAs/InGaAs well by InP islands has been used. The results show that variations of the quantum dot size in the range considered do not dramatically modify the relative energy levels of the excitonic and biexcitonic states, whereas the rate shows size-dependency. The electron-hole correlation, taken into account at the FCI level, increases the recombination rate as compared to the Hartree-Fock results. The correlation effects significantly modify the recombination trends as a function of the dot size.