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## Advanced Silicon Materials for Photovoltaic Applications

**John Wiley & Sons** Today, the silicon feedstock for photovoltaic cells comes from processes which were originally developed for the microelectronic industry. It covers almost 90% of the photovoltaic market, with mass production volume at least one order of magnitude larger than those devoted to microelectronics. However, it is hard to imagine that this kind of feedstock (extremely pure but heavily penalized by its high energy cost) could remain the only source of silicon for a photovoltaic market which is in continuous expansion, and which has a cumulative growth rate in excess of 30% in the last few years. Even though reports suggest that the silicon share will slowly decrease in the next twenty years, finding a way to manufacture a specific solar grade feedstock in large quantities, at a low cost while maintaining the quality needed, still remains a crucial issue. Thin film and quantum confinement-based silicon cells might be a complementary solution. *Advanced Silicon Materials for Photovoltaic Applications* has been designed to describe the full potentialities of silicon as a multipurpose material and covers: Physical, chemical and structural properties of silicon Production routes including the promise of low cost feedstock for PV applications Defect engineering and the role of impurities and defects Characterization techniques, and advanced analytical techniques for metallic and non-metallic impurities Thin film silicon and thin film solar cells Innovative quantum effects, and 3rd generation solar cells With contributions from internationally recognized authorities, this book gives a comprehensive analysis of the state-of-the-art of process technologies and material properties, essential for anyone interested in the application and development of photovoltaics.

## Silicon Materials

**BoD - Books on Demand** Apart from oxygen, silicon is the most commonly occurring element on Earth. Silicon materials have many applications in the manufacturing technology of microelectronic components, integrated circuits, and photovoltaic generators. Circuit complexity and higher degrees of integration of components require constant improvement and control of silicon's properties. This book provides information on silicon materials, their use, and their impact on the modern world economy.

## Materials Challenges

## Inorganic Photovoltaic Solar Energy

**Royal Society of Chemistry** This book will provide an authoritative reference on the various aspects of materials science that will impact the next generation of photovoltaic (PV) module technology. The materials emphasis will bring a fresh perspective to the literature and will highlight the many issues that are often buried in other texts where the solution to materials challenges can be crucial in developing a new PV technology. The emphasis of the book will be on the range of thin film PV materials. Thin film PV is growing more rapidly than crystalline silicon and although only 10% of the current market could dominate in the longer term. This book will address the fundamental aspects of PV solar cell materials and give a comprehensive description of each of the major thin film materials either in research or in production. Particular attention will be given to the key materials drivers of solar conversion efficiency, long term stability, materials costs and materials sustainability. The book will be essential reading for materials scientists, energy technologists and all those involved in solid-state physics.

## Emerging Photovoltaic Materials

## Silicon & Beyond

**John Wiley & Sons** This book covers the recent advances in photovoltaics materials and their innovative applications. Many materials science problems are encountered in understanding existing solar cells and the development of more efficient, less costly, and more stable cells. This important and timely book provides a historical overview, but concentrates primarily on the exciting developments in the last decade. It includes organic and perovskite solar cells, photovoltaics in ferroelectric materials, organic-inorganic hybrid perovskite, materials with improved photovoltaic efficiencies as well as the full range of semiconductor materials for solar-to-electricity conversion, from crystalline silicon and amorphous silicon to cadmium telluride, copper indium gallium sulfide selenides, dye sensitized solar cells, organic solar cells, and environmentally-friendly copper zinc tin sulfide selenides.

## Future of solar photovoltaic

**International Renewable Energy Agency (IRENA)** This study presents options to fully unlock the world's vast solar PV potential over the period until 2050. It builds on IRENA's global roadmap to scale up renewables and meet climate goals.

## Solar Silicon Processes

## Technologies, Challenges, and Opportunities

**CRC Press** Polycrystalline silicon (commonly called "polysilicon") is the material of choice for photovoltaic (PV) applications. Polysilicon is the purest synthetic material on the market, though its processing through gas purification and decomposition (commonly called "Siemens" process) carries high environmental risk. While many current optoelectronic applications require high purity, PV applications do not and therefore alternate processes and materials are being explored for PV grade silicon. *Solar Silicon Processes: Technologies, Challenges, and Opportunities* reviews current and potential future processing technologies for PV applications of solar silicon. It describes alternative processes and issues of material purity, cost, and environmental impact. It covers limits of silicon use with respect to high-efficiency solar cells and challenges arising from R&D activities. The book also defines purity requirements and purification processes of metallurgical grade silicon (MG-Si) and examines production of solar grade silicon by novel processes directly from MG-Si and/or by decomposition of silane gas in a fluidized bed reactor (FBR). Furthermore, the book: Analyzes past research and industrial development of low-cost silicon processes in view of understanding future trends in this field. Discusses challenges and probability of success of various solar silicon processes. Covers processes that are more environmentally sensitive. Describes limits of silicon use with respect to high-efficiency solar cells and challenges arising from R&D activities. Defines purity requirements and purification processes of MG-Si. Examines production of solar grade silicon directly from MG-Si.

## Fundamentals and Applications of Nano Silicon in Plasmonics and Fullerines

## Current and Future Trends

**Elsevier** *Fundamentals and Applications of Nano Silicon in Plasmonics and Fullerines: Current and Future Trends* addresses current and future trends in the application and commercialization of nanosilicon. The book presents current, innovative and prospective applications and products based on nanosilicon and their binary system in the fields of energy harvesting and storage, lighting (solar cells and nano-capacitor and fuel cell devices and nanoLEDs), electronics (nanotransistors and nanomemory, quantum computing, photodetectors for space applications; biomedicine (substance detection, plasmonic treatment of disease, skin and hair care, implantable glucose sensor, capsules for drug delivery and underground water and oil exploration), and art (glass and pottery). Moreover, the book includes material on the use of advanced laser and proximal probes for imaging and manipulation of nanoparticles and atoms. In addition, coverage is given to carbon and how it contrasts and integrates with silicon with additional related applications. This is a valuable resource to all those seeking to learn more about the commercialization of nanosilicon, and to researchers wanting to learn more about emerging nanosilicon applications. Features a variety of designs and operation of nano-devices, helping engineers to make the best use of nanosilicon Contains underlying principles of how nanomaterials work and the variety of applications they provide, giving those new to nanosilicon a fundamental understanding Assesses the viability of various nanosilicon devices for mass production and commercialization, thereby providing an important source of information for engineers

## Optoelectronics

## Advanced Device Structures

**BoD - Books on Demand** *Optoelectronics - Advanced Device Structures (Book IV)* is following the *Optoelectronics (Books I, II, and III)* published in 2011, 2013, and 2015, as part of the InTech collection of international works on optoelectronics. Accordingly, as with the first three books of the collection, this book covers recent achievements by specialists around the world. The growing number of countries participating in this endeavor as well as joint participation of the US and Moldova scientists in edition of this book testifies to the unifying effect of science. An interested reader will find in the book the description of properties and applications employing organic and inorganic materials, as well as the methods of fabrication and analysis of operation and regions of application of modern optoelectronic devices.

## Thin-Film Silicon Solar Cells

**EPFL Press** This text provides a comprehensive treatment of thin-film silicon as a semiconductor material. Beginning with fundamental physical properties, it concentrates on device applications, solar cells in particular. Intended for students & professional scientists, it presents the concepts required for understanding thin-film electronics.

## Perovskite Photovoltaics

### Basic to Advanced Concepts and Implementation

**Academic Press** *Perovskite Photovoltaics: Basic to Advanced Concepts and Implementation* examines the emergence of perovskite photovoltaics, associated challenges and opportunities, and how to achieve broader development. Consolidating developments in perovskite photovoltaics, including recent progress solar cells, this text also highlights advances and the research necessary for sustaining energy. Addressing different photovoltaics fields with tailored content for what makes perovskite solar cells suitable, and including commercialization examples of large-scale perovskite solar technology. The book also contains a detailed analysis of the implementation and economic viability of perovskite solar cells, highlighting what photovoltaic devices need to be generated by low cost, non-toxic, earth abundant materials using environmentally scalable processes. This book is a valuable resource engineers, scientists and researchers, and all those who wish to broaden their knowledge on flexible perovskite solar cells. Includes contributions by leading solar cell academics, industrialists, researchers and institutions across the globe Addresses different photovoltaics fields with tailored content for what makes perovskite solar cells different Provides commercialization examples of large-scale perovskite solar technology, giving users detailed analysis on the implementation, technical challenges and economic viability of perovskite solar cells

## Solar Cells

### Theory, Materials and Recent Advances

**BoD - Books on Demand** Solar cell energy is the single most pressing issue facing humanity, with a more technologically advanced society requiring better energy resources. This book discusses technologies broadly, depending on how they capture and distribute solar energy or convert it into solar power. The major areas covered in this book are: • The theory of solar cells, which explains the conversion of light energy in photons into electric current. The theoretical studies are practical because they predict the fundamental limits of a solar cell. • The design and development of thin-film technology-based solar cells. • State of the art for bulk material applied for solar cells based on crystalline silicon (c-Si), also known as "solar grade silicon," and emerging photovoltaics.

## Sustainable Material Solutions for Solar Energy Technologies

### Processing Techniques and Applications

**Elsevier** *Sustainable Material Solutions for Solar Energy Technologies: Processing Techniques and Applications* provides an overview of challenges that must be addressed to efficiently utilize solar energy. The book explores novel materials and device architectures that have been developed to optimize energy conversion efficiencies and minimize environmental impacts. Advances in technologies for harnessing solar energy are extensively discussed, with topics including materials processing, device fabrication, sustainability of materials and manufacturing, and current state-of-the-art. Leading international experts discuss the applications, challenges, and future prospects of research in this increasingly vital field, providing a valuable resource for students and researchers working in this field. Explores the fundamentals of sustainable materials for solar energy applications, with in-depth discussions of the most promising material solutions for solar energy technologies: photocatalysis, photovoltaic, hydrogen production, harvesting and storage Discusses the environmental challenges to be overcome and importance of efficient materials utilization for clean energy Looks at design materials processing and optimization of device fabrication via metrics such as power-to-weight ratio, effectiveness at EOL compared to BOL, and life-cycle analysis

## Crystalline Silicon

### Properties and Uses

**BoD - Books on Demand** The exciting world of crystalline silicon is the source of the spectacular advancement of discrete electronic devices and solar cells. The exploitation of ever changing properties of crystalline silicon with dimensional transformation may indicate more innovative silicon based technologies in near future. For example, the discovery of nanocrystalline silicon has largely overcome the obstacles of using silicon as optoelectronic material. The further research and development is necessary to find out the treasures hidden within this material. The book presents different forms of silicon material, their preparation and properties. The modern techniques to study the surface and interface defect states, dislocations, and so on, in different crystalline forms have been highlighted in this book. This book presents basic and applied aspects of different crystalline forms of silicon in wide range of information from materials to devices.

## Silicon Heterojunction Solar Cells

**Trans Tech Publications Ltd** The world of today must face up to two contradictory energy problems: on the one hand, there is the sharply growing consumer demand in countries such as China and India. On the other hand, natural resources are dwindling. Moreover, many of those countries which still possess substantial gas and oil supplies are politically unstable. As a result, renewable natural energy sources have received great attention. Among these, solar-cell technology is one of the most promising candidates. However, there still remains the problem of the manufacturing costs of such cells. Many attempts have been made to reduce the production costs of [conventional] solar cells (manufactured from monocrystalline silicon using diffusion methods) by instead using cheaper grades of silicon, and simpler pn-junction fabrication. That is the [hero] of this book; the heterojunction solar cell.

## Silicon Based Thin Film Solar Cells

**Bentham Science Publishers** *Silicon Based Thin Film Solar Cells* explains concepts related to technologies for silicon (Si) based photovoltaic applications. Topics in this book focus on 'new concept' solar cells. These kinds of cells can make photovoltaic power production an economically viable option in comparison to the bulk crystalline semiconductor technology industry. A transition from bulk crystalline Si solar cells toward thin-film technologies reduces usage of active material and introduces new concepts based on nanotechnologies. Despite its importance, the scientific development and understanding of new solar cells is not very advanced, and educational resources for specialized engineers and scientists are required. This textbook presents the fundamental scientific aspects of Si thin films growth technology, together with a clear understanding of the properties of the material and how this is employed in new generation photovoltaic solar cells. The textbook is a valuable resource for graduate students working on their theses, young researchers and all people approaching problems and fundamental aspects of advanced photovoltaic conversion.

## Photovoltaic Solar Energy

### From Fundamentals to Applications

**John Wiley & Sons** *Solar PV* is now the third most important renewable energy source, after hydro and wind power, in terms of global installed capacity. Bringing together the expertise of international PV specialists *Photovoltaic Solar Energy: From Fundamentals to Applications* provides a comprehensive and up-to-date account of existing PV technologies in conjunction with an assessment of technological developments. Key features: Written by leading specialists active in concurrent developments in material sciences, solar cell research and application-driven R&D. Provides a basic knowledge base in light, photons and solar irradiance and basic functional principles of PV. Covers characterization techniques, economics and applications of PV such as silicon, thin-film and hybrid solar cells. Presents a compendium of PV technologies including: crystalline silicon technologies; chalcogenide thin film solar cells; thin-film silicon based PV technologies; organic PV and III-Vs; PV concentrator technologies; space technologies and economics, life-cycle and user aspects of PV technologies. Each chapter presents basic principles and formulas as well as major technological developments in a contemporary context with a look at future developments in this rapidly changing field of science and engineering. Ideal for industrial engineers and scientists beginning careers in PV as well as graduate students undertaking PV research and high-level undergraduate students.

## Solar Panels and Photovoltaic Materials

**BoD - Books on Demand** 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.

## Emerging Solar Energy Materials

**BoD - Books on Demand** This book provides the fundamental understanding of the functioning of solar cells and the materials for the effective utilization of energy resources. The main objective of writing this book is to create a comprehensive and easy-to-understand source of information on the advances in the rapidly growing research on solar cells. Emerging Solar Energy Materials comprises 12 chapters written by the experts in the solar cell field and is organized with the intention to provide a big picture of the latest progress in the solar cell field and at the same time give an in-depth discussion on fundamentals of solar cells for interested audiences. In this book, each part opens with a new author's essay highlighting their work for contribution toward solar energy. Critical, cutting-edge subjects are addressed, including: Photovoltaic device technology and energy applications; Functional solar energy materials; New concept in solar energy; Perovskite solar cells; Dye-sensitized solar cells; Organic solar cells; Thin-film solar cells. The book is written for a large and broad readership including researchers and university graduate students from diverse backgrounds such as chemistry, physics, materials science, and photovoltaic device technology. The book includes enough information on the basics to be used as a textbook undergraduate coursework in engineering and the sciences.

## Advanced Energy Materials

**John Wiley & Sons** An essential resource for scientists designing new energy materials for the vast landscape of solar energy conversion as well as materials processing and characterization Based on the new and fundamental research on novel energy materials with tailor-made photonic properties, the role of materials engineering has been to provide much needed support in the development of photovoltaic devices. Advanced Energy Materials offers a unique, state-of-the-art look at the new world of novel energy materials science, shedding light on the subject's vast multi-disciplinary approach. The book focuses particularly on photovoltaics, efficient light sources, fuel cells, energy-saving technologies, energy storage technologies, nanostructured materials as well as innovating materials and techniques for future nanoscale electronics. Pathways to future development are also discussed. Critical, cutting-edge subjects are addressed, including: Non-imaging focusing heliostat; state-of-the-art of nanostructures Metal oxide semiconductors and their nanocomposites Superionic solids; polymer nanocomposites; solid electrolytes; advanced electronics Electronic and optical properties of lead sulfide High-electron mobility transistors and light-emitting diodes Anti-ferroelectric liquid crystals; PEEK membrane for fuel cells Advanced phosphors for energy-efficient lighting Molecular computation photovoltaics and photocatalysts Photovoltaic device technology and non-conventional energy applications Readership The book is written for a large and broad readership including researchers and university graduate students from diverse backgrounds such as chemistry, materials science, physics, and engineering working in the fields of nanotechnology, photovoltaic device technology, and non-conventional energy.

## Atomic Layer Deposition in Energy Conversion Applications

**John Wiley & Sons** Combining the two topics for the first time, this book begins with an introduction to the recent challenges in energy conversion devices from a materials preparation perspective and how they can be overcome by using atomic layer deposition (ALD). By bridging these subjects it helps ALD specialists to understand the requirements within the energy conversion field, and researchers in energy conversion to become acquainted with the opportunities offered by ALD. With its main focus on applications of ALD for photovoltaics, electrochemical energy storage, and photo- and electrochemical devices, this is important reading for materials scientists, surface chemists, electrochemists, electrotechnicians, physicists, and those working in the semiconductor industry.

## Silicon Carbide Technology for Advanced Human Healthcare Applications

**Elsevier** After over two decades of focused research and development, silicon carbide (SiC) is now ready for use in the healthcare sector and Silicon Carbide Technology for Advanced Human Healthcare Applications provides an up-to-date assessment of SiC devices for long-term human use. It explores a plethora of applications that SiC is uniquely positioned for in human healthcare, beginning with the three primary areas of technology which are closest to human trials and thus adoption in the healthcare industry: neural implants and spinal cord repair, graphene and biosensors, and finally deep tissue cancer therapy using SiC nanotechnology. Biomedical-inspired engineers, scientists, and healthcare professionals will find this book to be very useful in two ways: (I) as a guide to new ways to design and develop advanced medical devices and (II) as a reference for new developments in the field. The book's intent is to stimulate ideas for further technological enhancements and breakthroughs, which will provide alternative solutions for human healthcare applications. Discusses the utilization of SiC materials for biomedical applications Provides a logical pathway to understand why SiC is ideal for several critical applications, in particular for long-term implantable devices, and will serve as a guide to new ways to design and develop advanced medical devices Serves as a reference for new developments in the field and as a technology resource for medical doctors and practitioners looking to identify and implement advanced engineering solutions to everyday medical challenges that currently lack long-term, cost-effective solutions

## Handbook of Photovoltaic Silicon

"Updated content will continue to be published as 'Living Reference Works'"--Publisher.

## Functional Materials for Sustainable Energy Applications

**Elsevier** Global demand for low cost, efficient and sustainable energy production is ever increasing. Driven by recent discoveries and innovation in the science and technology of materials, applications based on functional materials are becoming increasingly important. Functional materials for sustainable energy applications provides an essential guide to the development and application of these materials in sustainable energy production. Part one reviews functional materials for solar power, including silicon-based, thin-film, and dye sensitized photovoltaic solar cells, thermophotovoltaic device modelling and photoelectrochemical cells. Part two focuses on functional materials for hydrogen production and storage. Functional materials for fuel cells are then explored in part three where developments in membranes, catalysts and membrane electrode assemblies for polymer electrolyte and direct methanol fuel cells are discussed, alongside electrolytes and ion conductors, novel cathodes, anodes, thin films and proton conductors for solid oxide fuel cells. Part four considers functional materials for demand reduction and energy storage, before the book concludes in part five with an investigation into computer simulation studies of functional materials. With its distinguished editors and international team of expert contributors, Functional materials for sustainable energy applications is an indispensable tool for anyone involved in the research, development, manufacture and application of materials for sustainable energy production, including materials engineers, scientists and academics in the rapidly developing, interdisciplinary field of sustainable energy. An essential guide to the development and application of functional materials in sustainable energy production Reviews functional materials for solar power Focuses on functional materials for hydrogen production and storage, fuel cells, demand reduction and energy storage

## Eco- and Renewable Energy Materials

**Springer** "Eco- and Renewable Energy Materials" provides a survey of the current topics and the major developmental trends in the rapidly growing research area of clean energy materials. This book covers, but is not limited to, photochemical materials (fuels from light), fuel cells (electricity from fuels), batteries (electricity storage), and hydrogen production and storage. This book is intended as a vehicle for the dissemination of research results on energy-based material science in the form of commissioned reviews and commentaries. This book is for scientists and engineers interested in energy-related materials, compounds and electronic devices. Prof. Yong Zhou is currently serving as a full professor at the Eco-Materials and Renewable Energy Research Center (ERERC), Nanjing University, China.

## Advanced Materials for Agriculture, Food, and Environmental Safety

**John Wiley & Sons** The book focuses on the role of advanced materials in the food, water and environmental applications. The monitoring of harmful organisms and toxicants in water, food and beverages is mainly discussed in the respective chapters. The senior contributors write on the following topics: Layered double hydroxides and environment Corrosion resistance of aluminium alloys of silanes New generation material for the removal of arsenic from water Prediction and optimization of heavy clay products quality Enhancement of physical and mechanical properties of fiber Environment friendly acrylates latices Nanoparticles for trace analysis of toxins Recent development on gold nanomaterial as catalyst Nanosized metal oxide based adsorbents for heavy metal removal Phytosynthesized transition metal nanoparticles- novel functional agents for textiles Kinetics and equilibrium modeling Magnetic nanoparticles for heavy metal removal Potential applications of nanoparticles as antipathogens Gas barrier properties of biopolymer based nanocomposites: Application in food packing Application of zero-valent iron nanoparticles for environmental clean up Environmental application of novel TiO<sub>2</sub> nanoparticles

## Photovoltaic and Photoactive Materials

## Properties, Technology and Applications

**Springer Science & Business Media** The primary objective of this NATO Advanced Study Institute (ASI) was to present an up-to-date overview of various current areas of interest in the field of photovoltaic and related photoactive materials. This is a wide-ranging subject area, of significant commercial and environmental interest, and involves major contributions from the disciplines of physics, chemistry, materials, electrical and instrumentation engineering, commercial realisation etc. Therefore, we sought to adopt an interdisciplinary approach, bringing together recognised experts in the

various fields while retaining a level of treatment accessible to those active in specific individual areas of research and development. The lecture programme commenced with overviews of the present relevance and historical development of the subject area, plus an introduction to various underlying physical principles of importance to the materials and devices to be addressed in later lectures. Building upon this, the ASI then progressed to more detailed aspects of the subject area. We were also fortunately able to obtain a contribution from Thierry Langlois d'Estaintot of the European Commission Directorate, describing present and future EC support for activities in this field. In addition, poster sessions were held throughout the meeting, to allow participants to present and discuss their current activities. These were supported by what proved to be very effective feedback sessions (special thanks to Martin Stutzmann), prior to which groups of participants enthusiastically met (often in the bar) to identify and agree topics of common interest.

## Advanced Functional Materials

**John Wiley & Sons** Because of their unique properties (size, shape, and surface functions), functional materials are gaining significant attention in the areas of energy conversion and storage, sensing, electronics, photonics, and biomedicine. Within the chapters of this book written by well-known researchers, one will find the range of methods that have been developed for preparation and functionalization of organic, inorganic and hybrid structures which are the necessary building blocks for the architecture of various advanced functional materials. The book discusses these innovative methodologies and research strategies, as well as provides a comprehensive and detailed overview of the cutting-edge research on the processing, properties and technology developments of advanced functional materials and their applications. Specifically, *Advanced Functional Materials: Compiles the objectives related to functional materials and provides detailed reviews of fundamentals, novel production methods, and frontiers of functional materials, including metallic oxides, conducting polymers, carbon nanotubes, discotic liquid crystalline dimers, calixarenes, crown ethers, chitosan and graphene. Discusses the production and characterization of these materials, while mentioning recent approaches developed as well as their uses and applications for sensitive chemiresistors, optical and electronic materials, solar hydrogen generation, supercapacitors, display and organic light-emitting diodes, functional adsorbents, and antimicrobial and biocompatible layer formation. This volume in the Advanced Materials Book Series includes twelve chapters divided into two main areas: Part 1: Functional Metal Oxides: Architecture, Design and Applications and Part 2: Multifunctional Hybrid Materials: Fundamentals and Frontiers*

## Solar Cells

## Materials, Manufacture and Operation

**Academic Press** Enormous leaps forward in the efficiency and the economy of solar cells are being made at a furious pace. New materials and manufacturing processes have opened up new realms of possibility for the application of solar cells. Crystalline silicon cells are increasingly making way for thin film cells, which are spawning experimentation with third-generation high-efficiency multijunction cells, carbon-nanotube based cells, UV light for voltage enhancement, and the use of the infrared spectrum for night-time operation, to name only a few recent advances. This thoroughly updated new edition of Markvart and Castaner's *Solar Cells*, extracted from their industry standard *Practical Handbook of Photovoltaics*, is the definitive reference covering the science and operation, materials and manufacture of solar cells. It is essential reading for engineers, installers, designers, and policy-makers who need to understand the science behind the solar cells of today, and tomorrow, in order to take solar energy to the next level. A thorough update to the definitive reference to solar cells, created by a cast of international experts from industry and academia to ensure the highest quality information from multiple perspectives. Covers the whole spectrum of solar cell information, from basic scientific background, to the latest advances in materials, to manufacturing issues, to testing and calibration. Case studies, practical examples and reports on the latest advances take the new edition of this amazing resource beyond a simple amalgamation of a vast amount of knowledge, into the realm of real world applications

## Solar Cells

## From Materials to Device Technology

**Springer Nature** This book addresses the rapidly developing class of solar cell materials and designed to provide much needed information on the fundamental principles of these materials, together with how these are employed in photovoltaic applications. A special emphasize have been given for the space applications through study of radiation tolerant solar cells. This book present a comprehensive research outlining progress on the synthesis, fabrication and application of solar cells from fundamental to device technology and is helpful for graduate students, researchers, and technologists engaged in research and development of materials.

## Recent Developments in Photovoltaic Materials and Devices

**BoD - Books on Demand** This book covers the recent advances in solar photovoltaic materials and their innovative applications. Many problems in material science are explored for enhancing the understanding of solar cells and the development of more efficient, less costly, and more stable cells. This book is crucial and relevant at this juncture and provides a historical overview focusing primarily on the exciting developments in the last decade. This book primarily covers the different Maximum Power Point Tracking control techniques that have led to the improved speed of response of solar photovoltaics, augmented search accuracy, and superior control in the presence of perturbations such as sudden variations in illumination and temperature. Furthermore, the optimal design of a photovoltaic system based on two different approaches such as consumed power and economics is discussed.

## Thin Film Solar Cells

## Fabrication, Characterization and Applications

**John Wiley & Sons** Thin-film solar cells are either emerging or about to emerge from the research laboratory to become commercially available devices finding practical various applications. Currently no textbook outlining the basic theoretical background, methods of fabrication and applications currently exist. Thus, this book aims to present for the first time an in-depth overview of this topic covering a broad range of thin-film solar cell technologies including both organic and inorganic materials, presented in a systematic fashion, by the scientific leaders in the respective domains. It covers a broad range of related topics, from physical principles to design, fabrication, characterization, and applications of novel photovoltaic devices.

## Handbook of Photovoltaic Science and Engineering

**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.

## Practical Handbook of Photovoltaics

## Fundamentals and Applications

**Academic Press** As part of the growing sustainable and renewable energy movement, the design, manufacture and use of photovoltaic devices is increasing in pace and frequency. The *Handbook of Photovoltaics* will be a 'benchmark' publication for those involved in the design, manufacture and use of these devices. The *Handbook* covers the principles of solar cell function, the raw materials, photovoltaic systems, standards, calibration, testing, economics and case studies. The editors have assembled a cast of internationally-respected contributors from industry and academia. The report is essential reading for: Physicists, electronic engineers, designers of systems, installers, architects, policy-makers relating to photovoltaics. A thorough update to the 'benchmark' publication from a cast of industrial and academic international experts ensures top quality information from multiple stakeholder perspectives. Covers all things PV- from principles of solar cells and their raw materials, to the installation and design of full PV systems, including standards, testing, economics and environmental impacts Case studies, practical examples and reports on the latest advances take the new edition of this amazing resource beyond a vast collection of knowledge, into the realm of real world applications

## The Power of Renewables

## Opportunities and Challenges for China and the United States

**National Academies Press** *The United States and China are the world's top two energy consumers and, as of 2010, the two largest economies. Consequently, they have a decisive role to play in the world's clean energy future. Both countries are also motivated by related goals, namely diversified energy portfolios, job creation, energy security, and pollution reduction, making renewable energy development an important strategy with wide-ranging implications. Given the size of their energy markets, any substantial progress the two countries make in advancing use of renewable energy will provide global benefits, in terms of enhanced technological understanding, reduced costs through expanded deployment, and reduced greenhouse gas (GHG) emissions relative to conventional generation from fossil fuels. Within this context, the U.S. National Academies, in collaboration with the Chinese Academy of Sciences (CAS) and Chinese Academy of Engineering (CAE), reviewed renewable energy development and deployment in the two countries, to highlight prospects for collaboration across the research to deployment chain and to suggest strategies which would promote more rapid and economical attainment of renewable energy goals. Main findings and concerning renewable resource assessments, technology development, environmental impacts, market infrastructure, among others, are presented. Specific recommendations have been limited to those judged to be most likely to accelerate the pace of deployment, increase cost-competitiveness, or shape the future market for renewable energy. The recommendations presented here are also pragmatic and achievable.*

## Spectroscopic Ellipsometry for Photovoltaics

### Volume 1: Fundamental Principles and Solar Cell Characterization

**Springer** *This book provides a basic understanding of spectroscopic ellipsometry, with a focus on characterization methods of a broad range of solar cell materials/devices, from traditional solar cell materials (Si, CuInGaSe<sub>2</sub>, and CdTe) to more advanced emerging materials (Cu<sub>2</sub>ZnSnSe<sub>4</sub>, organics, and hybrid perovskites), fulfilling a critical need in the photovoltaic community. The book describes optical constants of a variety of semiconductor light absorbers, transparent conductive oxides and metals that are vital for the interpretation of solar cell characteristics and device simulations. It is divided into four parts: fundamental principles of ellipsometry; characterization of solar cell materials/structures; ellipsometry applications including optical simulations of solar cell devices and online monitoring of film processing; and the optical constants of solar cell component layers.*

## Crystalline Silicon Solar Cells

## Solar PV Power

## Design, Manufacturing and Applications from Sand to Systems

**Academic Press** *Solar PV Power: Design, Manufacturing and Applications from Sand to Systems details developments in the solar cell manufacturing process, including information from system design straight through to the entire value chain of Solar PV Manufacturing. In addition, the book includes aspects of ground mounted grid connected solar PV systems and optimization for solar PV plants, economic analyses, and reliability and performance. The advances and processes of solar product technology and reliability, along with the performance of solar PV plants and operational and maintenance aspects with advance diagnostic techniques are also presented, making this an ideal resource. With rapid change in the manufacturing process, it is crucial for solar cells and solar PV modules to adapt to new developments in solar products, especially with regard to reliability, financial aspects and performance. Includes detailed solar panel module assembly and analysis Offers new concepts for solar PV system design that are presented alongside field related issues and examples Saves time and resources by collecting all pieces of information needed by engineers in the same text*

## Encyclopedia of Renewable and Sustainable Materials

**Elsevier** *Encyclopedia of Renewable and Sustainable Materials provides a comprehensive overview, covering research and development on all aspects of renewable, recyclable and sustainable materials. The use of renewable and sustainable materials in building construction, the automotive sector, energy, textiles and others can create markets for agricultural products and additional revenue streams for farmers, as well as significantly reduce carbon dioxide (CO<sub>2</sub>) emissions, manufacturing energy requirements, manufacturing costs and waste. This book provides researchers, students and professionals in materials science and engineering with tactics and information as they face increasingly complex challenges around the development, selection and use of construction and manufacturing materials. Covers a broad range of topics not available elsewhere in one resource Arranged thematically for ease of navigation Discusses key features on processing, use, application and the environmental benefits of renewable and sustainable materials Contains a special focus on sustainability that will lead to the reduction of carbon emissions and enhance protection of the natural environment with regard to sustainable materials*

## Photovoltaic Manufacturing

## Etching, Texturing, and Cleaning

**John Wiley & Sons** *This is the first book on photovoltaic wet processing for silicon wafers, both mono- and multi-crystalline. The comprehensive book provides information to process, equipment, and device engineers and researchers in the solar manufacturing field. The authors of the chapters are world-class researchers and experts in their field of endeavor. The fundamentals of wet processing chemistry are introduced, covering etching, texturing, cleaning and metrology. New developments, innovative approaches, as well as current challenges are presented. A detailed discussion of black silicon is provided.*

## Advances in Energy Materials

**Springer Nature** *This book presents recent advances in experimental and theoretical research on energy materials, focusing on materials that can potentially be used in the production of solar cells, hydrogen and energy storage devices. It discusses in detail the latest synthetic methods, processes, characterization methods and applications of materials like perovskite materials, metal sulfides, nanomaterials, and two-dimensional, transition metal dichalcogenides.*