

# Preface

Quantum dot molecules are artificial molecules made from coupled quantum dots. Quantum dot molecules have attracted significant attention since the first observation of coupled quantum dots with molecular wavefunctions. Such artificial molecules possess unique and fascinating properties, which make these coupled quantum systems promising in quantum information technologies. Over the last few years, quantum dot molecules have been used to implement quantum qubits, quantum gates, and exciton-spin memory. It is clear that quantum dot molecules will have great impact on next-generation information technologies. The main objective of this edited book is to provide a description of recent experimental and theoretical developments in quantum dot molecules.

The book consists of 11 chapters that present both experimental and theoretical considerations covering the fabrication, characterization, and properties of quantum dot molecules. The first chapter reviews two fabrication methods for quantum dot molecules. These methods involve of pre-patterning of substrates with either in situ droplet epitaxy “nanodrilling” or ex situ local oxidation nanolithography. In Chap. 2, the fabrication of ring-shaped InP quantum dot molecules is presented. This growth method employs droplet epitaxy to form self-assembled quantum dot molecules. Chapter 3 covers the growth of InGaAs quantum dot molecules by a partial-capping and regrowth technique. The nucleation mechanism and optical properties of lateral quantum dot molecules are also discussed. Chapter 4 presents a unique composite quantum system made of “quantum dot–dye” nanoassemblies. This chapter discusses “bottom-up,” non-covalent self-assembly principles and exciton dynamics of nanoassemblies that contain organic colloidal semiconductor quantum dots and various inorganic dye molecules.

Chapters 5–10 are theoretical contributions focused on various types of quantum dot molecules. Chapter 5 presents a detailed analysis of the polarization response of multilayer quantum dot molecules. Chapter 6 presents a systematic theoretical investigation of the polarization potential in isolated and coupled  $\text{In}_x\text{Ga}_{1-x}\text{N}/\text{GaN}$  QDs and its effect on electronic structure and optical properties. Chapter 7 presents a theory of interference blockade and analyzes interference single electron transistors based on quantum dot molecules. In Chap. 8, the authors deal with two quantum

interference-based phenomena, the Fano and Aharonov-Bohm effects in a ring of quantum dot molecules. Chapter 9 introduces phonon-assisted carrier dynamics in coupled quantum dots. Chapter 10 considers Förster resonant energy transfer in optically driven quantum dot molecules. In this chapter, the authors theoretically demonstrate a detection method of resonant energy transfer in quantum dot molecules by using level anticrossing spectroscopy.

Finally, in the last chapter, the authors report an experimental investigation of the Stark effect in quantum dot molecules.

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