Preface

Quantum dots, coherent inclusions in a semiconductor matrix with truely zero dimensional electronic properties, present the utmost challenge and point of culmination of semiconductor physics: They resemble atoms in an electromagnetic cage, rendering possible fascinating novel devices.

It was at the beginning of the 1990s that a modified Stranski-Krastanow growth mechanism driven by self-organization phenomena at the surface of strongly strained heterostructures has been realized for the fabrication of such dots. This process presents a sound way to fabricate easily and fast large densities of quantum dots. A rapidly increasing number of leading laboratories around the world embarked on the investigation and modeling of the growth, the physical properties, and device applications of the numerous possible material combinations.

Many fundamental facts and phenomena are now at least qualitatively understood, but no comprehensive survey exists to guide newcomers to the field. This book tries to fill this gap. It focuses on phenomena and principles. With regard to collecting *all* existing experimental material it is as incomplete as such a work in a rapidly progressing field necessarily must be.

In chapter 1 a brief account of the history of quantum dots is given and basic requirements on their properties for making them useful in devices operating at room temperature are formulated. Chapter 2 surveys various alternative techniques used in the past decade to fabricate quantum dots. The chapter ends by introducing the concept of self-organized growth. The following chapter extends this subject and presents a broad review of thermodynamically driven self-organization phenomena at surfaces of crystals.

Results on growth for a number of different quantum dot structures and on their structural characterization are presented in chapter 4. Knowledge of the geometric structure and chemical composition of dots is prerequisite for numerically modeling the electronic and optical properties of real dots. Such modeling is presented in chapter 5, together with general theoretical considerations on carrier capture, relaxation and properties of quantum dot lasers.

Experimental results on electronic and optical properties are summarized in chapter 6 followed by a rather brief chapter 7 on electrical properties. The final chapter 8 presents results on quantum dot based photonic devices, mainly quantum dot lasers.

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