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[Elementary Semiconductor Physics for Transition Metal . Oxide . Heterostructure. Seiji Yunoki \(UT & ORNL\)](#)

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Elementary Semiconductor Physics for Transition Metal ...

The elemental semiconductors are those composed of single species of atoms, such as silicon (Si), germanium (Ge), and tin (Sn) in column IV and selenium (Se) and tellurium (Te) in column VI of the periodic table. There are, however, numerous compound semiconductors, which are composed of two or more elements.

semiconductor | Definition, Examples, Types, Materials ...

A semiconductor can be considered a material having a conductivity ranging between that of an insulator and a metal. A crucial property of semiconductors is the band gap; a range of forbidden energies within the electronic structure of the material. Semiconductors typically have bandgaps ranging between 1 and 4 eV, whilst insulators have larger bandgaps, often greater than 5 eV [1].

Introduction to Semiconductors - University of Warwick

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[Elementary Semiconductor Physics Semiconductor, any of a class of crystalline solids intermediate in electrical conductivity between a conductor and an insulator. Semiconductors are employed in the manufacture of various kinds of electronic devices, including diodes, transistors, and integrated circuits.](#)

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[Here we demonstrate that the elemental semiconductor tellurium is a Weyl semiconductor, with typical Weyl signatures, including the negative longitudinal magnetoresistance, the planar Hall effect, as well as the intriguing logarithmically periodic magneto-oscillations in the quantum limit regime.](#)

Magnetotransport signatures of Weyl physics and discrete ...

This book describes in details the theory of the electron transport in the materials and structures at the basis of modern micro- and nano-electronics. It leads and accompanies the reader, through a step-by-step derivation of all calculations, from the basic laws of classical and quantum physics up to the most modern theoretical techniques, such as nonequilibrium Green functions, to study transport properties of both semiconductor materials and modern low-dimensional and mesoscopic structures.

A detailed description of the basic physics of semiconductors. All the important equations describing the properties of these materials are derived without the help of other textbooks. The reader is assumed to have only a basic command of mathematics and some elementary semiconductor physics. The text covers a wide range of important semiconductor phenomena, from the simple to the advanced.

This book originated out of a desire to provide students with an instrument which might lead them from knowledge of elementary classical and quantum physics to modern theoretical techniques for the analysis of electron transport in semiconductors. The book is basically a textbook for students of physics, material science, and electronics. Rather than a monograph on detailed advanced research in a specific area, it intends to introduce the reader to the fascinating field of electron dynamics in semiconductors, a field that, through its applications to electronics, greatly contributed to the transformation of all our lives in the second half of the twentieth century, and continues to provide surprises and new challenges. The field is so extensive that it has been necessary to leave aside many subjects, while others could be dealt with only in terms of their basic principles. The book is divided into five major parts. Part I moves from a survey of the fundamentals of classical and quantum physics to a brief review of basic semiconductor physics. Its purpose is to establish a common platform of language and symbols, and to make the entire treatment, as far as possible, self-contained. Parts II and III, respectively, develop transport theory in bulk semiconductors in semiclassical and quantum frames. Part IV is devoted to semiconductor structures, including devices and mesoscopic coherent systems. Finally, Part V develops the basic theoretical tools of transport theory within the modern nonequilibrium Green-function formulation, starting from an introduction to second-quantization formalism.

This book is an introduction to the principles of semiconductor physics, linking its scientific aspects with practical applications. It is addressed to both readers who wish to learn semiconductor physics and those seeking to understand semiconductor devices. It is particularly well suited for those who want to do both. Intended as a teaching vehicle, the book is written in an expository manner aimed at conveying a deep and coherent understanding of the field. It provides clear and complete derivations of the basic concepts of modern semiconductor physics. The mathematical arguments and physical interpretations are well balanced: they are presented in a measure designed to ensure the integrity of the delivery of the subject matter in a fully comprehensible form. Experimental procedures and measured data are included as well. The reader is generally not expected to have background in quantum mechanics and solid state physics beyond the most elementary level. Nonetheless, the presentation of this book is planned to bring the student to the point of research/design capability as a scientist or engineer. Moreover, it is sufficiently well endowed with detailed knowledge of the field, including recent developments bearing on submicron semiconductor structures, that the book also constitutes a valuable reference resource. In Chapter 1, basic features of the atomic structures, chemical nature and the macroscopic properties of semiconductors are discussed. The band structure of ideal semiconductor crystals is treated in Chapter 2, together with the underlying one-electron picture and other fundamental concepts. Chapter 2 also provides the requisite background of the tight binding method and the k.p-method, which are later used extensively. The electron states of shallow and deep centers, clean semiconductor surfaces, quantum wells and superlattices, as well as the effects of external electric and magnetic fields, are treated in Chapter 3. The one- or multi-band effective mass theory is used wherever this method is applicable. A summary of group theory for application in semiconductor physics is given in an Appendix. Chapter 4 deals with the statistical distribution of charge carriers over the band and localized states in thermodynamic equilibrium. Non-equilibrium processes in semiconductors are treated in Chapter 5. The physics of semiconductor junctions (pn-, hetero-, metal-, and insulator-) is developed in Chapter 6 under conditions of thermodynamic equilibrium, and in Chapter 7 under non-equilibrium conditions. On this basis, the most important electronic and opto-electronic semiconductor devices are treated, among them uni- and bi-polar transistors, photodetectors, solar cells, and injection lasers. A summary of group theory for applications in semiconductors is given in an Appendix.

This well-established monograph, updated and now in its ninth edition, deals mainly with electron transport in, and optical properties of semiconductors. It includes lasers, e.g. the quantum cascade laser, quantum processes such as the quantum Hall effect, quantum dots, fullerenes, carbon nanotubes, molecular electronics, the nitrides, and many other recent discoveries in the field. New diagrams and tables provide a comprehensive source of materials data. Selected problems help readers to consolidate their knowledge and invite teachers to use this text for graduate courses on semiconductor physics, solid state physics, and physical electronics.

This book covers the physics of semiconductors on an introductory level, assuming that the reader already has some knowledge of condensed matter physics. Crystal structure, band structure, carrier transport, phonons, scattering processes and optical properties are presented for typical semiconductors such as silicon, but III-V and II-VI compounds are also included. In view of the increasing importance of wide-gap semiconductors, the electronic and optical properties of these materials are dealt with too.

It is a pleasure to take the opportunity to express my sincere gratitude to many colleagues who provided valuable hints for improvements, even including lists of misprints (which I hope have now been completely eliminated). It is not possible to name all of them, and so I will only mention the interesting discussions over so many years I had with Professor Hans W. Pötzl of the Technical University of Vienna on the occasion of our common weekly semiconductor seminar. I am grateful to

Professor H.-J. Queisser and Professor M. Cardona for helpful criticism. Special thanks are due to Frau Jitka Fucik for typing and Frau Viktoria Köver for drawing services. The cooperation with Dr. H.K. Lotsch of Springer-Verlag has been a pleasure. Vienna, January 1982 K. Seeger Contents 1. Elementary Properties of Semiconductors . . . I 1.1 Insulator - Semiconductor - Semimetal - Metal 1 1.2 The Positive Hole 3 1.3 Conduction Processes, Compensation, Law of Mass Action 4 Problems . 8 2. Energy Band Structure . 10 2.1 Single and Periodically Repeated Potential Well 10 2.2 Energy Bands by Tight Binding of Electrons to Atoms 17 2.3 The Brillouin Zone 21 2.4 Constant Energy Surfaces 30 Problems . 33 3. Semiconductor Statistics 34 3.1 Fermi Statistics ... 35 3.2 Occupation Probabilities of Impurity Levels 39 Problems . 45 4. Charge and Energy Transport in a Nondegenerate Electron Gas.

The 3rd edition of this successful textbook contains ample material for a comprehensive upper-level undergraduate or beginning graduate course, guiding readers to the point where they can choose a special topic and begin supervised research. The textbook provides a balance between essential aspects of solid-state and semiconductor physics, on the one hand, and the principles of various semiconductor devices and their applications in electronic and photonic devices, on the other. It highlights many practical aspects of semiconductors such as alloys, strain, heterostructures, nanostructures, that are necessary in modern semiconductor research but typically omitted in textbooks. Coverage also includes additional advanced topics, such as Bragg mirrors, resonators, polarized and magnetic semiconductors, nanowires, quantum dots, multi-junction solar cells, thin film transistors, carbon-based nanostructures and transparent conductive oxides. The text derives explicit formulas for many results to support better understanding of the topics. The Physics of Semiconductors requires little or no prior knowledge of solid-state physics and evolved from a highly regarded two-semester course. In the third edition several topics are extended and treated in more depth including surfaces, disordered materials, amorphous semiconductors, polarons, thermopower and noise. More than 1800 references guide the reader to historic and current literature including original and review papers and books.

This book provides an overview of compound semiconductor materials and their technology. After presenting a theoretical background, it describes the relevant material preparation technologies for bulk and thin-layer epitaxial growth. It then briefly discusses the electrical, optical, and structural properties of semiconductors, complemented by a description of the most popular characterization tools, before more complex hetero- and low-dimensional structures are discussed. A special chapter is devoted to GaN and related materials, owing to their huge importance in modern optoelectronic and electronic devices, on the one hand, and their particular properties compared to other compound semiconductors, on the other. In the last part of the book, the physics and functionality of optoelectronic and electronic device structures (LEDs, laser diodes, solar cells, field-effect and heterojunction bipolar transistors) are discussed on the basis of the specific properties of compound semiconductors presented in the preceding chapters of the book. Compound semiconductors form the backbone of all opto-electronic and electronic devices besides the classical Si electronics. Currently the most important field is solid state lighting with highly efficient LEDs emitting visible light. Also laser diodes of all wavelength ranges between mid-infrared and near ultraviolet have been the enabler for a huge number of unprecedented applications like CDs and DVDs for entertainment and data storage, not to speak about the internet, which would be impossible without optical data communications with infrared laser diodes as key elements. This book provides a concise overview over this class of materials, including the most important technological aspects for their fabrication and characterisation, also covering the most relevant devices based on compound semiconductors. It presents therefore an excellent introduction into this subject not only for students, but also for engineers and scientist who intend to put their focus on this field of science.

This invaluable textbook presents the basic elements needed to understand and research into semiconductor physics. It deals with elementary excitations in bulk and low-dimensional semiconductors, including quantum wells, quantum wires and quantum dots. This fifth edition includes an additional chapter on `Quantum Optical Effects` where the theory of quantum optical effects in semiconductors is detailed. Besides deriving the `semiconductor luminescence equations` and the expression for the stationary luminescence spectrum, results are presented to show the importance of Coulombic effects on the semiconductor luminescence and to elucidate the role of excitonic populations.

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