Physics Of Solar Cells From Basic Principles To A

Physics and Technology
From Principles to New Concepts
Crystalline Silicon Solar Cells
Materials Concepts for Solar Cells
Perovskites, Organics, and Photovoltaic Fundamentals
The Physics of Solar Cells
Physics, Technologies, and Thin Film Devices
Physics of Solar Cells
Physics, Technology and Use of Photovoltaics,
New Approaches and Reviews
Perovskites, Organics, and Photovoltaic Fundamentals
Operating Principles, Technology and System Applications
An Introduction
Solar Cells
Solar Cells
Physics of Solar Energy
Fundamentals, Technology and Systems
Photophysics and Devices
Optoelectronics of Solar Cells
Perovskites, Organics, and Photovoltaic Fundamentals
Development of Solar Cells
Organic and Hybrid Solar Cells
Nanostructured Materials for Solar Energy Conversion
The Physics of Solar Cells
Handbook of Photovoltaic Science and Engineering
Copper Zinc Tin Sulfide-Based Thin Film Solar Cells

From Basic Principles to Advanced Concepts
Solar Cells
Theory and Experiment
Organic Solar Cells
Thin-Film Crystalline Silicon Solar Cells
The Role of the PN Junction
Perovskite Photovoltaics and Optoelectronics
Solar Energy
Principles of Solar Cells, LEDs and Diodes
Physics and Technology of Amorphous-Crystalline Heterostructure Silicon Solar Cells
Solar Cell Device Physics
Chalcogenide Photovoltaics
Physics of Solar Cells
Solar Panels and Photovoltaic Materials

MIDDLETON JOHANNA

Physics and Technology World Scientific Publishing Company The fundamental concept of the book is to explain how to make thin film solar cells from the abundant solar energy materials by low cost. The proper and optimized growth conditions are very essential while sandwiching thin films to make solar cell otherwise secondary phases play a role to undermine the working function of solar cells. The book illustrates growth and characterization of Cu2ZnSn(S1-xSex)4 thin film absorbers and their solar cells. The fabrication process of absorber layers by either vacuum or non-vacuum process is readily elaborated in the book, which helps for further development of cells. The characterization analyses such as XPS, XRD, SEM, AFM etc., lead to tailor the physical properties of the absorber layers to fit well for the solar cells. The role of secondary phases such as ZnS, Cu2-xS,SnS etc., which are determined by XPS, XRD or Raman, in the absorber layers is promptly discussed. The optical spectroscopy analysis, which finds band gap, optical constants of the films, is mentioned in the book. The electrical properties of the absorbers deal the influence of substrates, growth temperature, impurities, secondary phases etc. The low temperature I-V and C-V measurements of Cu2ZnSn(S1-xSex)4 thin film solar cells are clearly described. The solar cell parameters such as efficiency, fill factor, series resistance, parallel resistance provide handful information to understand the

mechanism of physics of thin film solar cells in the book. The band structure, which supports to adjust interface states at the p-n junction of the solar cells is given. On the other hand the role of window layers with the solar cells is discussed. The simulation of theoretical efficiency of Cu2ZnSn(S1-xSex)4 thin film solar cells explains how much efficiency can be experimentally extracted from the cells. One of the first books exploring how to conduct research on thin film solar cells, including reducing costs Detailed instructions on conducting research

From Principles to New Concepts World Scientific Publishing Company

This book provides a comprehensive introduction to the physics of the photovoltaic cell. It is suitable for undergraduates, graduate students, and researchers new to the field. It covers: basic physics of semiconductors in photovoltaic devices; physical models of solar cell operation; characteristics and design of common types of solar cell; and approaches to increasing solar cell efficiency. The text explains the terms and concepts of solar cell device physics and shows the reader how to formulate and solve relevant physical problems. Exercises and worked solutions are included.

Crystalline Silicon Solar Cells CRC Press

Solar Cells and Energy Materials takes an in-depth look at the basics behind energy, solar energy as well as future and alternative energy materials. The author presents insights into the current state-of-the-art of solar cells, including their basic science, inorganic, organic and Perovskite-type cells. The author also gives an outlook into next generation energy materials and sources. The focus of this book is not only the presentation of available and developing energy materials, but their thorough examination and characterization. In addition to solar cell technology and the promising application of nanostructures like quantum dots, the author discusses the science and potential of nuclear fusion materials and other energy materials like hydrogen storage materials, BN nanomaterials, alternative fuel cells and SIC FET.

Materials Concepts for Solar Cells John Wiley & Sons

Photovoltaics, the direct conversion of sunlight to electricity, is now the fastest growing technology for electricity generation. Present "first generation" products use the same silicon wafers as in microelectronics. "Second generation" thin-films, now entering the market, have the potential to greatly improve the economics by eliminating material costs. Martin Green, one of the world’s foremost photovoltaic researchers, argues in this book that "second generation" photovoltaics will eventually reach its own material cost constraints, engendering a "third generation" of high performance thin-films. The book explores, self-consistently, the energy conversion potential of advanced approaches for improving photovoltaic performance and outlines possible implementation paths.

Perovskites, Organics, and Photovoltaic Fundamentals John Wiley & Sons

The most comprehensive, authoritative and widely cited reference on photovoltaic solar energy Fully revised and updated, the Handbook of Photovoltaic Science and Engineering, Second Edition incorporates the substantial technological advances and research developments in photovoltaics since its previous release. All topics relating to the photovoltaic (PV) industry are

discussed with contributions by distinguished international experts in the field. Significant new coverage includes: three completely new chapters and six chapters with new authors device structures, processing, and manufacturing options for the three major thin film PV technologies high performance approaches for multijunction, concentrator, and space applications new types of organic polymer and dye-sensitized solar cells economic analysis of various policy options to stimulate PV growth including effect of public and private investment Detailed treatment covers: scientific basis of the photovoltaic effect and solar cell operation the production of solar silicon and of silicon-based solar cells and modules how choice of semiconductor materials and their production influence costs and performance making measurements on solar cells and modules and how to relate results under standardised test conditions to real outdoor performance photovoltaic system installation and operation of components such as inverters and batteries. architectural applications of building-integrated PV Each chapter is structured to be partially accessible to beginners while providing detailed information of the physics and technology for experts. Encompassing a review of past work and the fundamentals in solar electric science, this is a leading reference and invaluable resource for all practitioners, consultants, researchers and students in the PV industry.

The Physics of Solar Cells John Wiley & Sons

A modern challenge is for solar cell materials to enable the highest solar energy conversion efficiencies, at costs as low as possible, and at an energy balance as sustainable as necessary in the future. This textbook explains the principles, concepts and materials used in solar cells. It combines basic knowledge about solar cells and the demanded criteria for the materials with a comprehensive introduction into each of the four classes of materials for solar cells, i.e. solar cells based on crystalline silicon, epitaxial layer systems of III-V semiconductors, thin-film absorbers on foreign substrates, and nano-composite absorbers. In this sense, it bridges a gap between basic literature on the physics of solar cells and books specialized on certain types of solar cells. The last five years had several breakthroughs in photovoltaics and in the research on solar cells and solar cell materials. We consider them in this second edition. For example, the high potential of crystalline silicon with charge-selective hetero-junctions and alkaline treatments of thin-film absorbers, based on chalcopyrite, enabled new records. Research activities were boosted by the class of hybrid organic-inorganic metal halide perovskites, a promising newcomer in the field. This is essential reading for students interested in solar cells and materials for solar cells. It encourages students to solve tasks at the end of each chapter. It has been well applied for postgraduate students with background in materials science, engineering, chemistry or physics.

Physics, Technologies, and Thin Film Devices World Scientific Publishing Company

The need to address the energy problem and formulate a lasting solution to tame climate change has never been so urgent. The rise of various renewable energy sources, such as solar cell technologies, has given humanity a glimpse of hope that can delay the catastrophic effects of these problems after decades of neglect. This review volume provides in-depth discussion of the

fundamental photophysical processes as well as the state-of-the-art device engineering of various emerging photovoltaic technologies, including organic (fullerene, non-fullerene, and ternary), dye-sensitized (ruthenium, iron, and quantum dot), and hybrid metal-halide perovskite solar cells. The book is essential reading for graduate and postgraduate students involved in the photophysics and materials science of solar cell technologies.

Physics of Solar Cells Newnes

A discussion of how solar cell devices function, and of the parameters that control their operation. The text is designed as an overview for those in the fields of optics and optical engineering, as well as those interested in energy policy, economics and photo-to-electric energy conversion.

Physics, Technology and Use of Photovoltaics, World Scientific

Peter Würfel describes in detail all aspects of solar cell function, the physics behind every single step, as well as all the issues to be considered when improving solar cells and their efficiency. Based on the highly successful German version, but thoroughly revised and updated, this edition contains the latest knowledge on the mechanisms of solar energy conversion. Requiring no more than standard physics knowledge, it enables readers to understand the factors driving conversion efficiency and to apply this knowledge to their own solar cell development.

New Approaches and Reviews John Wiley & Sons

This first comprehensive description of the most important material properties and device aspects closes the gap between general books on solar cells and journal articles on chalcogenide-based photovoltaics. Written by two very renowned authors with years of practical experience in the field, the book covers II-VI and I-III-VI2 materials as well as energy conversion at heterojunctions. It also discusses the latest semiconductor heterojunction models and presents modern analysis concepts. Thin film technology is explained with an emphasis on current and future techniques for mass production, and the book closes with a compendium of failure analysis in photovoltaic thin film modules. With its overview of the semiconductor physics and technology needed, this practical book is ideal for students, researchers, and manufacturers, as well as for the growing number of engineers and researchers working in companies and institutes on chalcogenide photovoltaics.

Perovskites, Organics, and Photovoltaic Fundamentals SPIE Press

Research on advanced energy conversion devices such as solar cells has intensified in the last two decades. A broad landscape of candidate materials and devices were discovered and systematically studied for effective solar energy conversion and utilization. New concepts have emerged forming a rather powerful picture embracing the mechanisms and limitation to efficiencies of different types of devices. The Physics of Solar Energy Conversion introduces the main physico-chemical principles that govern the operation of energy devices for energy conversion and storage, with a detailed view of the principles of solar energy conversion using advanced materials. Key Features include: Highlights recent rapid advances with the discovery of perovskite solar cells and their development. Analyzes the properties of organic solar cells, lithium ion batteries, light emitting diodes and the semiconductor materials for hydrogen production by water splitting. Embraces concepts from

nanostructured and highly disordered materials to lead halide perovskite solar cells Takes a broad perspective and comprehensively addresses the fundamentals so that the reader can apply these and assess future developments and technologies in the field. Introduces basic techniques and methods for understanding the materials and interfaces that compose operative energy devices such as solar cells and solar fuel converters.

Operating Principles, Technology and System Applications Springer Science & Business Media

Despite their wide availability and relatively low prices, the conventional energy sources have harmful consequences on the environment and are exhaustible. In order to circumvent these negative effects, the renewable energies in general and the photovoltaic energy in particular are becoming more and more attractive. Solar cell is an electrical device that converts light into electricity at the atomic level. These devices use inorganic or organic semiconductor materials that absorb photons with energy greater than their bandgap to promote energy carriers into their conduction band. They do not pollute the atmosphere by releasing harmful gases, do not require any fuel to produce electricity, and do not move parts so they are rugged. Solar panels have a very long life and do not need much maintenance.

An Introduction John Wiley & Sons

Solar Cell Device Physics offers a balanced, in-depth qualitative and quantitative treatment of the physical principles and operating characteristics of solar cell devices. Topics covered include photovoltaic energy conversion and solar cell materials and structures, along with homojunction solar cells. Semiconductor-semiconductor heterojunction cells and surface-barrier solar cells are also discussed. This book consists of six chapters and begins by introducing the reader to the basic physical principles and materials properties that are the foundations of photovoltaic energy conversion, with emphasis on various photovoltaic devices capable of efficiently converting solar energy into usable electrical energy. The electronic and optical properties of crystalline, polycrystalline, and amorphous materials with both organic and inorganic materials are considered, together with the manner in which these properties change from one material class to another and the implications of such changes for photovoltaics. Generation, recombination, and bulk transport are also discussed. The two mechanisms of photocarrier collection in solar cells, drift and diffusion, are then compared. The remaining chapters focus on specific solar cell device classes defined in terms of the interface structure employed: homojunctions, semiconductor-semiconductor heterojunctions, and surface-barrier devices. This monograph is appropriate for use as a textbook for graduate students in engineering and the sciences and for seniors in electrical engineering and applied physics, as well as a reference book for those actively involved in solar cell research and development.

Solar Cells CRC Press

The Physics of Solar CellsWorld Scientific Publishing Company

Solar Cells Elsevier

This book presents a comprehensive overview of the fundamental concept, design, working protocols, and diverse photo-chemicals aspects of different solar cell systems with promising prospects, using computational and experimental techniques. It presents

and demonstrates the art of designing and developing various solar cell systems through practical examples. Compared to most existing books in the market, which usually analyze existing solar cell approaches this volume provides a more comprehensive view on the field. Thus, it offers an in-depth discussion of the basic concepts of solar cell design and their development, leading to higher power conversion efficiencies. The book will appeal to readers who are interested in both fundamental and application-oriented research while it will also be an excellent tool for graduates, researchers, and professionals working in the field of photovoltaics and solar cell systems.

Physics of Solar Energy Walter de Gruyter GmbH & Co KG

How does a solar cell work? How efficient can it be? Why do intricate patterns of metal lines decorate the surface of a solar module? How are the modules arranged in a solar farm? How can sunlight be stored during the day so that it can be used at night? And, how can a lifetime of more than 25 years be ensured in solar modules, despite the exposure to extreme patterns of weather? How do emerging machine-learning techniques assess the health of a solar farm? This practical book will answer all these questions and much more.Written in a conversational style and with over one-hundred homework problems, this book offers an end-to-end perspective, connecting the multi-disciplinary and multi-scale physical phenomena of electron-photon interaction at the molecular level to the design of kilometers-long solar farms. A new conceptual framework explains each concept in a simple, crystal-clear form. The novel use of thermodynamics not only determines the ultimate conversion efficiencies of the various solar cells proposed over the years, but also identifies the measurement artifacts and establishes practical limits by correlating the degradation modes. Extensive coverage of conceptual techniques already developed in other fields further inspire innovative designs of solar farms.This book will not only help you to make a solar cell, but it will help you make a solar cell better, to trace and reclaim the photons that would have been lost otherwise. Collaborations across multiple disciplines make photovoltaics real and given the concern about reducing the overall cost of solar energy, this interdisciplinary book is essential reading for anyone interested in photovoltaic technology.Readership: Advanced undergraduate to beginning graduate students in physics and engineering to researchers and material scientists working in academia, industry, and national laboratories across the world.

Fundamentals, Technology and Systems Springer Nature

The book provides an explanation of the operation of photovoltaic devices from a broad perspective that embraces a variety of materials concepts, from nanostructured and highly disordered organic materials, to highly efficient devices such as the lead halide perovskite solar cells. The book establishes from the beginning a simple but very rich model of a solar cell, in order to develop and understand step by step the photovoltaic operation according to fundamental physical properties and constraints. It emphasizes the aspects pertaining to the functioning of a solar cell and the determination of limiting efficiencies of energy conversion. The final chapters of the book establish a more refined and realistic treatment of the many factors that determine the actual performance of experimental devices: transport gradients, interfacial recombination, optical losses and

so forth. The book finishes with a short review of additional important aspects of solar energy conversion, such as the photonic aspects of spectral modification, and the direct conversion of solar photons to chemical fuel via electrochemical reactions.

Photophysics and Devices BoD – Books on Demand
The research of functional materials has attracted extensive attention in recent years, and its advancement nitrifies the developments of modern sciences and technologies like green sciences and energy, aerospace, medical and health, telecommunications, and information technology. The present book aims to summarize the research activities carried out in recent years devoting to the understanding of the physics and chemistry of how the defects play a role in the electrical, optical and magnetic properties and the applications of the different functional materials in the fields of magnetism, optoelectronic, and photovoltaic etc.

Optoelectronics of Solar Cells Springer Science & Business Media
As environmental concerns escalate, solar power is increasingly seen as an attractive alternative energy source. Crystalline Silicon Solar Cells addresses the practical and theoretical issues fundamental to the viable conversion of sunlight into electricity. Written by three internationally renowned experts, this valuable reference profits from results and experience gained from research at the Fraunhofer Institute for Solar Energy Systems. Features include: Introduction to the principles of photovoltaics, providing a grounding in semiconductor physics for the novice reader Special emphasis on the methods of attaining high efficiency and thereby cost-effective solar power Examination of the physics, design and technology of crystalline silicon solar cells, in particular thin film cells Survey of a selection of alternative cell types equipping the reader with a complete overview Detailed description of measuring and analysis techniques to facilitate determining physical semiconductor and solar cell parameters Accessible to those with a basic knowledge of physics and mathematics, this is an excellent introductory book for students studying solid state and semiconductor physics. All those working in photovoltaic development and production will find Crystalline Silicon Solar Cells an indispensable resource.

Perovskites, Organics, and Photovoltaic Fundamentals Walter de Gruyter GmbH & Co KG
Covering both organic materials, where recent advances in the understanding of device physics is driving progress, and the newly emerging field of mixed halide perovskites, which are challenging the efficiencies of conventional thin film PV cells, this book provides a balanced overview of the experimental and theoretical aspects of these two classes of solar cell. The book explores both the experimental and theoretical aspects of these solar cell classes. Emphasis is placed on understanding the fundamental physics of the devices. The book also discusses modelling over many length scales, from nano to macro. The first book to cover perovskites, this is an important reference for industrialists and researchers working in energy technologies and materials.