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Optical properties of nano-multi-layered quantum dot: oscillator strength, absorption coefficient and refractive index

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Abstract In this paper, the exact solution of Schrödinger equation for multi-layered quantum dot (MLQD) within the effective mass approximation and dielectric continuum model is obtained with finite and infinite confining potential (CP). The MLQD is a nano-structured semiconductor system that consists of a spherical core (GaAs) and a coated spherical shell ($Ga_{1-x}Al_xAs$) as the whole dot is embedded inside a bulk material ($Ga_{1-y}Al_yAs$). Using the obtained energies, wave functions and taking advantage of numeric calculations, the oscillator strength, refractive index and absorbtion coefficient change associated with intersubband electronic transition from the ground state to the first allowed excited state are investigated for different CPs (both finite and infinite) and shell thicknesses. The results show that all values of ground state energy for large core dot radius approach the same value (the energy of bulk material) independent of CPs and shell thicknesses. Also it is shown that the optical properties are strongly affected by the changes in CPs and shell thicknesses.

Keywords Multi-layered QD · Core radius · Optical properties · Confining potential

1 Introduction

The importance of quasi-zero dimensional electronic systems, the so-called quantum dots (QD), and also the confining effect on such systems have led to a wide range of research interest both in pure theoretical physics and applied science (Tanaka et al. 2003; Khordad 2010; Aghchegala et al. 2010; Varshni 1999; Holovatsky et al. 2009; Davatolhagh et al. 2012; Sadeghi 2009; Dane et al. 2010; Vaseghi et al. 2011). One of the most intensively explored classes of the semiconductor nano-systems is the class of single-layered and multi-layered quantum dots. The presence of a donor impurity plays an important role in the electronic

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