PREFACE

Semiconductors have become increasingly important over the last fifty years since the invention of the transistor, which was originally based on the semiconducting material germanium. However, today silicon is by far the technologically most important semiconductor. The development of the information highway is closely connected with the success of the miniaturization of silicon-based electronics. By the year 2010, dynamical random access memory (DRAM) chips with 10 Gigabit memory are expected to be incorporated in conventional personal computers. In the last 15 years, additional applications of semiconductors such as light detectors (solar cells) and light emitters (light emitting diodes and lasers) have become increasingly important. In contrast to electronic devices, light-emitting devices are based on direct energy gap semiconductors such as GaAs and related compounds, ZnSe, and most recently GaN.

The first part of this book is based on an international course entitled *Introduction to Semiconductor Physics* given within the Department of Physical Electronics at Tōkyō Institute of Technology (Tōkyō Kōgyō Daigaku) in Tōkyō, Japan, during the second semester of the academic year 1995-96. The second part, in particular the extensive discussion of optical properties including the effects of external fields, is based on a lecture entitled *Optical Properties of Semiconductors* given within the Institute for Solid State Physics (Institut für Festkörperphysik) at the Technical University (Technische Universität) Berlin, Germany, during the spring semester 1997. This introductory course does not require a deep knowledge of condensed matter physics. However, a basic knowledge of classical physics, quantum mechanics, and condensed matter physics is essential in order to follow the material presented here. This book also contains a summary of many material parameters of the most commonly used and investigated semiconductors. Since band structure parameters such as effective masses as well as optical constants such as the dielectric constant are sometimes revised in the course of time, not all parameters listed in this book correspond to their most recent values. For this introductory course, the parameters are only used to show general trends and to give a feeling for their possible range.

After an introduction, the book begins with a review of the crystal structure of semiconductors followed by a chapter on the formation of energy bands and energy gaps, which is discussed within the framework of the periodic potential. The band structure of the most common semiconductors together with the concept of the effective mass is presented in the following chapter. After introducing the density of states and their critical points for bulk as well as for low-dimensional semiconductors, the statistics of carriers and the temperature dependence of the carrier density is reviewed. The next chapter deals with basic models for carrier transport and the Hall effect. Before discussing the important scattering processes, which determine the carrier mobility, the phonon dispersion of semiconductors are presented followed by the phonon statistics and the thermal occupation of phonon states. After reviewing the scattering processes, the concept of excitons is introduced, which forms the basis for the second part of the book focusing on optical properties. In the last three chapters, the optical absorption of free carriers and excitons as well as emission processes are presented for bulk and low-dimensional semiconductors including the effects of an external electric and magnetic field.

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