

GRADUATE TEXTS IN PHYSICS

Peter Y. Yu  
Manuel Cardona

# Fundamentals of Semiconductors

Physics and Materials  
Properties

Fourth Edition

 Springer

# Fundamentals Of Semiconductors Physics And Materials Properties

**M. Cardona**



## **Fundamentals Of Semiconductors Physics And Materials Properties:**

**Fundamentals of Semiconductors** Peter YU, Manuel Cardona, 2010-04-07 Excellent bridge between general solid state physics textbook and research articles packed with providing detailed explanations of the electronic vibrational transport and optical properties of semiconductors The most striking feature of the book is its modern outlook provides a wonderful foundation The most wonderful feature is its efficient style of exposition an excellent book Physics Today Presents the theoretical derivations carefully and in detail and gives thorough discussions of the experimental results it presents This makes it an excellent textbook both for learners and for more experienced researchers wishing to check facts I have enjoyed reading it and strongly recommend it as a text for anyone working with semiconductors I know of no better text I am sure most semiconductor physicists will find this book useful and I recommend it to them Contemporary Physics Offers much new material an extensive appendix about the important and by now well established deep center known as the DX center additional problems and the solutions to over fifty of the problems at the end of the various chapters      Fundamentals of Semiconductors Peter YU, Manuel Cardona, 2010-05-17 Excellent bridge between general solid state physics textbook and research articles packed with providing detailed explanations of the electronic vibrational transport and optical properties of semiconductors The most striking feature of the book is its modern outlook provides a wonderful foundation The most wonderful feature is its efficient style of exposition an excellent book Physics Today Presents the theoretical derivations carefully and in detail and gives thorough discussions of the experimental results it presents This makes it an excellent textbook both for learners and for more experienced researchers wishing to check facts I have enjoyed reading it and strongly recommend it as a text for anyone working with semiconductors I know of no better text I am sure most semiconductor physicists will find this book useful and I recommend it to them Contemporary Physics Offers much new material an extensive appendix about the important and by now well established deep center known as the DX center additional problems and the solutions to over fifty of the problems at the end of the various chapters      **Fundamentals of Semiconductors** Peter YU, Manuel Cardona, 2013-03-09 We have so far received many comments and feedback on our book from all quarters including students instructors and of course many friends We are most grateful to them not only for their compliments but also for their valuable criticism We also received many requests for an instructor manual and solutions to the problems at the end of each chapter We realize that semiconductor physics has continued to evolve since the publication of this book and there is a need to continue to update its content To keep our readers informed of the latest developments we have created a Web Page for this book Its address as of the writing of this preface is <http://pauline.berkeley.edu/textbook> At this point this Web Page displays the following information 1 Content outline and an excerpt of the book 2 Reviews of the book in various magazines and journals 3 Errata to both first and second printing most have been corrected in the second edition as of this date 4 Solutions to selected problems 5 Additional supplementary problems      **Fundamentals of**

**Semiconductor Properties** Peter Yu, Manuel Cardona, 2014-01-15  
**3E Y. Yu Peter, Manuel Cardona**, 2007-03-01  
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**Fundamentals Of Semiconductors: Physics And Materials**  
Fundamentals of Semiconductors Peter Y. Yu, Manuel

**Fundamentals Of Semiconductors Physics And Materials Properties** M. Cardona,

*Quantum Physics of Semiconductor Materials and Devices* Debdeep Jena, 2022-05-16 Quantum Phenomena do not occur in a Hilbert space They occur in a laboratory Asher Peres Semiconductor physics is a laboratory to learn and discover the concepts of quantum mechanics and thermodynamics condensed matter physics and materials science and the payoffs are almost immediate in the form of useful semiconductor devices Debdeep Jena has had the opportunity to work on both sides of the fence on the fundamental materials science and quantum physics of semiconductors and in their applications in semiconductor electronic and photonic devices In Quantum Physics of Semiconductors and Nanostructures Jena uses this experience to make each topic as tangible and accessible as possible to students at all levels Consider the simplest physical processes that occur in semiconductors electron or hole transport in bands and over barriers collision of electrons with the atoms in the crystal or when electrons and holes annihilate each other to produce a photon The correct explanation of these processes require a quantum mechanical treatment Any shortcuts lead to misconceptions that can take years to dispel and sometimes become roadblocks towards a deeper understanding and appreciation of the richness of the subject A typical introductory course on semiconductor physics would then require prerequisites of quantum mechanics statistical physics and thermodynamics materials science and electromagnetism Rarely would a student have all this background when s he takes a course of this nature in most universities Jena s work fills in these gaps and gives students the background and deeper understanding of the quantum physics of semiconductors and nanostructures Basic Semiconductor Physics Chihiro Hamaguchi, 2017-11-27 The new edition of this textbook presents a detailed description of basic semiconductor physics The text covers a wide range of important phenomena in semiconductors from the simple to the advanced Four different methods of energy band calculations in the full band region are explained local empirical pseudopotential non local pseudopotential KP perturbation and tight binding methods The effective mass approximation and electron motion in a periodic potential Boltzmann transport equation and deformation potentials used for analysis of transport properties are discussed Further the book examines experiments and theoretical analyses of cyclotron resonance in detail Optical and transport properties magneto transport two dimensional electron gas transport HEMT and MOSFET and quantum transport are reviewed while optical transition electron phonon interaction and electron mobility are also addressed Energy and electronic structure of a quantum dot artificial atom are explained with the help of Slater determinants The physics of semiconductor lasers is also described including Einstein coefficients stimulated emission spontaneous emission laser gain double heterostructures blue lasers optical confinement laser modes and strained quantum well lasers offering insights into the physics of various kinds of semiconductor lasers In this third edition energy band calculations in full band zone with spin orbit interaction are presented

showing all the matrix elements and equipping the reader to prepare computer programs of energy band calculations The Luttinger Hamiltonian is discussed and used to analyze the valence band structure Numerical calculations of scattering rate relaxation time and mobility are presented for typical semiconductors which are very helpful for understanding of transport Energy band structures and effective masses of nitrides such as GaN InN AlN and their ternary alloys are discussed because they are very important materials for the blue light emission and high power devices with and high frequency Learning and teaching with this textbook is supported by problems and solutions in the end of the chapters The book is written for bachelor and upper undergraduate students of physics and engineering

*II-VI Semiconductor Materials and their Applications* MariaC. Tamargo, 2018-05-04 II VI Semiconductor Materials and Their Applications deals with II VI compound semiconductors and the status of the two areas of current optoelectronics applications blue green emitters and IR detectors Specifically the growth characterization materials and device issues for these two applications are described Emphasis is placed on the wide bandgap emitters where much progress has occurred recently The book also presents new directions that have potential future applications in optoelectronics for II VI materials In particular it discusses the status of dilute magnetic semiconductors for magneto optical and electromagnetic devices nonlinear optical properties photorefractive effects and new materials and physics phenomena such as self organized low dimensional structures II\_VI Semiconductor Materials and Their Applications is a valuable reference book for researchers in the field as well as a textbook for materials science and applied physics courses

*Semiconductor Materials* B.G. Yacobi, 2006-04-18 The technological progress is closely related to the developments of various materials and tools made of those materials Even the different ages have been defined in relation to the materials used Some of the major attributes of the present day age i e the electronic materials age are such common tools as computers and fiber optic telecommunication systems in which semiconductor materials provide vital components for various micro electronic and optoelectronic devices in applications such as computing memory storage and communication The field of semiconductors encompasses a variety of disciplines This book is not intended to provide a comprehensive description of a wide range of semiconductor properties or of a continually increasing number of the semiconductor device applications Rather the main purpose of this book is to provide an introductory perspective on the basic principles of semiconductor materials and their applications that are described in a relatively concise format in a single volume Thus this book should especially be suitable as an introductory text for a single course on semiconductor materials that may be taken by both undergraduate and graduate engineering students This book should also be useful as a concise reference on semiconductor materials for researchers working in a wide variety of fields in physical and engineering sciences

Comprehensive Semiconductor Science and Technology, 2024-11-28 Semiconductors are at the heart of modern living Almost everything we do be it work travel communication or entertainment all depend on some feature of semiconductor technology Comprehensive Semiconductor Science and Technology Second Edition Three Volume Set captures the breadth of

this important field and presents it in a single source to the large audience who study make and use semiconductor devices Written and edited by a truly international team of experts and newly updated to capture key advancements in the field this work delivers an objective yet cohesive review of the semiconductor world The work is divided into three sections fully updated and expanded from the first edition The first section is concerned with the fundamental physics of semiconductors showing how the electronic features and the lattice dynamics change drastically when systems vary from bulk to a low dimensional structure and further to a nanometer size Throughout this section there is an emphasis on the full understanding of the underlying physics especially quantum phenomena The second section deals largely with the transformation of the conceptual framework of solid state physics into devices and systems which require the growth of high purity or doped bulk and epitaxial materials with low defect density and well controlled electrical and optical properties The third section is devoted to design fabrication and assessment of discrete and integrated semiconductor devices It will cover the entire spectrum of devices we see all around us for telecommunications computing automation displays illumination and consumer electronics Provides a comprehensive global picture of the semiconductor world Written and Edited by an international team of experts Compiles the most important semiconductor knowledge into one comprehensive resource Moves from fundamentals and theory to more advanced knowledge such as applications allowing readers to gain a deeper understanding of the field

Optik und Photonik Bahaa E. A. Saleh, Malvin Carl Teich, 2020-04-30 Vollständig bearbeitete Neuauflage des maßgeblichen Grundlagen Lehrbuchs zur Optik und Photonik umfassend bearbeitet und mit einem neuen Kapitel zur Metamaterialoptik erweitert Die Optik ist eines der ältesten und faszinierendsten Teilgebiete der Physik und fest in den Curricula des Physikstudiums verankert Sie beschäftigt sich mit der Ausbreitung von Licht und Phänomenen wie Interferenz Brechung Beugung und optischen Abbildungen Die Photonik umfasst optische Phänomene die primär auf der Wechselwirkung von quantisiertem Licht und Materie beruhen und befasst sich mit dem Verständnis und der Entwicklung optischer Bauteile und Systeme wie etwa Lasern LEDs und photonischen Kristallen In bewährter Weise gibt die vollständig bearbeitete und erweiterte Neuauflage des Saleh Teich eine Einführung in die Grundlagen der Optik und Photonik für Studierende der Physik und verwandter Wissenschaften Ausführliche Erklärungen rund 1000 Abbildungen und die zur quantitativen Durchdringung notwendige Mathematik ermöglichen ein tiefes Verständnis aller Teilgebiete der klassischen und modernen Optik Umfassend und verständlich sämtliche Grundlagen der Optik und Photonik in einem Werk vereint Geschrieben von hervorragenden Didaktikern mit langer Lehrerfahrung optische Phänomene und deren Physik stehen im Vordergrund der notwendigen mathematische Apparat wird behutsam entwickelt bearbeitet und erweitert alle Kapitel wurden mit Blick auf noch bessere Verständlichkeit kritisch geprüft und aktualisiert Komplett neu umfangreiches Kapitel zu Metamaterialoptik Optik und Photonik richtet sich an Bachelor und Master Studierende der Physik Materialwissenschaften und Ingenieurwissenschaften

**Phononen in II-VI-Halbleiter-Nanostrukturen** Gerwin Chilla, 2009-11-04 In dieser Arbeit werden Phononen in

nasschemisch synthetisierten sphrischen Nanokristallen und Tetrapods aus II VI Verbindungshalbleitern mittels verschiedener optischer Messverfahren untersucht Ziel ist es erstens Photolumineszenz Prozesse in einzelnen Core Shell und Core Shell Shell Nanokristallen und zweitens Raman Streuprozesse in CdTe Nanopartikeln zu detektieren Den Kern der Untersuchungen bilden optische und akustische Phononen die sich auf Grund der hohen Stabilität der hier gezeigten einzelnen CdSe Nanokristalle in den Photolumineszenz Spektren nachweisen lassen Einzelne Phononen können confined akustischen Moden zugeordnet werden Die für die Nanokristalle typischen Effekte Blinking und spektrale Diffusion werden anhand von konsekutiv aufgenommenen Photolumineszenz Spektren diskutiert Die intensivste Linie in den Spektren der einzelnen Nanokristalle bildet die Dark State Zero Phonon Line Eine Nebenlinie kann auf Rekombinationen aus einem Bright State zurückgeführt werden Im Rahmen des Modells nach Lamb 1982 werden drei sphrische akustische Moden bestimmt Sowohl das LA Phonon als auch das LO Phonon des CdSe Cores lassen sich nachweisen Zusätzlich können LO Phononen der CdS und der ZnS Shell identifiziert werden Durch Polymerfilme wird eine definierte Umgebung für die CdSe Nanokristalle auf dem Si Substrat geschaffen Es werden Photolumineszenz Messungen an einzelnen Nanokristallen gezeigt die jeweils bis zu ca 4 5 Stunden reine Beleuchtungszeit ca 2 Stunden durchgeführt werden konnten Die verhältnismäßig intensiven schwachen Phonon Signale der einzelnen Nanokristalle werden über aufsummierte Einzelspektren ausgewertet Den Untersuchungen an einzelnen Nanokristallen gehen Photolumineszenz Messungen an InAs Quantenpunkten die in Heterostrukturen eingebettet sind voraus In den Spektren konnten Signaturen einzelner InAs Quantenpunkte nachgewiesen werden Die Raman Spektren der CdTe Tetrapods und der sphrischen CdTe Nanokristalle zeigen ebenfalls optische Phononen Diese Proben wurden im Ensemble gemessen Neben dem CdTe LO Phonon und seiner ersten Oberschwingung werden bei beiden Probenarten SO Phononen nachgewiesen Ferner kann eine Anregung in den Tetrapods durch einen Vergleich mit Rechnungen zu Nanowires vgl Mah03 als TOx Phonon interpretiert werden Die Analyse der Spektren von CdTe Tetrapods und von sphrischen CdTe Nanokristallen geben Aufschluss über elektronische Übergänge in den Nanopartikeln Demzufolge wird geschlossen dass sich Raman Spektren zur Differenzierung von Tetrapods mit gut ausgebildeter geometrischer Struktur und Tetrapods mit im Verhältnis zum Kern kurzen Armen eignen

**Strukturuntersuchungen an epitaktisch abgeschiedenen SiC-Schichten** Hans-Peter Lang, 1998 Ladungsträgerdynamik in verspannungsinduzierten Halbleiter-Quantenpunkten Jörg Sandmann, 1998

**Die Vision der Verlierer** Christian Staub, 2008 Die europäischen Verträge und die aus ihnen hervorgehenden europäischen Institutionen und politischen Handlungsmuster entspringen einer Vision die davon ausgeht dass Struktur und innere politische Ordnung der Europäischen Gemeinschaft in erster Linie von der Außenwelt abhängig sind und dass sie sich entsprechend den Vorgaben dieser Außenwelt zu gestalten haben Nach dieser politischen Grundvorstellung deren Autonomieverständnis sich auf die Verknüpfung zwischen unserer europäischen Kulturwelt und der fremden Außenwelt bezieht ist die Gemeinschaft dann autonom bzw unabhängig

wenn sie in der Lage ist kritische Einschränkungen in ihrem Verhalten die ihr von der Außenwelt auferlegt werden abzubauen Autonomie ist laut diesem in vielen politischen Kreisen der Europäischen Gemeinschaft vorherrschendes Verständnis somit eine Restgröße die bei guter Politik entsteht indem die europäischen Staats- und Regierungschefs und ihre Regierungen durch gute Wahl der Gestaltungsmöglichkeiten in der heutigen absoluten Gebundenheit der Europäischen Gemeinschaft im globalen Netz größere Handlungsfreiheitsspielräume für ihre Bürgerinnen und Bürger erarbeiten Ist der politische Leistungsausweis hingegen negativ und das ist er schon seit geraumer Zeit schrumpft die Restgröße zusammen die Handlungsfreiheitsspielräume der Europäischen Gemeinschaft und ihrer Bürgerinnen und Bürger werden kleiner

Optics of Nanomaterials Vladimir I. Gavrilenko, 2016-10-14 While the chemistry physics and optical properties of simple atoms and molecules are quite well understood this book demonstrates that there is much to be learned about the optics of nanomaterials Through comparative analysis of the size dependent optical response from nanomaterials it is shown that although strides have been made in computational chemistry and physics bridging length scales from nano to macro remains a major challenge Organic molecular polymer and biological systems are shown to be potentially useful models for assembly Our progress in understanding the optical properties of biological nanomaterials is important driving force for a variety of applications

Photoelectrochemical Hydrogen Production Roel van de Krol, Michael Grätzel, 2011-11-09 Photoelectrochemical Hydrogen Production describes the principles and materials challenges for the conversion of sunlight into hydrogen through water splitting at a semiconducting electrode Readers will find an analysis of the solid state properties and materials requirements for semiconducting photoelectrodes a detailed description of the semiconductor electrolyte interface in addition to the photoelectrochemical PEC cell Experimental techniques to investigate both materials and PEC device performance are outlined followed by an overview of the current state of the art in PEC materials and devices and combinatorial approaches towards the development of new materials Finally the economic and business perspectives of PEC devices are discussed and promising future directions indicated Photoelectrochemical Hydrogen Production is a one stop resource for scientists students and R D practitioners starting in this field providing both the theoretical background as well as useful practical information on photoelectrochemical measurement techniques Experts in the field benefit from the chapters on current state of the art materials devices and future directions

*Synthesis and Applications of Inorganic Nanostructures* Huaqiang Cao, 2017-09-13 Authored by a leading figure in the field this book systematically describes all the fundamental aspects and applications of inorganic nanostructures from zero to three dimensions It not only discusses various synthesis technologies but also covers the physical properties of inorganic nanostructures such as optical electric and magnetic properties and practical applications such as energy storage including Li ion and Ni MH batteries and supercapacitors superhydrophobic and bio applications etc The focus throughout is on the synthesis structure application relationships including the growth mechanisms for the nanostructures Concise yet comprehensive this is indispensable



reading for chemists and materials scientists

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