

# **Physical Foundations of Solid-State Devices**

***E. F. Schubert***

***Rensselaer Polytechnic Institute***

## **Introduction**

Quantum mechanics plays an essential role in modern semiconductor heterostructure devices. The spatial dimensions of such devices are frequently on the scale of just Angstroms. In the domain of microscopic structures with dimensions comparable to the electron de Broglie wavelength, size quantization occurs. Classical and semi-classical physics no longer gives a correct description of many physical processes. The inclusion of quantum mechanical principles becomes mandatory and provides a most useful description of many physical processes in electronic and photonic heterostructure devices.

## **Table of Contents**

- 1 Classical mechanics and the advent of quantum mechanics

- 2 The postulates of quantum mechanics
- 3 Position and momentum space
- 4 Operators
- 5 The Heisenberg uncertainty principle
- 6 The Schrödinger equation
- 7 Applications of the Schrödinger equation in nonperiodic
- 8 Applications of the Schrödinger equation in periodic semiconductor
- 9 Approximate solutions of the Schrödinger equations
- 10 Time-independent perturbation theory
- 11 Time-dependent perturbation theory

- 12 Density of states
- 13 Classical and quantum statistics
- 14 Carrier concentrations
- 15 Impurities in semiconductors
- 16 High doping effects
- 17 Heterostructures
- 18 Tunneling in heterostructures
- 19 Some electrical device structures
- 20 Some optical device structures