Solar Cell Simulation

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High Efficiency Amorphous Silicon Thin Film Solar Cells - Nowshad Amin 2014-06-11
The conversion efficiency of a solar cell can substantially be increased by improved material properties and associated designs. In this book, it has been shown that how the parametric optimization can lead to successful design of amorphous silicon thin film solar cells by using a software called AMPS-1D (Analysis of Microelectronic and Photonic Structures) prior to fabrication. Solar cells of single junction based on hydrogenated amorphous (a-Si: H) have been analyzed by using AMPS-1D simulator. The efficiency of single junction a-Si: H can be achieved as high as over 19% after parametric optimization in the simulation. Therefore, the numerically designed and optimized a-SiC: H/a-SiC: H-buffer/a-Si: H/a-Si: H solar cells have been fabricated by using PECVD (plasma enhanced chemical vapor deposition) where the best initial conversion efficiency of 10.02% has been achieved (Voc= 0.88 V, Jsc= 15.57 mA/cm2 and FF= 0.73) as one of the highest recorded efficiency to
Solar Cells and Light Management - Francesco Enrichi 2019-10-29
Solar Cells and Light Management: Materials, Strategies and Sustainability provides an extensive review on the latest advances in PV materials, along with light management strategies for better exploiting the solar spectrum. Following a brief review of the current status of solar cells, the book discusses different concepts, principles and technologies for solar devices, starting with standard silicon cells and then covering organic-hybrid, DSSC, perovskite, quantum dots and nanostructured oxide solar cells. Other sections focus on light manipulation and spectral modification, materials for spectral conversion, and environmental and sustainably considerations. An emergy analysis, which is an extension of the Life Cycle Assessment methodology, is applied to the study of solar PV systems, thus allowing for effective integrated indicators. Provides a comprehensive picture of light management strategies Features the most recent advances in the field, including novel materials and advanced solar cell technologies Presents a resource that is applicable to both new or experienced researchers in the field Contains a section on environmental and sustainability issues
Modelling Photovoltaic Systems Using PSpice - Luis Castañer 2003-03-07
Photovoltaics, the direct conversion of light from the sun into electricity, is an increasingly important means of distributed power generation. The SPICE modelling tool is typically used in the development of electrical and electronic circuits. When applied to the modelling of PV systems it provides a means of understanding and evaluating the performance of solar cells and systems. The majority of books currently on the market are based around discussion of the solar cell as semiconductor devices rather than as a system to be modelled and applied to real-world problems. Castaner and Silvestre provide a comprehensive treatment of PV system technology analysis. Using SPICE, the tool of choice for circuits and electronics designers, this book highlights the increasing importance of modelling techniques in the quantitative analysis of PV systems. This unique treatment presents both students and professional engineers, with the means to understand, evaluate and develop their own PV modules and systems. * Provides a unique, self-contained, guide to the modelling and design of PV systems * Presents a practical, application oriented approach to PV technology, something that is missing from the current literature * Uses the widely known SPICE circuit-modelling tool to analyse and simulate the performance of PV modules for the first time * Written by respected and well-known academics in the field
Computing and Simulation for Engineers - Ziya Uddin 2022-06-29
This book presents the reader with comprehensive insight into various kinds of mathematical modeling and numerical computation for problems arising in several branches of engineering, such as mechanical engineering, computer science engineering, electrical engineering, electronics and communication engineering, and civil engineering. The book: • Discusses topics related to clean and green energy production and storage • Bridges the gap between core theory and costly industrial experiments • Covers advanced biomechanics and nanodrug delivery topics • Explores diversified applications of mathematical techniques to solve practical engineering problems The text in this book emphasizes mathematical treatment of soft computing, image and signal processing, fluid flows in various geometries, biomechanics, biological modeling, a mathematical description of the solar cell, analytical and numerical treatment of problems in fracture mechanics, and antenna design modeling. It also discusses the numerical computations of biomechanics problems and problems arising in cryptography. The text further covers optimization techniques that are useful for real-world problems. This material is primarily written for graduate students and academic researchers in a number of engineering fields, including electrical, electronics and communication, industrial, manufacturing, mechanical, computer science, and mathematics.
Solar Energy - Radu Rugescu 2010-02-01
The present “Solar Energy” science book hopefully opens a series of other first-hand texts in new technologies with practical impact and subsequent interest. They might include the ecological combustion of fossil fuels, space technology in the benefit of local and remote communities, new trends in the development of secure Internet Communications on an interplanetary scale, new breakthroughs in the propulsion technology and others. The editors will be pleased to see that the present book is open to debate and they will wait for the readers’ reaction with great interest. Critics and proposals will be equally welcomed.
Organic Solar Cells - Wolfgang Tress 2016-08-23
This book covers in a textbook-like fashion the basics or organic solar cells, addressing the limits of photovoltaic energy conversion and giving a well-illustrated introduction to molecular electronics with focus on the working principle and characterization of organic solar cells. Further chapters based on the author’s dissertation focus on the electrical processes in organic solar cells by presenting a detailed drift-diffusion approach to describe exciton separation and charge-carrier transport and extraction. The results, although elaborated on small-molecule solar cells and with focus on the zinc phthalocyanine: C60 material system, are of general nature. They propose and demonstrate experimental approaches for getting a deeper understanding of the dominating processes in amorphous thin-film based solar cells in general. The main focus is on the interpretation of the current-voltage characteristics (J-V curve). This very standard measurement technique for a solar cell reflects the electrical processes in the device. Comparing experimental to simulation data, the author discusses the reasons for S-Shaped J-V curves, the role of charge carrier mobilities and energy barriers at interfaces, the dominating recombination mechanisms, the charge carrier generation profile, and other efficiency-limiting processes in organic solar cells. The book concludes with an illustrative guideline on how to identify reasons for changes in the J-V curve. This book is a suitable introduction for students in engineering, physics, material science, and chemistry starting in the field of organic or hybrid thin-film photovoltaics. It is just as valuable for professionals and experimentalists

who analyze solar cell devices.

Thin Film Solar Cells From Earth Abundant Materials - Subba Ramaiah Kodigala 2013-11-14

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

Optimization of Photovoltaic Power Systems - Djamila Rekioua 2012-01-03

Photovoltaic generation is one of the cleanest forms of energy conversion available. One of the advantages offered by solar energy is its potential to provide sustainable electricity in areas not served by the conventional power grid. Optimisation of Photovoltaic Power Systems details explicit modelling, control and optimisation of the most popular stand-alone applications such as pumping, power supply, and desalination. Each section is concluded by an example using the MATLAB® and Simulink® packages to help the reader understand and evaluate the performance of different photovoltaic systems. Optimisation of Photovoltaic Power Systems provides engineers, graduate and postgraduate students with the means to understand, assess and develop their own photovoltaic systems. As such, it is an essential tool for all those wishing to specialise in stand-alone photovoltaic systems. Optimisation of Photovoltaic Power Systems aims to enable all researchers in the field of electrical engineering to thoroughly understand the concepts of photovoltaic systems; find solutions to their problems; and choose the appropriate mathematical model for optimising photovoltaic energy.

Optical Modeling and Simulation of Thin-Film Photovoltaic Devices - Janez Krc 2013-04-05

In wafer-based and thin-film photovoltaic (PV) devices, the management of light is a crucial aspect of optimization since trapping sunlight in active parts of PV devices is essential for efficient energy conversions. Optical modeling and simulation enable efficient analysis and optimization of the optical situation in optoelectronic and PV devices. Optical Modeling and Simulation of Thin-Film Photovoltaic Devices provides readers with a thorough guide to performing optical modeling and simulations of thin-film solar cells and PV modules. It offers insight on examples of existing optical models, demonstrates the applicability of optical modeling, and presents concrete directions and solutions for improving the devices. Along with giving practical hints, the book highlights significant research, development, and production in the field. It covers numerous approaches of one-, two-, and three-dimensional optical modeling, including one-dimensional semi-coherent modeling and two-dimensional modeling based on the finite element method (FEM). Many practical examples illustrate the use of simulations with the developed models, helping readers better understand and develop their own models as well as appreciate innovative concepts in light management in thin-film PV devices.

Perovskite Solar Cells - Shahzada Ahmad 2022-03-14

Presents a thorough overview of perovskite research, written by leaders in the field of photovoltaics The use of perovskite-structured materials to produce high-efficiency solar cells is a subject of growing interest for academic researchers and industry professionals alike. Due to their excellent light absorption, longevity, and charge-carrier properties, perovskite solar cells show great promise as a low-cost, industry-scalable alternative to conventional photovoltaic cells. Perovskite Solar Cells: Materials, Processes, and Devices provides an up-to-date overview of the current state of perovskite solar cell research. Addressing the key areas in the rapidly growing field, this comprehensive volume covers novel materials, advanced theory, modelling and simulation, device physics, new processes, and the critical issue of solar cell stability. Contributions by an international panel of researchers highlight both the opportunities and challenges related to perovskite solar cells while offering detailed insights on topics such as the photon recycling processes, interfacial properties, and charge transfer principles of perovskite-based devices. Examines new compositions, hole and electron transport materials, lead-free materials, and 2D and 3D materials Covers interface modelling techniques, methods for modelling in two and three dimensions, and developments beyond Shockley-Queisser Theory Discusses new fabrication processes such as slot-die coating, roll processing, and vacuum sublimation Describes the device physics of perovskite solar cells, including recombination kinetics and optical absorption Explores innovative approaches to increase the light conversion efficiency of photovoltaic cells Perovskite Solar Cells: Materials, Processes, and Devices is essential reading for all those in the photovoltaic community, including materials scientists, surface physicists, surface chemists, solid state physicists, solid state chemists, and electrical engineers.

Solution-Processable Components for Organic Electronic Devices - Beata Luszczynska 2019-09-16

Provides first-hand insights into advanced fabrication techniques for solution processable organic electronics materials and devices The field of printable organic electronics has emerged as a technology which plays a major role in materials science research and development. Printable organic electronics soon compete with, and for specific applications can even outpace, conventional semiconductor devices in terms of performance, cost, and versatility. Printing techniques allow for large-scale fabrication of organic electronic components and functional devices for use as wearable electronics, health-care sensors, Internet of Things, monitoring of environment pollution and many others, yet-to-be-conceived applications. The first part of Solution-Processable Components for Organic Electronic Devices covers the synthesis of: soluble conjugated polymers; solution-processable nanoparticles of inorganic semiconductors; high-k nanoparticles by means of controlled radical polymerization; advanced blending techniques yielding novel materials with extraordinary properties. The book also discusses photogeneration of charge carriers in nanostructured bulk heterojunctions and charge carrier transport in multicomponent materials such as composites and nanocomposites as well as photovoltaic devices modelling. The second part of the book is devoted to organic electronic devices, such as field effect transistors, light emitting diodes, photovoltaics, photodiodes and electronic memory devices which can be produced by solution-based methods, including printing and roll-to-roll manufacturing. The book provides in-depth knowledge for experienced researchers and for those entering the field. It comprises 12 chapters focused on: ? novel organic electronics components synthesis and solution-based processing techniques ? advanced analysis of mechanisms governing charge carrier generation and transport in organic semiconductors and devices ? fabrication techniques and characterization methods of organic electronic devices Providing coverage of the state of the art of organic electronics, Solution-Processable Components for Organic Electronic Devices is an excellent book for materials scientists, applied physicists, engineering scientists, and those working in the electronics industry.

The Physics of Solar Cells - Jenny Nelson 2003-05-09

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.

Emerging Photovoltaic Technologies - Carlito S. Ponseca 2019-12-19

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.

Dye-Sensitized Solar Cells - Masoud Soroush 2019-02-23

Dye-Sensitized Solar Cells: Mathematical Modelling and Materials Design and Optimization presents the latest information as edited from leaders in the field. It covers advances in DSSC design, fabrication and mathematical modelling and optimization, providing a comprehensive coverage of various DSSC advances that includes different system scales, from electronic to macroscopic level, and a consolidation of the results with fundamentals. The book is extremely useful as a monograph for graduate students and researchers, but is also a comprehensive, general reference on state-of-the-art techniques in modelling, optimization and design of DSSCs. Includes chapter contributions from worldwide leaders in the field Offers first-principles of modelling solar cells with different system scales, from the electronic to macroscopic level References, in a single resource, state-of-the-art techniques in modelling, optimization and design of DSSC

Photon Management in Solar Cells - Ralf B. Wehrspohn 2015-04-02

Written by renowned experts in the field of photon management in solar cells, this one-stop reference gives an introduction to the physics of light management in solar cells, and discusses the different concepts and methods of applying photon management. The authors cover the physics, principles, concepts, technologies, and methods used, explaining how to increase the efficiency of solar cells by splitting or modifying the solar spectrum before they absorb the sunlight. In so doing, they present novel concepts and materials allowing for the cheaper, more flexible manufacture of solar cells and systems. For educational purposes, the authors have split the reasons for photon management into spatial and spectral light management. Bridging the gap between the photonics and the photovoltaics communities, this is an invaluable reference for materials scientists, physicists in industry, experimental physicists, lecturers in physics, Ph.D. students in physics and material sciences, engineers in power technology, applied and surface physicists.

Spectroscopic Ellipsometry for Photovoltaics - Hiroyuki Fujiwara 2019-01-10

Spectroscopic ellipsometry has been applied to a wide variety of material and device characterizations in solar cell research fields. In particular, device performance analyses using exact optical constants of component layers and direct analyses of complex solar cell structures are unique features of advanced ellipsometry methods. This second volume of Spectroscopic Ellipsometry for Photovoltaics presents various applications of the ellipsometry technique for device analyses, including optical/recombination loss analyses, real-time control and on-line monitoring of solar cell structures, and large-area structural mapping. Furthermore, this book describes the optical constants of 148 solar cell component layers, covering a broad range of materials from semiconductor light absorbers (inorganic, organic and hybrid perovskite semiconductors) to transparent conductive oxides and metals. The tabulated and completely parameterized optical constants described in this book are the most current resource that is vital for device simulations and solar cell structural analyses.

Organic Solar Cells - Qiquan Qiao 2017-12-19

Current energy consumption mainly depends on fossil fuels that are limited and can cause environmental issues such as greenhouse gas emissions and global warming. These factors have stimulated the search for alternate, clean, and renewable energy sources. Solar cells are some of the most promising clean and readily available energy sources. Plus, the successful utilization of solar energy can help reduce the dependence on fossil fuels. Recently, organic solar cells have gained extensive attention as a next-generation photovoltaic technology due to their light weight, mechanical flexibility, and solution-based cost-effective processing. Organic Solar Cells: Materials, Devices, Interfaces, and Modeling provides an in-depth understanding of the current state of the art of organic solar cell technology. Encompassing the full spectrum of organic solar cell materials, modeling and simulation, and device physics and engineering, this comprehensive text: Discusses active layer, interfacial, and transparent electrode materials Explains how to relate synthesis parameters to morphology of the photoactive layer using molecular dynamics simulations Offers insight into coupling morphology and interfaces with charge transport in organic solar cells Explores photoexcited carrier dynamics, defect states, interface engineering, and nanophase separation Covers inorganic–organic hybrids, tandem structure, and graphene-based polymer solar cells Organic Solar Cells: Materials, Devices, Interfaces, and Modeling makes an ideal reference for scientists and engineers as well as researchers and students entering the field from broad disciplines including chemistry, material science and engineering, physics, nanotechnology, nanoscience, and electrical engineering.

Multi-Junction Solar Cell Device Modeling - Khomdram Jolson Singh 2012-08

Manufacturing a solar cell and testing it to determine if it performs as desired is too expensive and time consuming, considering that this process may have to be repeated numerous times until a solar cell is built that produces the desired results. In order to give a real understanding & realization of all the phenomena occurring inside the solar cell devices, the development of a reliable simulated model first is very much essential.In this book, a new detailed method for developing realistic simulation models of advanced solar cells including III-V multi-junction, Thermophotovoltaic & textured ARC cell using device physics, material science and latest TCAD tool is presented.The flexibility of the proposed methodology is clearly demonstrated & the results are verified favorably with similar manufactured cells under the same parameters.The introduction of this realistic and reliable numerical modeling technique will prove to be of great importance in the design & development of advanced and cost effective solar cell.This book will be very helpful to students, research scholars, scientists or industrial experts who are currently working in the field of Photovoltaic cell device modeling.

High-Efficiency Crystalline Silicon Solar Cells - Eun-Chel Cho 2021-01-06

This book is composed of 6 papers. The first paper reports a novel technique for the selective emitter formation by controlling the surface morphology of Si wafers. Selective emitter (SE) technology has attracted renewed attention in the Si solar cell industry to achieve an improved conversion efficiency of passivated-emitter rear-contact (PERC) cells. In the second paper, the temperature dependence of the parameters was compared through the PERC of the industrial-scale solar cells. As a result of their analysis, PERC cells showed different temperature dependence for the fill factor loss as temperatures rose. The third paper reports the effects of carrier selective front contact layer and defect state of hydrogenated amorphous silicon passivation layer/n-type crystalline silicon interface. The results demonstrated the effects of band offset determined by band bending at the interface of the passivation layer and carrier selective front contact layer. In addition, the nc-SiOx: H CSFC layer not only reduces parasitic absorption loss but also has a tunneling effect and field-effect passivation. The fourth paper reports excimer laser annealing of hydrogenated amorphous silicon film for TOPCon solar cell application. This paper analyzes the crystallization of a-Si:H via excimer laser annealing (ELA) and compared this process with conventional thermal annealing. The fifth paper reports the contact mechanism between Ag–Al and Si and the change in contact resistance (Rc) by varying the firing profile. Rc was measured by varying the belt speed and peak temperature of the fast-firing furnace. The sixth paper reports a silicon tandem heterojunction solar cell based on a ZnO/Cu2O subcell and a c-Si bottom subcell using electro-optical numerical modeling. The buffer layer affinity and mobility together with a low conduction band offset for the heterojunction are discussed, as well as spectral properties of the device model.

Electricity from Photovoltaic Solar Cells: Project analysis and integration - 1986

Materials for Solar Cell Technologies II - Inamuddin 2021-06-20

The book presents current R&D and new trends in the field of solar cell technologies. Topics covered include fabrication methods, various types of cell design, versatile applications of solar cells, PEDOT:PSS thermoelectric materials, transparent conducting electrodes, simulation models for solar photovoltaic materials, and hybrid materials for solar cells. Keywords: Optoelectronic Devices, PEDOT:PSS Materials, Nanomaterials, Transparent Electrodes, Hybrid Solar Cell Materials, Simulation Models, Solar Cell Design, Solar Cell Applications.

Quantifying Recombination in CdTe Photovoltaics Using Numerical Simulation of Transient Spectroscopy

Data - Triet Minh Truong 2022
Traditional and thin film photovoltaics are at the forefront of the renewable energy revolution. Investigating how recombination in the device affects its carrier dynamics and ultimately its performance is essential to optimizing the solar cell design. In this work, a one-dimensional numerical COMSOL model is proposed to simulate CdTe solar cells. The relevant physics and mathematical formulas implemented in the model are discussed in detail. The results from the model closely align with the theoretical understanding of semiconductor physics and concur with results from SCAPS, a more well-known, established software. Experimental time-resolved photoluminescence and time-resolved terahertz spectroscopic signals from CdTe photovoltaics were fit with the simulated signal decays to estimate the bulk lifetimes and surface recombination velocities. The fitting provides a better approximation for the recombination parameters than traditional biexponential models and enables the comparison of different processing approaches and their effects on the CdTe samples. To simplify the process of creating the model, an application was designed to automatically define the rigorous mathematical expressions for different photovoltaic architectures, allowing more users to run simulations. The model will serve as a useful predictive tool for evaluating material properties of thin film photovoltaics at laboratory scale and, potentially, industrial scale. The tool also has great potential to assist research and development effort in understanding how changes to processing materials and design influence recombination.
Harvesting Solar Energy - Samson Mil'shtein 2022
This book deals with existing technologies of solar energy conversion as well as novel methods under consideration in academic and commercial R&D sites. The experimental results presented in the work are well crafted by both analytical and first-principle numerical simulations. The book highlights the real potential for economically justified use of solar energy at every household and/or commercial solar farms. The ever-improving methods of thin-film epitaxial growth combined with a better understanding of the sun light absorption and antireflection are highlighted. While there was a period when the material quality was considered to be cornerstone of the conversion efficiency followed by substantial efforts to optimize multiple-cell architecture, it became clear that many old ideas such as variable band gap, multi-junction intrinsic region, as well as solar tracking mechanisms offer new possibilities for improved harvesting of energy. Amplifying the importance of materials selection efficient design of the photo-voltaic elements various aspects of the production cost and the impact on the environment are discussed. In addition, the eligibility of the proposed production technologies in the current photovoltaic market are evaluated and confirmed.
Amorphous and Microcrystalline Silicon Solar Cells: Modeling, Materials and Device Technology - Ruud E.I. Schropp 2016-07-18
Amorphous silicon solar cell technology has evolved considerably since the first amorphous silicon solar cells were made at RCA Laboratories in 1974. Scien tists working in a number of laboratories worldwide have developed improved alloys based on hydrogenated amorphous silicon and microcrystalline silicon. Other scientists have developed new methods for growing these thin films while yet others have developed new photovoltaic (PV) device structures with im proved conversion efficiencies. In the last two years, several companies have constructed multi-megawatt manufacturing plants that can produce large-area, multijunction amorphous silicon PV modules. A growing number of people be lieve that thin-film photovoltaics will be integrated into buildings on a large scale in the next few decades and will be able to make a major contribution to the world's energy needs. In this book, Ruud E. I. Schropp and Miro Zeman provide an authoritative overview of the current status of thin film solar cells based on amorphous and microcrystalline silicon. They review the significant developments that have occurred during the evolution of the technology and also discuss the most im portant recent innovations in the deposition of the materials, the understanding of the physics, and the fabrication and modeling of the devices.
Thin-Film Solar Cells - Yoshihiro Hamakawa 2003-10-23
The first comprehensive book on thin-film solar cells, potentially a key technology for solving the energy production problem in the 21st century in an environmentally friendly way. It covers a wide range of scientific and technological aspects of thin film semiconductors - deposition technologies, growth mechanisms and the basic properties of amorphous and nano-crystalline silicon - as well as the optimum design theory and device physics of high-efficiency solar cells, especially of single-junction and multi-junction solar cells. The development of large-area solar cell modules using single and multi-junction solar cells is also considered. Examples of recent photovoltaic systems are presented and analysed.
Physics and Technology of Amorphous-Crystalline Heterostructure Silicon Solar Cells - Wilfried G. J. H. M. van Sark 2011-11-16
Today’s solar cell multi-GW market is dominated by crystalline silicon (c-Si) wafer technology, however new cell concepts are entering the market. One very promising solar cell design to answer these needs is the silicon hetero-junction solar cell, of which the emitter and back surface field are basically produced by a low temperature growth of ultra-thin layers of amorphous silicon. In this design, amorphous silicon (a-Si:H) constitutes both „emitter“ and „base-contact/back surface field“ on both sides of a thin crystalline silicon wafer-base (c-Si) where the electrons and holes are photogenerated; at the same time, a-Si:H passivates the c-Si surface. Recently, cell efficiencies above 23% have been demonstrated for such solar cells. In this book, the editors present an overview of the state-of-the-art in physics and technology of amorphous-crystalline heterostructure silicon solar cells. The heterojunction concept is introduced, processes and resulting properties of the materials used in the cell and their heterointerfaces are discussed and characterization techniques and simulation tools are presented.
Optical Modeling and Simulation of Thin-Film Photovoltaic Devices - Janez Krc 2016-04-19
In wafer-based and thin-film photovoltaic (PV) devices, the management of light is a crucial aspect of optimization since trapping sunlight in active parts of PV devices is essential for efficient energy conversions. Optical modeling and simulation enable efficient analysis and optimization of the optical situation in optoelectronic and PV devices. Optical Modeling and Simulation of Thin-Film Photovoltaic Devices provides readers with a thorough guide to performing optical modeling and simulations of thin-film solar cells and PV modules. It offers insight on examples of existing optical models, demonstrates the applicability of optical modeling, and presents concrete directions and solutions for improving the devices. Along with giving practical hints, the book highlights significant research, development, and production in the field. It covers numerous approaches of one-, two-, and three-dimensional optical modeling, including one-dimensional semi-coherent modeling and two-dimensional modeling based on the finite element method (FEM). Many practical examples illustrate the use of simulations with the developed models, helping readers better understand and develop their own models as well as appreciate innovative concepts in light management in thin-film PV devices.
Advanced Solar Cell Materials, Technology, Modeling, and Simulation - Fara, Laurentiu 2012-07-31
While measuring the effectiveness of solar cell materials may not always be practical once a device has been created, solar cell modeling may allow researchers to obtain prospective analyses of the internal processes of potential materials prior to their manufacture. Advanced Solar Cell Materials, Technology, Modeling, and Simulation discusses the development and use of modern solar cells made from composite materials. This volume is targeted toward experts from universities and research organizations, as well as young professionals interested in pursuing different subjects regarding advanced solar cells.
Analysis and Simulation of Semiconductor Devices - S. Selberherr 2012-12-06
The invention of semiconductor devices is a fairly recent one, considering classical time scales in human life. The bipolar transistor was announced in 1947, and the MOS transistor, in a practically usable manner, was demonstrated in 1960. From these beginnings the semiconductor device field has grown rapidly. The first integrated circuits, which contained just a few devices, became commercially available in the early 1960s. Immediately thereafter an evolution has taken place so that today, less than 25 years later, the manufacture of integrated circuits with over 400.000 devices per single chip is possible. Coincident with the growth in semiconductor device development, the literature concerning semiconductor device and technology issues has literally exploded. In the last decade about 50.000 papers have been published on these subjects. The advent of so called Very-Large-Scale-Integration (VLSI) has certainly revealed the need for a better understanding of basic device behavior. The miniaturization of the single transistor, which is the major prerequisite for VLSI, nearly led to a breakdown of the classical models of semiconductor devices.
Perovskite Materials - Likun Pan 2016-02-03

The book summarizes the current state of the know-how in the field of perovskite materials: synthesis, characterization, properties, and applications. Most chapters include a review on the actual knowledge and cutting-edge research results. Thus, this book is an essential source of reference for scientists with research fields in energy, physics, chemistry and materials. It is also a suitable reading material for graduate students.

2016 IEEE 43rd Photovoltaic Specialists Conference (PVSC) - IEEE Staff 2016-06-05

scientific and engineering technical conference covering all aspects of photovoltaics materials, devices, systems and reliability

Solar Photovoltaics Engineering. A Power Quality Analysis Using Matlab Simulation Case Studies - Akhil Gupta 2016-10

The solar Photovoltaic (PV) technology is gaining significant levels and is going to contribute a major share of total generated electricity in the coming years. PV technology is becoming a promising alternative source for fossil fuels. However, Power Quality (PQ) is the major concern that occurs between the grid and an end user. Any typical electrical distribution system exhibits a passive characteristic with respect to power flows when power flows from a substation to load. However, with inclusion of solar PV generators, this behaviour tends to be changed. The main characteristics related to PQ, such as voltage level, frequency, power factor and Total Harmonic Distortion (THD), may be affected. This book presents the analysis of PQ with the integration of grid-connected PV systems as distributed generation. The role of Maximum Power Point Tracking (MPPT) technique is investigated through implementing few basic MPPT techniques. Using the Matlab-simulation platform, the analysis of PQ is demonstrated. This analysis is based on real measurements of THD, Voltage levels, Current levels, DC voltage levels, real power and reactive power flows.

Experimental and Simulation Tools for Thin-film Solar Cells - Carmen M. Ruiz 2016

This Spotlight describes the methods used for the optical characterization and design of thin-film solar cells. A description of the cells under study (CdTe, CIGS, CZTS, Perovskite, and organic) is given, followed by coupling experimental and simulation studies in order to improve solar cell performances. A detailed discussion on specific optical tools (ellipsometry, photoluminescence and photoreflectance) is included, and a link between materials and measurements is made by studying the relevant physical principles. Finally, a numerical model is provided that can be used to design the structure of a thin-film solar cell.

Photovoltaic Modeling Handbook - Monika Freunek Müller 2018-10-26

This book provides the reader with a solid understanding of the fundamental modeling of photovoltaic devices. After the material independent limit of photovoltaic conversion, the readers are introduced to the most well-known theory of "classical" silicon modeling. Based on this, for each of the most important PV materials, their performance under different conditions is modeled. This book also covers different modeling approaches, from very fundamental theoretic investigations to applied numeric simulations based on experimental values. The book concludes wth a chapter on the influence of spectral variations. The information is supported by providing the names of simulation software and basic literature to the field. The information in the book gives the user specific application with a solid background in hand, to judge which materials could be appropriate as well as realistic expectations of the performance the devices could achieve.

Modeling, Simulation and Optimization - Biplab Das 2021-03-17

This book includes selected peer-reviewed papers presented at the International Conference on Modeling, Simulation and Optimization, organized by National Institute of Technology, Silchar, Assam, India, during 3–5 August 2020. The book covers topics of modeling, simulation and optimization, including computational modeling and simulation, system modeling and simulation, device/VLSI modeling and simulation, control theory and applications, modeling and simulation of energy system and optimization. The book disseminates various models of diverse systems and includes solutions of emerging challenges of diverse scientific fields.

Handbook of Optoelectronic Device Modeling and Simulation - Joachim Piprek 2017-10-12

Optoelectronic devices are now ubiquitous in our daily lives, from light emitting diodes (LEDs) in many household appliances to solar cells for energy. This handbook shows how we can probe the underlying and highly complex physical processes using modern mathematical models and numerical simulation for optoelectronic device design, analysis, and performance optimization. It reflects the wide availability of powerful computers and advanced commercial software, which have opened the door for non-specialists to perform sophisticated modeling and simulation tasks. The chapters comprise the know-how of more than a hundred experts from all over the world. The handbook is an ideal starting point for beginners but also gives experienced researchers the opportunity to renew and broaden their knowledge in this expanding field.

Modeling and Simulation of Charge Carrier Recombination Dynamics in Cu(In,Ga)Se2 Thin Film Solar Cells - José Fabio López Salas 2018

Solar cells with thin Cu(In,Ga)(S,Se)2 absorber films are well established in the photovoltaics market. They offer an advantage over other thin film technologies thanks to their lower content of elements with high toxicity or low earth abundance like Cd and Te. One approach to further improve the quality of production of these cells is to develop a method of material quality assessment during production that is fast, contactless and non-destructive. Time-resolved photoluminescence (TRPL) measurements offer all these characteristics. This work aims to establish the requirements to extract meaningful information about charge carrier recombination dynamics and solar cell performance parameters from TRPL measurements. To achieve this goal experiments and simulations are carried out. The material parameters are extracted from experiments and then built into the simulation model. Results from experiments also serve as the basis to verify the validity of this model. Parameter variations within the simulations function as one of the main methods in this work to gain deeper physical insight into the processes taking place during TRPL measurements. engl.

The Modeling and Simulation of Photovoltaic Solar Module Using Matlab Simulink - Emad Mohammed 2019-02-12

Scientific Study from the year 2018 in the subject Engineering - Power Engineering, grade: 90, , language: English, abstract: This work is a detailed modeling and simulation of the PV cell and module. It is implemented under MATLAB/Simulink environment; the most used software by researchers and engineers. This model is first drafted in accordance with the fundamentals of semiconductors and the PV cell technology. In other words, the PV module parameters have been selected according to their variation with illumination and temperature. It means that for any type of PV module, one can use this model and determine all the necessary parameters under any new conditions of irradiance and temperature and then obtain the I(V) and P(V) characteristics. This model can be considered as a tool which can be used to study all types of PV modules available in markets, and especially their behavior under different weather data of standard test conditions (STC). The PV module is the interface which converts light into electricity. Modeling this device, necessarily requires taking weather data (irradiance and temperature) as input variables. The output can be current, voltage, power or other. However, trace the characteristics I(V) or P(V) needs of these three variables. Any change in the entries immediately implies changes in outputs. That is why, it is important to use an accurate model for the PV module. The well-known five-parameter model is selected for the present study, and solves using a novel combination technique which integrates an algebraic simultaneous calculation of the parameters at standard test conditions (STC) with an analytical determination of the parameters under real operating conditions. A monocrystalline solar module will be simulated using MATLAB/Simulink software at different ambient temperature and the output power of cell was recorded. Solar Radiation and its effect on power of module is also simulated. Simulation shows that the output power of solar cell get decreased with decrease in sun’s radiation and raising temperature also decreases the output. In addition, the simulation performance of the model will be compared with other models, and further validated by outdoor tests, which indicate that the proposed model fits well the entire set of experimental field test I–V curves of the PV module, especially at the characteristic points.

Silicon Based Thin Film Solar Cells - Roberto Murri 2013-03-20

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.

Advances and Trends in Engineering Sciences and Technologies III - Mohamad Al Ali 2019-03-25

These are the proceedings of the 3rd International Conference on Engineering Sciences and Technologies (ESaT 2018), held from 12th - 14th September 2018 in the High Tatras Mountains, Tatranské Matliare, Slovak Republic. ESaT 2018 was organized under the auspices of the Faculty of Civil Engineering, Technical University of Košice - Slovak Republic in collaboration with Peter the Great St. Petersburg Polytechnic University - Russia after the successful organization with excellent feedback of the previous international conferences ESaT 2015 and ESaT 2016. The proceedings is covering various topics and disciplines in civil engineering sciences, such as Buildings and Architectural Engineering, Bearing Structures, Material and Environmental Engineering, Construction Technology and Management, Building Physics and Facilities, Geodesy, Surveying and Mapping, Geotechnics and Traffic Engineering. The proceedings report on new and original progress and trends in various fields of engineering sciences that will be of interest to a wide range of academics and professionals from university and industry. 116 papers originating from more than 10 countries have been accepted for publication in the conference proceedings. Each accepted paper was reviewed by two reviewers, selected according to the scientific area and orientation of the paper, which guarantees topicality, quality and an advanced level of the presented results.