Physics Of Solar Cells From Basic Principles To A

Solar Cells
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Physics of Solar Cells
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From Fundamentals to Advanced Applications
Handbook of the Physics of Thin-Film Solar Cells
Crystalline Silicon Solar Cells
From Principles to New Concepts
Physics of Solar Cells
The Physics of Solar Energy Conversion
Copper Zinc Tin Sulfide-Based Thin Film Solar Cells
Advanced Solar Energy Conversion
Crystalline Silicon Solar Cells
Photophysics and Devices
Solar Cell Device Physics
Defects In Functional Materials
Device Physics, Processing, Degradation, and Prevention
Materials, Manufacture and Operation
Principles of Solar Cells, LEDs and Diodes

New Approaches and Reviews
The Physics of Solar Cells
Materials Concepts for Solar Cells
Physics, Technologies, and Thin Film Devices
Fundamentals, Technology and Systems
Handbook of Photovoltaic Science and Engineering

JAMARCUS JAZLYN

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.

Principles of Solar Cells: Connecting Perspectives on Device, System, Reliability, and Data Science Wiley

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.

Perovskites, Organics, and Photovoltaic

Fundamentals John Wiley & Sons
The Physics of Solar CellsWorld Scientific Publishing Company
Unconventional Thin Film Photovoltaics World Scientific Publishing Company
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. The Physics of Solar Cells Elsevier Nanostructured Materials for Solar Energy Conversion covers a wide variety of materials and device types from inorganic materials to organic materials. This book deals with basic semiconductor physics, modelling of nanostructured solar cell, nanostructure of conventional solar cells such as silicon, CIS and CdTe, dye-sensitized solar cell, organic solar cell, photosynthetic materials, fullerene, extremely thin absorber (ETA) solar cell, quantum structured solar cell, intermediate band solar cell, carbon nanotube, etc. including basic principle and the latest results. There are many books written on conventional p-n junction solar cells, but few books focus on new concepts in this area. * Focuses on the use of nanostructured materials for solar energy * Looks at a wide variety of materials and device types * Covers both organic and inorganic materials

Chalcogenide Photovoltaics Royal Society of Chemistry
This handbook is a compendium giving a comprehensive description of the basics of semiconductor physics relevant to the design and analysis of thin film solar cell materials. It starts from the basics of material science, describing the material and its growth, defect and electrical properties, the basics of its interaction with photons and the involved statistics, proceeding to space charge effects in semiconductors and pn-junctions. Most attention is given to analyze homo- and hetero-junction solar cells using various models and applying the field-of-direction analysis for discussing current voltage characteristics, and helping to discover the involvement of high-field effects in solar cells. The comprehensive coverage of the main topics of - and relating to - solar cells with extensive reference to literature helps scientists and engineers at all levels to reach a better understanding and improvement of solar cell properties and their production. The author is one of the founders of thin film solar cell research.
Perovskites, Organics, and Photovoltaic Fundamentals World Scientific
This book contains chapters in which the problems of modern photovoltaics are considered. The majority of the chapters provide an overview of the results of research and development of different types of solar cells. Such chapters are completed by a justification for a new solar cell structure and technology. Of course, highly effective solar energy conversion is impossible without an in-

depth examination of the solar cell components as physical materials. The relations between structural, thermodynamic, and optical properties of the physical material without addressing the band theory of solids are of both theoretical and practical interest. Requirements formulated for the material are also to be used for maximally efficient conversion of solar radiation into useful work.

The Physics of Solar Cells Springer Nature

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.

From Basic Principles to Advanced Concepts CRC Press

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 John Wiley & Sons

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.

Materials Concepts for Solar Cells Springer Science & Business Media

The definitive guide to the science of solar energy You hold in your hands the first, and only, truly comprehensive

guide to the most abundant and most promising source of alternative energy—solar power. In recent years, all major countries in the world have been calling for an energy revolution. The renewable energy industry will drive a vigorous expansion of the global economy and create more "green" jobs. The use of fossil fuels to power our way of living is moving toward an inevitable end, with sources of coal, petroleum, and natural gas being fiercely depleted. Solar energy offers a ubiquitous, inexhaustible, clean, and highly efficient way of meeting the energy needs of the twenty-first century. This book is designed to give the reader a solid footing in the general and basic physics of solar energy, which will be the basis of research and development in new solar engineering technologies in the years to come. As solar technologies like solar cells, solar thermal power generators, solar water heaters, solar photochemistry applications, and solar space heating-cooling systems become more and more prominent, it has become essential that the next generation of energy experts—both in academia and industry—have a one-stop resource for learning the basics behind the science, applications, and technologies afforded by solar energy. This book fills that need by laying the groundwork for the projected rapid expansion of future solar projects.

The Role of the PN Junction John Wiley & Sons

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.

Physics and Technology of Amorphous-Crystalline Heterostructure Silicon Solar Cells

CRC Press

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.

Organic and Hybrid Solar Cells CRC Press
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 of Solar Cells Springer Science & Business
This comprehensive textbook takes you through everything you need to know about solar energy from the physics of photovoltaic (PV) cells through to the design of PV systems for real-life applications. Solar Energy is an invaluable reference for researchers,

industrial engineers and designers working in solar energy generation. The book is also ideal for university and third-level physics or engineering courses on solar photovoltaics, with exercises to check students' understanding and reinforce learning. It is the perfect companion to the Massive Open Online Course (MOOC) on Solar Energy (DelftX, ET.3034TU) presented by co-author Arno Smets. The course is available in English on the nonprofit open source edX.org platform, and in Arabic on edraak.org. Over 100,000 students have already registered for these MOOCs.

The Physics of Solar Cells World Scientific Publishing Company

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.
Emerging Photovoltaic Technologies BoD – Books on Demand
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.
Physics, Technology and Use of Photovoltaics, John Wiley & Sons
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.

Growth and Characterization of Cu2(ZnSn)(SSe)4 Thin Films and Their Solar Cells World Scientific Publishing Company

With the increasing world-energy demand there is a growing necessity for clean and renewable energy. The sun

being one of the most abundant potential sources accounts for less than 1% of the global energy supply. The market for solar cells is one of the most strongly increasing markets, even though the prize of conventional solar cells is still quite high. New emerging technologies, such as organic and hybrid solar cells have the potential to decrease the price of solar energy drastically. This book offers an introduction to these new types of solar cells and discusses fabrication, different architectures and their device physics on the bases of the author's teaching course on a master degree level. A comparison with conventional solar cells will be given and the specialties of organic solar cells emphasized.

From Fundamentals to Advanced Applications John Wiley & Sons

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.

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