

Thermal Energy Harvester Ect 100 Perpetuum Development Kit

Energy Harvesting Autonomous Sensor Systems Design, Analysis, and Practical Implementation CRC Press

Comprising two volumes, *Thermoelectrics and Its Energy Harvesting* reviews the dramatic improvements in technology and application of thermoelectric energy with a specific intention to reduce and reuse waste heat and improve novel techniques for the efficient acquisition and use of energy. This volume, *Modules, Systems and Applications in Thermoelectrics*, discusses the practical, novel, and truly groundbreaking applications of thermoelectrics in a range of markets. The book details the U.S. interest in alternative energy and energy harvesting, specifically, the current efforts to use thermoelectric generators (TGs) to reduce emissions. Internationally, it expounds on the strong interest in Japan, Korea and Europe to incorporate TGs in cars to reduce fuel consumption and meet EU carbon dioxide emission targets; the European plans to build an isotopic powered thermoelectric generator; and India's use of TGs in converting hot water from steel mills into electricity.

Metal oxide nanoparticles exhibit potential applications in energy and environmental fields, such as solar cells, fuel cells, hydrogen energy, and energy storage devices. This book covers all points from synthesis, properties, and applications of transition

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metal oxide nanoparticle materials in energy storage and conversion devices. Aimed at graduate-level students and researchers associated with the energy and environment sector, this book addresses the application of nontoxic and environmentally friendly metal oxide materials for a clean environment and deals with synthesis properties and application metal oxides materials for energy conversion, energy storage, and hydrogen generation.

Carbon nanotubes are rolled up graphene sheets with a quasi-one-dimensional structure of nanometer-scale diameter. In these last twenty years, carbon nanotubes have attracted much attention from physicists, chemists, material scientists, and electronic device engineers, because of their excellent structural, electronic, optical, chemical and mechanical properties. More recently, demand for innovative industrial applications of carbon nanotubes is increasing. This book covers recent research topics regarding syntheses techniques of carbon nanotubes and nanotube-based composites, and their applications. The chapters in this book will be helpful to many students, engineers and researchers working in the field of carbon nanotubes.

The concepts presented in this book are some of the new advancements in the design of structural health monitoring systems. It is envisaged that such advancements will lead to smart structural health monitoring that will result in sustainable engineering systems. Sustainability is considered an important objective in today's engineering design due to the current state of climate change and global warming, both of which are

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hugely aggravated by industrial and construction activities. This book presents demonstrations of and applications for new advancements such as infrared thermography, ultrasonic guided waves, and strain sensors, among others. The information presented will encourage further research and implementation of these advanced techniques and technologies in structural health monitoring.

Energy Harvesting Autonomous Sensor Systems: Design, Analysis, and Practical Implementation provides a wide range of coverage of various energy harvesting techniques to enable the development of a truly self-autonomous and sustainable energy harvesting wireless sensor network (EH-WSN). It supplies a practical overview of the entire EH-WSN system from energy source all the way to energy usage by wireless sensor nodes/network. After an in-depth review of existing energy harvesting research thus far, the book focuses on: Outlines two wind energy harvesting (WEH) approaches, one using a wind turbine generator and one a piezoelectric wind energy harvester Covers thermal energy harvesting (TEH) from ambient heat sources with low temperature differences Presents two types of piezoelectric-based vibration energy harvesting systems to harvest impact or impulse forces from a human pressing a button or switch action Examines hybrid energy harvesting approaches that augment the reliability of the wireless sensor node's operation Discusses a hybrid wind and solar energy harvesting scheme to simultaneously use both energy sources and therefore extend the lifetime of the wireless sensor node Explores a hybrid of indoor ambient light

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and TEH scheme that uses only one power management circuit to condition the combined output power harvested from both energy sources Although the author focuses on small-scale energy harvesting, the systems discussed can be upsized to large-scale renewable energy harvesting systems. The book goes beyond theory to explore practical applications that not only solve real-life energy issues but pave the way for future work in this area.

Provides in-depth knowledge of flexible energy conversion and storage devices- covering aspects from materials to technologies Written by leading experts on various critical issues in this emerging field, this book reviews the recent progresses on flexible energy conversion and storage devices, such as batteries, supercapacitors, solar cells, and fuel cells. It introduces not only the basic principles and strategies to make a device flexible, but also the applicable materials and technologies, such as polymers, carbon materials, nanotechnologies and textile technologies. It also discusses the perspectives for different devices. Flexible Energy Conversion and Storage Devices contains chapters, which are all written by top researchers who have been actively working in the field to deliver recent advances in areas from materials syntheses, through fundamental principles, to device applications. It covers flexible all-solid state supercapacitors; fiber/yarn based flexible supercapacitors; flexible lithium and sodium ion batteries; flexible diversified and zinc ion batteries; flexible Mg, alkaline, silver-zinc, and lithium sulfur batteries; flexible fuel cells; flexible nanodielectric materials with high

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permittivity for power energy storage; flexible dye sensitized solar cells; flexible perovskite solar cells; flexible organic solar cells; flexible quantum dot-sensitized solar cells; flexible triboelectric nanogenerators; flexible thermoelectric devices; and flexible electrodes for water-splitting. -Covers the timely and innovative field of flexible devices which are regarded as the next generation of electronic devices -Provides a highly application-oriented approach that covers various flexible devices used for energy conversion and storage -Fosters an understanding of the scientific basis of flexible energy devices, and extends this knowledge to the development, construction, and application of functional energy systems -Stimulates and advances the research and development of this intriguing field Flexible Energy Conversion and Storage Devices is an excellent book for scientists, electrochemists, solid state chemists, solid state physicists, polymer chemists, and electronics engineers.

This book comprises select peer-reviewed papers from the International Conference on VLSI, Communication and Signal processing (VCAS) 2019, held at Motilal Nehru National Institute of Technology (MNNIT) Allahabad, Prayagraj, India. The contents focus on latest research in different domains of electronics and communication engineering, in particular microelectronics and VLSI design, communication systems and networks, and signal and image processing. The book also discusses the emerging applications of novel tools and techniques in image, video and multimedia signal processing. This book will be useful to students, researchers and professionals working

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in the electronics and communication domain.

With escalating global population, increased consumption of fossil fuels, spiralling energy demand, rapid environmental degradation and global climate change, energy and environmental issues are receiving considerable attention worldwide from the purview of sustainable development. In order to address these complex and interlinked challenges, the development of new materials for affordable green energy technologies (batteries, supercapacitors, fuel cells and solar cells) and environmental remediation methods (adsorption, photocatalysis, separation, and sensing) is essential. Three-dimensional graphene-based macrostructures (3D GBMs) are of great interest in these applications given their large surface area and adaptable surface chemistry. Graphene-based 3D Macrostructures for Clean Energy and Environmental Applications provides a critical and comprehensive account of the recent advances in the development and potential applications of high performance 3D GBMs for tackling global energy and environmental issues in a sustainable manner. Particular attention is paid to the fabrication schemes, modulation of physiochemical properties, and their integration into practical devices, and the roles of surface chemistry and pore morphology, as well as their interplay, on the overall performance of 3D GBMs are examined. With contributions from authors around the world this book is a useful resource for both environmental scientists interested in sustainable energy and remediation solutions and materials scientists interested in applications for 3D GMBs.

This book provides a multidisciplinary overview of the design and implementation of systems for remote patient monitoring and healthcare. Readers are guided step-by-step through the components of such a system and shown how they could be integrated in a coherent

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framework for deployment in practice. The authors explain planning from subsystem design to complete integration and deployment, given particular application constraints. Readers will benefit from descriptions of the clinical requirements underpinning the entire application scenario, physiological parameter sensing techniques, information processing approaches and overall, application dependent system integration. Each chapter ends with a discussion of practical design challenges and two case studies are included to provide practical examples and design methods for two remote healthcare systems with different needs.

A one-of-a-kind examination of the latest developments in machine control In *Electronics in Advanced Research Industries: Industry 4.0 to Industry 5.0 Advances*, accomplished electronics researcher and engineer Alessandro Massaro delivers a comprehensive exploration of the latest ways in which people have achieved machine control, including automated vision technologies, advanced electronic and micro-nano sensors, advanced robotics, and more. The book is composed of nine chapters, each containing examples and diagrams designed to assist the reader in applying the concepts discussed within to common issues and problems in the real-world. Combining electronics and mechatronics to show how they can each be implemented in production line systems, the book presents insightful new ways to use artificial intelligence in production line machines. The author explains how facilities can upgrade their systems to an Industry 5.0 environment. *Electronics in Advanced Research Industries: Industry 4.0 to Industry 5.0 Advances* also provides: A thorough introduction to the state-of-the-art in a variety of technological areas, including flexible technologies, scientific approaches, and intelligent automatic systems Comprehensive explorations of information technology infrastructures that support Industry 5.0 facilities, including production process

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simulation Practical discussions of human-machine interfaces, including mechatronic machine interface architectures integrating sensor systems and machine-to-machine (M2M) interfaces In-depth examinations of internet of things (IoT) solutions in industry, including cloud computing IoT Perfect for professionals working in electrical industry sectors in manufacturing, production line manufacturers, engineers, and members of R&D industry teams, Electronics in Advanced Research Industries: Industry 4.0 to Industry 5.0 Advances will also earn a place in libraries of technicians working in the process industry.

Piezoelectric energy is a renewable alternative energy source that operates on a smaller scale than renewable energy generation plants which generate Mega-Giga Watts of power. Its potential to 'eliminate' contemporary batteries, which are classified as hazardous wastes, makes it an important technological advancement in a world increasingly concerned about eliminating waste, increasing sustainability and shifting to more 'green' consumption habits. Authored by a pioneer of piezoelectric actuators and piezoelectric energy harvesting, this unique compendium provides a solid theoretical background of piezoelectrics, practical material selection, device design optimization, and energy harvesting electric circuits. Included in each chapter are a list of chapter essentials, check points, example problems and solutions, and practice problems. Written for advanced undergraduate and graduate students, university researchers, and industry engineers studying or working in the field of piezoelectric energy harvesting systems, the useful reference text provides readers with the essential knowledge to conduct research and raises readers' awareness of known pitfalls and mis-directions in the field.

Discover state-of-the-art developments in textile-based wearable and stretchable electronics

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from leaders in the field In *Textile-Based Energy Harvesting and Storage Devices for Wearable Electronics*, renowned researchers Professor Xing Fan and his co-authors deliver an insightful and rigorous exploration of textile-based energy harvesting and storage systems. The book covers the principles of smart fibers and fabrics, as well as their fabrication methods. It introduces, in detail, several fiber- and fabric-based energy harvesting and storage devices, including photovoltaics, piezoelectrics, triboelectrics, supercapacitors, batteries, and sensing and self-powered electric fabrics. The authors also discuss expanded functions of smart fabrics, like stretchability, hydrophobicity, air permeability and color-changeability. The book includes sections on emerging electronic fibers and textiles, including stress-sensing, strain-sensing, and chemical-sensing textiles, as well as emerging self-powered electronic textiles. *Textile-Based Energy Harvesting and Storage Devices for Wearable Electronics* concludes with an in-depth treatment of upcoming challenges, opportunities, and commercialization requirements for electronic textiles, providing valuable insight into a highly lucrative new commercial sector. The book also offers:

- A thorough introduction to the evolution from classical functional fibers to intelligent fibers and textiles
- An exploration of typical film deposition technologies, like dry-process film deposition and wet-process technologies for roll-to-roll device fabrication
- Practical discussions of the fabrication process of intelligent fibers and textiles, including the synthesis of classical functional fibers and nano/micro assembly on fiber materials
- In-depth examinations of energy harvesting and energy storage fibers, including photovoltaic, piezoelectric, and supercapacitor fibers

Perfect for materials scientists, engineering scientists, and sensor developers, *Textile-Based Energy Harvesting and Storage Devices for Wearable Electronics* is also an indispensable resource for electrical engineers

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and professionals in the sensor industry seeking a one-stop reference for fiber- and fabric-based energy harvesting and storage systems for wearable and stretchable power sources. Wireless sensor networks are deployed in a rapidly increasing number of arenas, with uses ranging from healthcare monitoring to industrial and environmental safety, as well as new ubiquitous computing devices that are becoming ever more pervasive in our interconnected society. This book presents a range of exciting developments in software communication technologies including some novel applications, such as in high altitude systems, ground heat exchangers and body sensor networks. Authors from leading institutions on four continents present their latest findings in the spirit of exchanging information and stimulating discussion in the WSN community worldwide.

This book contains reviews of recent experimental and theoretical results related to nanomaterials. It focuses on novel functional materials and nanostructures in combination with silicon on insulator (SOI) devices, as well as on the physics of new devices and sensors, nanostructured materials and nano scaled device characterization. Special attention is paid to fabrication and properties of modern low-power, high-performance, miniaturized, portable sensors in a wide range of applications such as telecommunications, radiation control, biomedical instrumentation and chemical analysis. In this book, new approaches exploiting nanotechnologies (such as UTBB FD SOI, Fin FETs, nanowires, graphene or carbon nanotubes on dielectric) to pave a way between “More Moore” and “More than Moore” are considered, in order to create different kinds of sensors and devices which will consume less electrical power, be more portable and totally compatible with modern microelectronics products.

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This book provides a comprehensive platform to the scientific, education and research communities working on various fields related to sustainable energy. It covers the exploration, generation and application of this area to meet societal needs as well as addressing global issues related to the environment. The content of this book presents research related to energy and how to tackle climate change as a comprehensive framework based on the success of the Millennium Development Goals (MDGs). The authors use the scientific method to analyze and deliver viable technical solutions, demonstrating how chemistry and engineering can be combined to solve technically challenging problems. While maintaining high scientific rigor, a quantitative approach is offered in select chapters to the study of energy related to our societies increasing need for electrical and chemical energy feedstocks.

The Proceedings of the 11th European Conference on Thermoelectrics contains manuscripts from leading experts on topics spanning from material processing to applications in the field of thermoelectrics. The selected manuscripts also describe recent developments on measurement systems of thermoelectric properties, and the design and modelling of thermoelectric generators.

The release of this second volume of CHIPS 2020 coincides with the 50th anniversary of Moore's Law, a critical year marked by the end of the nanometer roadmap and by a significantly reduced annual rise in chip performance. At the same time, we are witnessing a data explosion in the Internet, which is consuming 40% more electrical power every year, leading to fears of a major blackout of the Internet by 2020. The messages of the first CHIPS 2020, published in 2012, concerned the realization of

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quantum steps for improving the energy efficiency of all chip functions. With this second volume, we review these messages and amplify upon the most promising directions: ultra-low-voltage electronics, nanoscale monolithic 3D integration, relevant-data, brain- and human-vision-inspired processing, and energy harvesting for chip autonomy. The team of authors, enlarged by more world leaders in low-power, monolithic 3D, video, and Silicon brains, presents new vistas in nanoelectronics, promising Moore-like exponential growth sustainable through to the 2030s.

Providing a detailed overview of the fundamentals and latest developments in the field of energy autonomous microsystems, this book delivers an in-depth study of the applications in the fields of health and usage monitoring in aeronautics, medical implants, and home automation, drawing out the main specifications on such systems. Introductory information on photovoltaic, thermal and mechanical energy harvesting, and conversion, is given, along with the latest results in these fields. This book also provides a state of the art of ultra-low power sensor interfaces, digital signal processing and wireless communications. In addition, energy optimizations at the sensor node and sensors network levels are discussed, thus completing this overview. This book details the challenges and latest techniques available to readers who are interested in this field. A major strength of this book is that the first three chapters are application oriented and thus, by setting the landscape, introduce the technical chapters. There is also a good balance between the technical application, covering all the system-related aspects and,

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withineach chapter, details on the physics, materials and technologiesassociated with electronics. Contents Introduction. Introduction to Energy AutonomousMicro& and Nano Systems and Presentation of Contributions,Marc Belleville and Cyril Condemine. 1. Sensors at the Core of Building Control, Gilles Chabanis,Laurent Chiesi, Hynek Raisigel,& Isabelle Ressejac andVéronique Boutin. 2. Toward Energy Autonomous MedicalImplants, Raymond Campagnolo andDaniel Kroiss. 3. Energy Autonomous Systems in Aeronautic Applications, ThomasBecker, Jirka Klaue and Martin Kluge. 4. Energy Harvesting by Photovoltaic Effect, EmmanuelleRouvière, Simon Perraud, Cyril Condemine and& GuyWaltisperger. 5. Mechanical Energy Harvesting, Ghislain Despesse, Jean JacquesChaillout,& Sébastien Boisseau and ClaireJean-Mistral. 6. Thermal Energy Harvesting, Tristan Caroff, EmmanuelleRouvière and Jérôme Willemin. 7. Lithium Micro-Batteries, Raphaël Salot. 8. Ultra-Low-Power Sensors, Pascal Nouet, Norbert Dumas, LaurentLatorre and& Frédérick Maily. 9. Ultra-Low-Power Signal Processing in Autonomous Systems,Christian Piguet. 10. Ultra-Low-Power Radio Frequency Communications and Protocols,Eric Mercier. 11. Energy Management in an Autonomous Microsystem,Jean-Frédéric Christmann, Edith Beigne, Cyril Condemine,Jérôme Willemin and Christian Piguet. 12. Optimizing Energy Efficiency of & Sensor Networks,Olivier Sentieys and Olivier Berder. Encyclopedia of Renewable and Sustainable Materials provides a comprehensive overview, covering research and development on all aspects of renewable, recyclable

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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 (CO₂) 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

Advanced Thermoelectric Materials for Energy Harvesting Applications is a research-intensive textbook covering the fundamentals of thermoelectricity and the process of converting heat energy into electrical energy. It covers the design, implementation, and performance of existing and advanced thermoelectric materials. Chapters examine such topics as organic/inorganic thermoelectric materials, performance and behaviors of thermoelectric devices, and energy harvesting applications of thermoelectric devices. The transformation of vibrations into electric energy through the use of piezoelectric

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devices is an exciting and rapidly developing area of research with a widening range of applications constantly materialising. With Piezoelectric Energy Harvesting, world-leading researchers provide a timely and comprehensive coverage of the electromechanical modelling and applications of piezoelectric energy harvesters. They present principal modelling approaches, synthesizing fundamental material related to mechanical, aerospace, civil, electrical and materials engineering disciplines for vibration-based energy harvesting using piezoelectric transduction. Piezoelectric Energy Harvesting provides the first comprehensive treatment of distributed-parameter electromechanical modelling for piezoelectric energy harvesting with extensive case studies including experimental validations, and is the first book to address modelling of various forms of excitation in piezoelectric energy harvesting, ranging from airflow excitation to moving loads, thus ensuring its relevance to engineers in fields as disparate as aerospace engineering and civil engineering. Coverage includes:

- Analytical and approximate analytical distributed-parameter electromechanical models with illustrative theoretical case studies as well as extensive experimental validations
- Several problems of piezoelectric energy harvesting ranging from simple harmonic excitation to random vibrations
- Details of introducing and modelling piezoelectric coupling for various problems
- Modelling and exploiting nonlinear dynamics for performance enhancement, supported with experimental verifications
- Applications ranging from moving load excitation of slender bridges to airflow excitation of

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aeroelastic sections A review of standard nonlinear energy harvesting circuits with modelling aspects.

For decades, people have searched for ways to harvest energy from natural sources. Lately, a desire to address the issue of global warming and climate change has popularized solar or photovoltaic technology, while piezoelectric technology is being developed to power handheld devices without batteries, and thermoelectric technology is being explored to convert wasted heat, such as in automobile engine combustion, into electricity. Featuring contributions from international researchers in both academics and industry, *Energy Harvesting with Functional Materials and Microsystems* explains the growing field of energy harvesting from a materials and device perspective, with resulting technologies capable of enabling low-power implantable sensors or a large-scale electrical grid. In addition to the design, implementation, and components of energy-efficient electronics, the book covers current advances in energy-harvesting materials and technology, including: High-efficiency solar technologies with lower cost than existing silicon-based photovoltaics Novel piezoelectric technologies utilizing mechanical energy from vibrations and pressure The ability to harness thermal energy and temperature profiles with thermoelectric materials Whether you're a practicing engineer, academician, graduate student, or entrepreneur looking to invest in energy-harvesting devices, this book is your complete guide to fundamental materials and applied microsystems for energy harvesting.

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This e-book is a compilation of papers presented at the 6th Mechanical Engineering Research Day (MERD'19) - Kampus Teknologi UTeM, Melaka, Malaysia on 31 July 2019.

This book describes the development of core technologies to address two of the most challenging issues in research for future IT platform development, namely innovative device design and reduction of energy consumption. Three key devices, the FinFET, the TunnelFET, and the electromechanical nanoswitch are described with extensive details of use for practical applications. Energy issues are also covered in a tutorial fashion from material physics, through device technology, to innovative circuit design. The strength of this book lies in its holistic approach dealing with material trends, state-of-the-art of key devices, new examples of circuits and systems applications. This is the first of three books based on the Integrated Smart Sensors research project, which describe the development of innovative devices, circuits, and system-level enabling technologies. The aim of the project was to develop common platforms on which various devices and sensors can be loaded, and to create systems offering significant improvements in information processing speed, energy usage, and size. The book contains extensive reference lists and with over 200 figures introduces the reader to the general subject in a tutorial style, also addressing the state-of-the-art, allowing it to be used as a guide for starting researchers in these fields.

This book presents the select proceedings of the International Conference on Automation, Signal Processing, Instrumentation and Control (i-CASIC) 2020. The book mainly focuses on emerging technologies in electrical systems, IoT-based instrumentation, advanced industrial automation, and advanced image and signal processing. It also includes studies on the

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analysis, design and implementation of instrumentation systems, and high-accuracy and energy-efficient controllers. The contents of this book will be useful for beginners, researchers as well as professionals interested in instrumentation and control, and other allied fields. This book focuses on solar-energy-based renewable energy systems and discusses the generation of electric power using solar photovoltaics, as well as some new techniques, such as solar towers, for both residential and commercial needs. Such systems have played an important role in the move towards low-emission and sustainable energy sources. The book covers a variety of applications, such as solar water heaters, solar air heaters, solar drying, nanoparticle-based direct absorption solar systems, solar volumetric receivers, solar-based cooling systems, solar-based food processing and cooking, efficient buildings using solar energy, and energy storage for solar thermal systems. Given its breadth of coverage, the book offers a valuable resource for researchers, students, and professionals alike.

This second book by the author on WSNs focuses on the concepts of energy, and energy harvesting and management techniques. Definitions and terminologies are made clear without leaning on the relaxing assumption that they are already known or easily reachable, the reader is not to be diverted from the main course. Neatly drawn figures assist in viewing and imagining the offered topics. To make energy related topics felt and seen, the adopted technologies as well as their manufacturers are presented in details. With such a depth, this book is intended for a wide audience, it is meant to be helper and motivator, for the senior undergraduates, postgraduates, researchers, and practitioners; concepts and energy related applications are laid out, research and practical issues are backed by appropriate literature, and new trends are put under focus. For senior undergraduate students, it familiarizes with

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conceptual foundations and practical projects implementations. Also, it is intended for graduate students working on their thesis and in need of specific knowledge on WSNs and the related energy harvesting and management techniques. Moreover, it is targeting researchers and practitioners interested in features and applications of WSNs, and on the available energy harvesting and management projects and testbeds. Exercises at the end of each chapter are not just questions and answers; they are not limited to recapitulate ideas. Their design objective is not bound to be a methodical review of the provided concepts, but rather as a motivator for lot more of searching, finding, and comparing beyond what has been presented in the book.

As the human population expands and natural resources become depleted, it becomes necessary to explore other sources for energy consumption and usage. Renewable and Alternative Energy: Concepts, Methodologies, Tools, and Applications provides a comprehensive overview of emerging perspectives and innovations for alternative energy sources. Highlighting relevant concepts on energy efficiency, current technologies, and ongoing industry trends, this is an ideal reference source for academics, practitioners, professionals, and upper-level students interested in the latest research on renewable energy. A thorough treatment of the principles, applications and system integration of energy harvesting technology.

The volume is a collection of best selected research papers presented at the 4th International Conference on Inventive Material Science Applications (ICIMA 2021) organized by PPG Institute of Technology, Coimbatore, India during 14 – 15 May 2021. The book includes original research by material science researchers towards developing a compact and efficient

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functional elements and structures for micro, nano and optoelectronic applications. The book covers important topics like nanomaterials and devices, optoelectronics, sustainable electronic materials, nanocomposites and nanostructures, hybrid electronic materials, medical electronics, computational material science, wearable electronic devices and models, and optical/nano-sensors.

Harvesting useful electric energy from ambient thermal gradients and/or temperature fluctuations is immensely important. For many years, a number of direct and indirect thermal-to-electrical energy conversion technologies have been developed. Typically, direct energy conversion is achieved by using thermoelectric generators or thermogalvanic cells; indirect energy conversion is achieved by using Organic Rankine Cycle or Sterling Engines. On the one hand, there is a fundamental technical difficulty, thermal shorting, that limits the energy conversion efficiency of direct thermoelectric energy conversion methods. While extensive study has been conducted in this area, currently the portion of thermal energy that can be converted to electricity is still small. On the other hand, the indirect energy conversion systems tend to be complicated and expensive. Thus, existing energy harvesting technologies are less economically competitive compared with the grid power. To develop advanced energy harvesting systems, a novel concept using nanoporous materials is investigated. Nanoporous materials have been widely used as advanced absorbents. Because of their ultra-large surface areas (100-2000 m²/g), they can adsorb a large amount of ions when they are immersed in electrolyte solutions. The ion adsorption capacity is thermally dependent. If two nanoporous electrodes are placed at different temperatures, they adsorb different amounts of ions, generating a net output voltage. The thermally driven ion motion causes a transient current,

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which can be reactivated through temperature fluctuation or internal grounding. The two electrodes are isolated; that is, the direct heat loss between them is minimized. Our experimental data have shown encouraging results: the output voltage and the energy conversion efficiency are higher than that of conventional thermoelectric materials by orders of magnitude. Our study will not only lead to the development of high-performance thermal energy harvesting systems, but also shed light on fundamentals of electrophysics in nanoenvironment. The thermal effect on surface electrification (i.e. the capacitive effect) in nanopores is a new scientific area. Conventional interface theories have failed in explaining a number of experimental observations. We have carried out a systematic study of the effects of ions, solvent, electrode, cell configuration, etc. to understand the fundamental mechanisms and processes that govern the ion motion and charge transfer in nanopores.

Waste Energy Harvesting overviews the latest progress in waste energy harvesting technologies, with specific focusing on waste thermal mechanical energies. Thermal energy harvesting technologies include thermoelectric effect, storage through phase change materials and pyroelectric effect. Waste mechanical energy harvesting technologies include piezoelectric (ferroelectric) effect with ferroelectric materials and nanogenerators. The book aims to strengthen the syllabus in energy, materials and physics and is well suitable for students and professionals in the fields.

This book addresses the Internet of Things (IoT), an essential topic in the

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technology industry, policy, and engineering circles, and one that has become headline news in both the specialty press and the popular media. The book focuses on energy efficiency concerns in IoT and the requirements related to Industry 4.0. It is the first-ever “how-to” guide on frequently overlooked practical, methodological, and moral questions in any nations’ journey to reducing energy consumption in IoT devices. The book discusses several examples of energy-efficient IoT, ranging from simple devices like indoor temperature sensors, to more complex sensors (e.g. electrical power measuring devices), actuators (e.g. HVAC room controllers, motors) and devices (e.g. industrial circuit-breakers, PLC for home, building or industrial automation). It provides a detailed approach to conserving energy in IoT devices, and comparative case studies on performance evaluation metrics, state-of-the-art approaches, and IoT legislation.

Offers the first comprehensive account of this interesting and growing research field Printed Batteries: Materials, Technologies and Applications reviews the current state of the art for printed batteries, discussing the different types and materials, and describing the printing techniques. It addresses the main applications that are being developed for printed batteries as well as the major advantages and remaining challenges that exist in this rapidly evolving area of research. It is the first book on printed batteries that seeks to promote a deeper

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understanding of this increasingly relevant research and application area. It is written in a way so as to interest and motivate readers to tackle the many challenges that lie ahead so that the entire research community can provide the world with a bright, innovative future in the area of printed batteries. Topics covered in Printed Batteries include, Printed Batteries: Definition, Types and Advantages; Printing Techniques for Batteries, Including 3D Printing; Inks Formulation and Properties for Printing Techniques; Rheological Properties for Electrode Slurry; Solid Polymer Electrolytes for Printed Batteries; Printed Battery Design; and Printed Battery Applications. Covers everything readers need to know about the materials and techniques required for printed batteries Informs on the applications for printed batteries and what the benefits are Discusses the challenges that lie ahead as innovators continue with their research Printed Batteries: Materials, Technologies and Applications is a unique and informative book that will appeal to academic researchers, industrial scientists, and engineers working in the areas of sensors, actuators, energy storage, and printed electronics.

This book includes updated theoretical considerations which provide an insight into avenues of research most likely to result in further improvements in material performance. It details the latest techniques for the preparation of thermoelectric

