



Semiconductor Quantum Dots (World Scientific Series on Atomic, Molecular and Optical Physics, Vol 2)

L. Banyai, Stephan W. Koch

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"Semiconductor Quantum Dots" presents an overview of the background and recent developments in the rapidly growing field of ultrasmall semiconductor microcrystallites, in which the carrier confinement is sufficiently strong to allow only quantized states of the electrons and holes. The main emphasis of this book is the theoretical analysis of the confinement induced modifications of the optical and electronic properties of quantum dots in comparison to extended materials. The book develops the theoretical background material for the analysis of carrier quantum-confinement effects, it introduces different confinement regimes for absolute or center-of-mass motion quantization of the electron-hole-pairs, and it gives an overview of the best approximation schemes for each regime. A detailed discussion of the carrier states in quantum dots is presented, including variational calculations, a configuration interaction approach, and quantum Monte Carlo techniques. Surface polarization instabilities are analyzed which lead to the self-trapping of carriers near the surface of the dots and the influence of spin-orbit coupling on the quantum-confined carrier states is discussed. The linear and nonlinear optical properties of small and large quantum dots are analyzed in detail, including transient optical nonlinearities (photon echo) and two-photon transitions. The influence of the quantum-dot size distribution in many realistic samples is outlined, including the analysis of quantum dot growth laws and universal size distributions. Phonons in quantum dots, as well as the influence of external electric or magnetic fields are discussed. The recent developments dealing with regular systems of quantum dots are reviewed, including a lattice model of quantum dots and quantum dot superlattices.

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