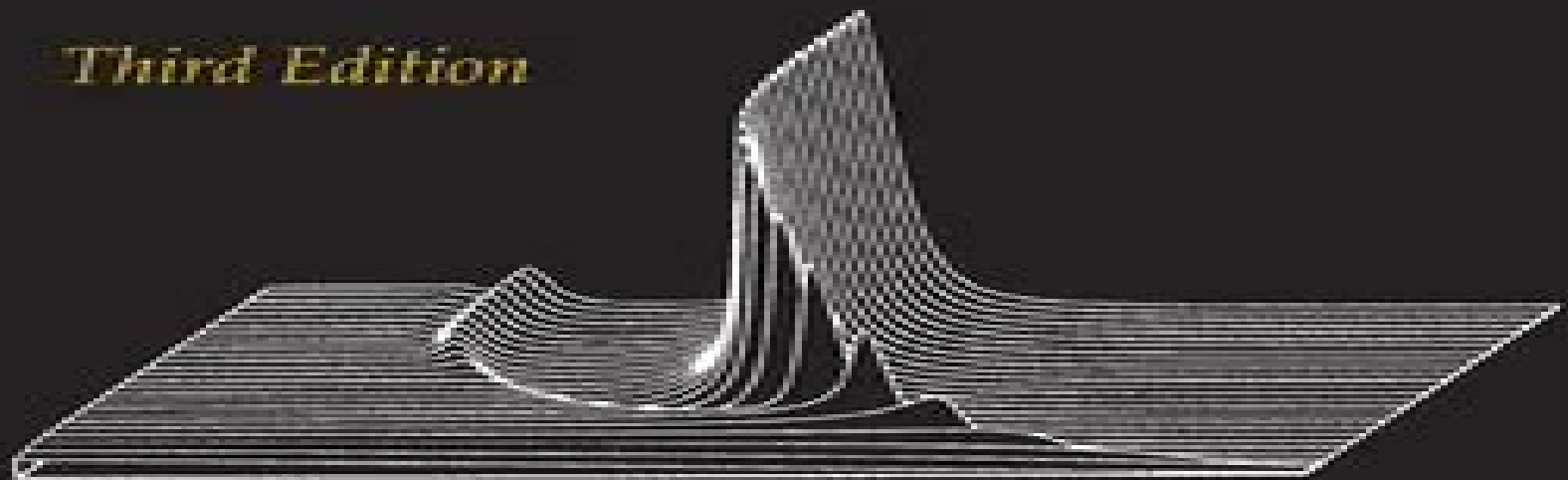


# QUANTUM THEORY OF THE OPTICAL AND ELECTRONIC PROPERTIES OF SEMICONDUCTORS

*Third Edition*



**Hartmut Haug**

**Stephan W. Koch**

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# Quantum Theory Of Optical And Electronic Properties Of Semiconductors

**Hartmut Haug**



## **Quantum Theory Of Optical And Electronic Properties Of Semiconductors:**

*Quantum Theory of the Optical and Electronic Properties of Semiconductors* Hartmut Haug, Stephan W. Koch, 2004 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 The basic principles underlying optical nonlinearities are developed including excitonic and many body plasma effects Fundamentals of optical bistability semiconductor lasers femtosecond excitation the optical Stark effect the semiconductor photon echo magneto optic effects as well as bulk and quantum confined Franz Keldysh effects are covered The material is presented in sufficient detail for graduate students and researchers with a general background in quantum mechanics

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Hartmut Haug, Stephan W Koch, 1990-04-01 The current technological revolution in the development of computing devices has created a demand for a textbook on the quantum theory of the electronic and optical properties of semiconductors and semiconductor devices This book successfully fulfills this need Based on lectures given by the authors it is a comprehensive introduction for researchers or graduate level students to the subject Certain sections can also serve as a graduate level textbook for use in solid state physics courses or for more specialized courses The final chapters establish a

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dynamics in nanostructure semiconductors Chapter 5 reviews experimental and theoretical work on the use of the phase properties of one or more ultrashort optical pulses to generate and control electrical currents in semiconductors

Semiconductor Optics Claus F. Klingshirn, 2007-03-07 The updated and enlarged new edition of this book provides an introduction to and an overview of semiconductor optics from the IR through the visible to the UV It includes coverage of linear and nonlinear optical properties dynamics magneto and electrooptics high excitation effects some applications experimental techniques and group theory The mathematics is kept as elementary as possible The subjects covered extend from physics to materials science and optoelectronics New or updated chapters add coverage of current topics while the chapters on bulk materials have been revised and updated

Semiconductor Nanophotonics Prasanta Kumar Basu, Bratati Mukhopadhyay, Rikmantra Basu, 2022 One of the first comprehensive textbooks dealing with the modern field of Nanophotonics Though emphasis is given on semiconductors optical processes in metals and insulators are discussed as well Provides basic theoretical models in simple terms and discusses the application areas

*Semiconductor Physics* Sandip Tiwari, 2020 This text brings together traditional solid state approaches from the 20th century with developments of the early part of the 21st century to reach an understanding of semiconductor physics in its multifaceted forms It reveals how an understanding of what happens within the material can lead to insights into what happens in its use

**Advanced Silicon & Semiconducting Silicon-Alloy Based Materials & Devices** Jo Nijs, 2021-05-30 One of the first books to cover advanced silicon based technologies Advanced Silicon and Semiconducting Silicon Alloy Based Materials and Devices presents important directions for research into silicon its alloy based semiconducting devices and its development in commercial applications The first section deals with single mono crystalline silicon focusing on the effects of heavy doping the structure and electronic properties of defects and their impact on devices the MBE of silicon silicon alloys and metals CVD techniques for silicon and silicon germanium the material properties of silicon germanium strained layers silicon germanium heterojunction bipolar applications FETs IR detectors and resonant tunneling devices in silicon silicon germanium and doped silicon and the fascinating properties of crystalline silicon carbide and its applications The second section explores polycrystalline silicon It examines large grain polysilicon substrates for solar cells the properties analysis and modeling of polysilicon TFTs the technology of polysilicon TFTs in LCD displays and the use of polycrystalline silicon and its alloys in VLSI applications With contributors from leading academic and industrial research centers this book provides wide coverage of fabrication techniques material properties and device applications

**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

Concepts and Applications of Nonlinear Terahertz Spectroscopy Thomas Elsaesser, Klaus Reimann, Michael Woerner, 2019-02-22 Terahertz THz radiation with frequencies between 100 GHz and 30 THz has developed into an important tool of science and technology with numerous applications in materials characterization imaging sensor technologies and telecommunications Recent progress in THz generation has provided ultrashort THz pulses with electric field amplitudes of up to several megavolts cm This development opens the new research field of nonlinear THz spectroscopy in which strong light matter interactions are exploited to induce quantum excitations and or charge transport and follow their nonequilibrium dynamics in time resolved experiments This book introduces methods of THz generation and nonlinear THz spectroscopy in a tutorial way discusses the relevant theoretical concepts and presents prototypical experimental and theoretical results in condensed matter physics The potential of nonlinear THz spectroscopy is illustrated by recent research including an overview of the relevant literature

*LED Lighting* Malvin Carl Teich, 2025-04-14 LED Lighting is a self contained and introductory level book featuring a blend of theory and applications that thoroughly covers this important interdisciplinary area Building on the underlying fields of optics photonics and vision science it comprises four parts PART I is devoted to fundamentals The behavior of light is described in terms of rays waves and photons Each of these approaches is best suited to a particular set of applications The properties of blackbody radiation thermal light and incandescent light are derived and explained The essentials of semiconductor physics are set forth including the operation of junctions and heterojunctions quantum wells and quantum dots and organic and perovskite semiconductors PART II deals with the generation of light in semiconductors and details the operation and properties of III V semiconductor devices MQWLEDs microLEDs quantum dot devices QLEDs WQLEDs organic

semiconductor devices OLEDs SMOLEDs PLEDs WOLEDs and perovskite devices PeLEDs PPeLEDs QPeLEDs PeWLEDs PART III focuses on vision and the perception of color as well as on colorimetry It delineates radiometric and photometric quantities as well as various measures of luminous efficacy and efficiency It also elucidates the significance of commonly used LED lighting metrics such as the color rendering index CRI color temperature CT correlated color temperature CCT and chromaticity diagram PART IV is devoted to LED lighting focusing on its history and salutary features and on how this modern form of illumination is deployed It describes the principal components used in LED lighting including phosphor conversion LEDs PCLEDs for generating cool and warm white light chip on board COB devices color mixing LEDs LED filaments retrofit LED lamps hybrid devices LED luminaires and OLED light panels It concludes with a discussion of smart and connected lighting that reviews plant centric lighting and highlights the roles of gamma and circadian brain rhythms in human centric lighting Finally the performance metrics for traditional and LED light sources are summarized Each chapter contains practical examples highlighted equations color coded figures and an extensive bibliography

**Ultrafast Spectroscopy of Semiconductors and Semiconductor Nanostructures** Jagdeep Shah, 2013-11-21 The field of ultrafast spectroscopy of semiconductors and their nanostructures continues to be an active field of research Exciting new developments have taken place since the first edition of this book was completed in 1995 This revised edition includes a discussion of many of these recent developments in the field This is accomplished by adding a chapter on Recent Developments at the end of the book This approach was selected to provide a discussion of results while they are still relatively recent Results published before the end of May 1998 were considered for inclusion in this book The objective of this revised edition remains the same as before to provide a cohesive discussion of the many diverse contributions of ultrafast spectroscopy to the field of semiconductors Extensive cross references are made to earlier chapters in order to accomplish this goal The chapter on Recent Developments begins with a brief discussion of new lasers new techniques of ultrafast spectroscopy and novel nanostructures This is followed by a section on Coherent Spectroscopy where some of the most interesting recent developments have taken place These include observation of quantum kinetic effects effects that require going beyond the mean field approach of the semiconductor Bloch equations coherent control of populations and current in semiconductors exciton continuum interactions and many diverse aspects of coherent spectroscopy including studies of microcavities Bragg structures quantum dots and quantum wires

**Plasmonic Effects in Metal-Semiconductor Nanostructures** Alexey A. Toropov, Tatiana V. Shubina, 2015-04-02 Metal semiconductor nanostructures represent an important new class of materials employed in designing advanced optoelectronic and nanophotonic devices such as plasmonic nanolasers plasmon enhanced light emitting diodes and solar cells plasmonic emitters of single photons and quantum devices operating in infrared and terahertz domains The combination of surface plasmon resonances in conducting structures providing strong concentration of an electromagnetic optical field nearby with sharp optical resonances in semiconductors which are highly sensitive to

external electromagnetic fields creates a platform to control light on the nanoscale The design of the composite metal semiconductor system imposes the consideration of both the plasmonic resonances in metal and the optical transitions in semiconductors a key issue being their resonant interaction providing a coupling regime In this book the reader will find descriptions of electrodynamics of conducting structures quantum physics of semiconductor nanostructures and guidelines for advanced engineering of metal semiconductor composites These constituents form together the physical basics of the metal semiconductor plasmonics underlying many effective practical applications The list of covered topics also includes the review of recent results such as the achievement of a strong coupling regime and the preservation of non classical statistics of photons in plasmonic cavities combined with semiconductor nanostructures

**The Physics of Low-dimensional Semiconductors** John H. Davies, 1998 The composition of modern semiconductor heterostructures can be controlled precisely on the atomic scale to create low dimensional systems These systems have revolutionised semiconductor physics and their impact on technology particularly for semiconductor lasers and ultrafast transistors is widespread and burgeoning This book provides an introduction to the general principles that underlie low dimensional semiconductors As far as possible simple physical explanations are used with reference to examples from actual devices The author shows how beginning with fundamental results from quantum mechanics and solid state physics a formalism can be developed that describes the properties of low dimensional semiconductor systems Among numerous examples two key systems are studied in detail the two dimensional electron gas employed in field effect transistors and the quantum well whose optical properties find application in lasers and other opto electronic devices The book includes many exercises and will be invaluable to undergraduate and first year graduate physics or electrical engineering students taking courses in low dimensional systems or heterostructure device physics

**Proceedings of the International Conference on Computers and Devices for Communication** , 1998



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## **Table of Contents Quantum Theory Of Optical And Electronic Properties Of Semiconductors**

1. Understanding the eBook Quantum Theory Of Optical And Electronic Properties Of Semiconductors
  - The Rise of Digital Reading Quantum Theory Of Optical And Electronic Properties Of Semiconductors
  - Advantages of eBooks Over Traditional Books
2. Identifying Quantum Theory Of Optical And Electronic Properties Of Semiconductors
  - Exploring Different Genres
  - Considering Fiction vs. Non-Fiction
  - Determining Your Reading Goals
3. Choosing the Right eBook Platform
  - Popular eBook Platforms
  - Features to Look for in an Quantum Theory Of Optical And Electronic Properties Of Semiconductors
  - User-Friendly Interface
4. Exploring eBook Recommendations from Quantum Theory Of Optical And Electronic Properties Of Semiconductors
  - Personalized Recommendations

- Quantum Theory Of Optical And Electronic Properties Of Semiconductors User Reviews and Ratings
- Quantum Theory Of Optical And Electronic Properties Of Semiconductors and Bestseller Lists
- 5. Accessing Quantum Theory Of Optical And Electronic Properties Of Semiconductors Free and Paid eBooks
  - Quantum Theory Of Optical And Electronic Properties Of Semiconductors Public Domain eBooks
  - Quantum Theory Of Optical And Electronic Properties Of Semiconductors eBook Subscription Services
  - Quantum Theory Of Optical And Electronic Properties Of Semiconductors Budget-Friendly Options
- 6. Navigating Quantum Theory Of Optical And Electronic Properties Of Semiconductors eBook Formats
  - ePub, PDF, MOBI, and More
  - Quantum Theory Of Optical And Electronic Properties Of Semiconductors Compatibility with Devices
  - Quantum Theory Of Optical And Electronic Properties Of Semiconductors Enhanced eBook Features
- 7. Enhancing Your Reading Experience
  - Adjustable Fonts and Text Sizes of Quantum Theory Of Optical And Electronic Properties Of Semiconductors
  - Highlighting and Note-Taking Quantum Theory Of Optical And Electronic Properties Of Semiconductors
  - Interactive Elements Quantum Theory Of Optical And Electronic Properties Of Semiconductors
- 8. Staying Engaged with Quantum Theory Of Optical And Electronic Properties Of Semiconductors
  - Joining Online Reading Communities
  - Participating in Virtual Book Clubs
  - Following Authors and Publishers Quantum Theory Of Optical And Electronic Properties Of Semiconductors
- 9. Balancing eBooks and Physical Books Quantum Theory Of Optical And Electronic Properties Of Semiconductors
  - Benefits of a Digital Library
  - Creating a Diverse Reading Collection Quantum Theory Of Optical And Electronic Properties Of Semiconductors
- 10. Overcoming Reading Challenges
  - Dealing with Digital Eye Strain
  - Minimizing Distractions
  - Managing Screen Time
- 11. Cultivating a Reading Routine Quantum Theory Of Optical And Electronic Properties Of Semiconductors
  - Setting Reading Goals Quantum Theory Of Optical And Electronic Properties Of Semiconductors
  - Carving Out Dedicated Reading Time
- 12. Sourcing Reliable Information of Quantum Theory Of Optical And Electronic Properties Of Semiconductors
  - Fact-Checking eBook Content of Quantum Theory Of Optical And Electronic Properties Of Semiconductors

- Distinguishing Credible Sources
- 13. Promoting Lifelong Learning
  - Utilizing eBooks for Skill Development
  - Exploring Educational eBooks
- 14. Embracing eBook Trends
  - Integration of Multimedia Elements
  - Interactive and Gamified eBooks

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