Modeling Confinement in Quantum Dot Solar Cells

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Abstract

The efficiency of the first and second generations of solar cell has hardly seen dramatically increase over the years, in which most PV cells cannot use about 55% of the energy of sunlight because a single material can not capture the entire spectrum of sunlight. To achieve the objective of higher efficiency and low production cost, the third generations solar cells are still under investigation. Although one of the best known multi-junction solar cell could overcome Shockley-Queisser limit with a stacking number of solar cells, the market of which is obstructed by the high cost as well as non-abundant material. For the fact that each bandgap of single solar cell is fixed, it is advancing a technology called quantum dot solar cell that could manipulate quantized energy levels to absorb sunlight by varying quantum dot's parameters. Unlike the existing directly researches on size or shape of quantum dots, it is of great significance to understand the mechanistic coupling between quantum dots (QDs) and the substrate on which they are grown. By using the finite element method with a powerful PDE module and LiveLink™ for MATLAB® in COMSOL Multiphysics® simulation software, I solved the Time Independent Schrödinger Equation for variations of energy states and corresponding wave functions. The correlations between QDs and their substrate are researched by changing the confining potential and effective mass associated with substrate composition. The results show that the substrate composition plays an important role in engineering electron energies as well as wave functions in QDs.

Figures used in the abstract

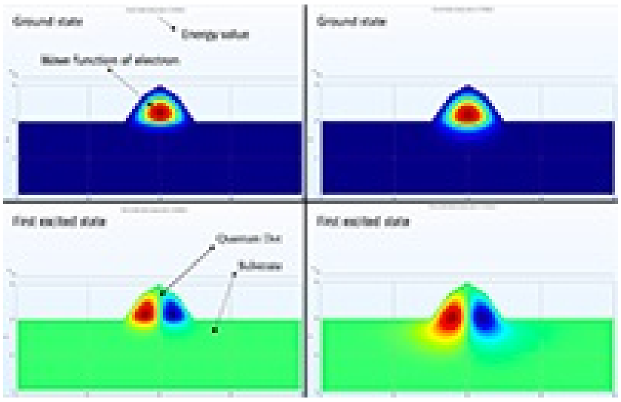

Figure 1: Variation of Electron Energies and Corresponding Wave Functions in QD