Battery Management Algorithm for Electric Vehicles

This book systematically introduces readers to the core algorithms of battery management system (BMS) for electric vehicles. These algorithms cover most of the technical bottlenecks encountered in BMS applications, including battery system modeling, state of charge (SOC) and state of health (SOH) estimation, state of power (SOP) estimation, remaining useful life (RUL) prediction, heating at low temperature, and optimization of charging. The book not only presents these algorithms, but also discusses their background, as well as related experimental and hardware developments. The concise figures and program codes provided make the calculation process easy to follow and apply, while the results obtained are presented in a comparative way, allowing readers to intuitively grasp the characteristics of different algorithms. Given its scope, the book is intended for researchers, senior undergraduate and graduate students, as well as engineers in the fields of electric vehicles and energy storage.

Rechargeable Lithium Batteries

Lithium-ion batteries are the most promising among the secondary battery technologies, for providing high energy and high power required for hybrid electric vehicles (HEV) and electric vehicles (EV). Lithium-ion batteries consist of conventional graphite or lithium titanate as anode and lithium transition metal-oxides as cathode. A lithium salt dissolved in an aprotic solvent such as ethylene carbonate and diethylene carbonate is used as electrolyte. This rechargeable battery operates based on the principle of electrochemical lithium insertion/re-insertion or intercalation/de-intercalation during charging/discharging of the battery. It is essential that both electrodes have layered structure which
should accept and release the lithium-ion. In advanced lithium-ion battery technologies, other than layered anodes are also considered. High cell voltage, high capacity as well as energy density, high Columbic efficiency, long cycle life, and convenient to fabricate any size or shape of the battery, are the vital features of this battery technology. Lithium-ion batteries are already being used widely in most of the consumer electronics such as mobile phones, laptops, PDAs etc. and are in early stages of application in HEV and EV, which will have far and wide implications and benefits to society. The book contains ten chapters, each focusing on a specific topic pertaining to the application of lithium-ion batteries in Electric Vehicles. Basic principles, electrode materials, electrolytes, high voltage cathodes, recycling spent Li-ion batteries and battery charge controller are addressed. This book is unique among the countable books focusing on the lithium-ion battery technologies for vehicular applications. It provides fundamentals and practical knowledge on the lithium-ion battery for vehicular application. Students, scholars, academicians, and battery and automobile industries will find this volume useful.

Nanostructured Materials for Next-Generation Energy Storage and Conversion

Lithium air rechargeable batteries are the best candidate for a power source for electric vehicles, because of their high specific energy density. In this book, the history, scientific background, status and prospects of the lithium air system are introduced by specialists in the field. This book will contain the basics, current statuses, and prospects for new technologies. This book is ideal for those interested in electrochemistry, energy storage, and materials science.

Metal-Air Batteries

This book offers comprehensive coverage of carbon-based nanomaterials and electrochemical energy conversion and storage technologies such as batteries, fuel cells, supercapacitors, and hydrogen generation and storage, as well as the latest material and new technology development. It addresses a variety of topics such as electrochemical processes, materials, components, assembly and manufacturing, degradation mechanisms, challenges, and strategies. With in-depth discussions ranging from electrochemistry fundamentals to engineering components and applied devices, this all-inclusive reference offers a broad view of various carbon nanomaterials and technologies for electrochemical energy conversion and storage devices.

Lithium-Ion Battery Chemistries

Lithium-ion Supercapacitors

Written at an intermediate level in a way that is easy to understand, Fundamentals and Applications of Ultrasonic Waves, Second Edition provides an up-to-date exposition of ultrasonics and some of its main applications. Designed specifically for newcomers to the field, this fully updated second edition emphasizes underlying physical concepts over mathematics. The first half covers the fundamentals of ultrasonic waves for isotropic media. Starting with bulk liquid and solid media, discussion extends to surface and plate effects, at which point the author introduces new modes such as Rayleigh and Lamb waves. This focus on only isotropic media simplifies the usually complex mathematics
involved, enabling a clearer understanding of the underlying physics to avoid the complicated tensorial description characteristic of crystalline media. The second part of the book addresses a broad spectrum of industrial and research applications, including quartz crystal resonators, surface acoustic wave devices, MEMS and microacoustics, and acoustic sensors. It also provides a broad discussion on the use of ultrasonics for non-destructive evaluation. The author concentrates on the developing area of microacoustics, including exciting new work on the use of probe microscopy techniques in nanotechnology. Focusing on the physics of acoustic waves, as well as their propagation, technology, and applications, this book addresses viscoelasticity, as well as new concepts in acoustic microscopy. It updates coverage of ultrasonics in nature and developments in sonoluminescence, and it also compares new technologies, including use of atomic force acoustic microscopy and lasers. Highlighting both direct and indirect applications for readers working in neighboring disciplines, the author presents particularly important sections on the use of microacoustics and acoustic nanoprobe techniques in next-generation devices and instruments.

Rechargeable Lithium-Ion Batteries

Rechargeable Batteries with high energy density are in great demand as energy sources for various purposes, e.g. handies, zero emission electric vehicles, or load leveling in electric power. Lithium batteries are the most promising to fulfill such needs because of their intrinsic discharge voltage with relatively light weight. This volume has been conceived keeping in mind selected fundamental topics together with the characteristics of the lithium ion battery on the market. It is thus a comprehensive overview of the new challenges facing the further development of lithium ion batteries from the standpoint of both materials science and technology. It will be useful for any scientist involved in the research and development of batteries in academia and industry, and also for graduate students entering the field, since it covers important topics from both fundamental and application points of view.

Fuel Cells

A comprehensive overview of the research developments in the burgeoning field of metal-air batteries An innovation in battery science and technology is necessary to build better power sources for our modern lifestyle needs. One of the main fields being explored for the possible breakthrough is the development of metal-air batteries. Metal-Air Batteries: Fundamentals and Applications offers a systematic summary of the fundamentals of the technology and explores the most recent advances in the applications of metal-air batteries. Comprehensive in scope, the text explains the basics in electrochemical batteries and introduces various species of metal-air batteries. The author-a noted expert in the field-explores the development of metal-air batteries in the order of Li-air battery, sodium-air battery, zinc-air battery and Mg-O2 battery, with the focus on the Li-air battery. The text also addresses topics such as metallic anode, discharge products, parasitic reactions, electrocatalysts, mediator, and X-ray diffraction study in Li-air battery. Metal-Air Batteries provides a summary of future perspectives in the field of the metal-air batteries. This important resource: -Covers various species of metal-air batteries and their components as well as system designation -Contains groundbreaking content that reviews recent advances in the field of metal-air batteries -Focuses on the battery systems which have the greatest potential for renewable energy storage Written for electrochemists, physical chemists, materials scientists, professionals in the electrotechnical industry, engineers in power technology, Metal-Air Batteries offers a review of the fundamentals and the most recent developments in the area of metal-air batteries.
Prospects For Li-ion Batteries And Emerging Energy Electrochemical Systems

This concise sourcebook of the electrochemical, engineering and economic principles involved in the development and commercialization of fuel cells offers a thorough review of applications and techno-economic assessment of fuel cell technologies, plus in-depth discussion of conventional and novel approaches for generating energy. Parts I and II explain basic and applied electrochemistry relevant to an understanding of fuel cells. Part III covers engineering and technology aspects. The book is useful for undergraduate and graduate students and scientists interested in fuel cells. Unlike any other current book on fuel cells, each chapter includes problems based on the discussions in the text.

Nitroxides as Mobile Catalysts for Rechargeable Lithium-oxygen (Li-O2) Batteries

Flow batteries have received attention in large-scale energy storage due to their flexible design, high safety, high energy efficiency, and environmental friendliness. In recent years, they have been rapidly developed and tested in a variety of scales that prove their feasibility and advantages of use. As energy becomes a global focus, it is important to consider flow battery systems. This book offers a detailed introduction to the function of different kinds of redox flow batteries, including vanadium flow batteries, as well as the electrochemical processes for their development, materials and components, applications, and near future prospects. Redox Flow Batteries: Fundamentals and Applications will give readers a full understanding of flow batteries from fundamentals to commercial applications.

Electrolytes

Energy Storage explains the underlying scientific and engineering fundamentals of all major energy storage methods. These include the storage of energy as heat, in phase transitions and reversible chemical reactions, and in organic fuels and hydrogen, as well as in mechanical, electrostatic and magnetic systems. Updated coverage of electrochemical storage systems considers exciting developments in materials and methods for applications such as rapid short-term storage in hybrid and intermittent energy generation systems, and battery optimization for increasingly prevalent EV and stop-start automotive technologies. This nuanced coverage of cutting-edge advances is unique in that it does not require prior knowledge of electrochemistry. Traditional and emerging battery systems are explained, including lithium, flow and liquid batteries. Energy Storage provides a comprehensive overview of the concepts, principles and practice of energy storage that is useful to both students and professionals.

Fundamentals and Applications of Lithium-ion Batteries in Electric Drive Vehicles

This concise sourcebook of the electrochemical, engineering and economic principles involved in the development and commercialization of fuel cells offers a thorough review of applications and techno-economic assessment of fuel cell technologies, plus in-depth discussion of conventional and novel approaches for generating energy. Parts I and II explain basic and applied electrochemistry relevant to an understanding of fuel cells. Part III covers engineering and technology aspects. The book is useful for undergraduate and graduate students and scientists interested in fuel cells. Unlike any other current book on fuel cells, each chapter includes problems based on the discussions in
Energy Materials

Metal–air and metal–sulfur batteries (MABs/MSBs) represent one of the most efficient-energy storage technologies, with high round trip efficiency, a long life cycle, fast response at peak demand/supply of electricity, and decreased weight due to the use of atmospheric oxygen as one of the main reactants. This book presents an overview of the main MABs/MSBs from fundamentals to applications. Recent technological trends in their development are reviewed. It also offers a detailed analysis of these batteries at the material, component, and system levels, allowing the reader to evaluate the different approaches of their integration. The book provides a systematic overview of the components, design, and integration, and discusses current technologies, achievements, and challenges, as well as future directions. Each chapter focuses on a particular battery type including zinc–air batteries, lithium–air batteries, aluminum–air batteries, magnesium–air batteries, lithium–sulfur batteries, and vanadium–air redox flow batteries, and metal–sulfur batteries. Features the most recent advances made in metal–air/metal–sulfur batteries. Describes cutting-edge materials and technology for metal–air/metal–sulfur batteries. Includes both fundamentals and applications, which can be used to guide and promote materials as well as technology development for metal–air/metal–sulfur batteries. Provides a systematic overview of the components, design, and integration, and discusses current technologies, achievements, and challenges, as well as future directions. Covers a variety of battery types in depth, such as zinc–air batteries, lithium–air batteries, aluminum–air batteries, magnesium–air batteries, lithium–sulfur batteries, vanadium–air redox flow batteries, and metal–sulfur batteries.

Lithium Compounds in Organic Synthesis

Lithium-Ion Batteries: Fundamentals and Applications offers a comprehensive treatment of the principles, background, design, production, and use of lithium-ion batteries. Based on a solid foundation of long-term research work, this authoritative monograph: Introduces the underlying theory and history of lithium-ion batteries Describes the key components.

Redox Flow Batteries

Research in electrochemical energy storage has witnessed exponential growth in recent years, with rapid development in new electrolyte systems. Electrolytes are an essential component in batteries systems and the fast-growing energy storage markets, especially on lithium related batteries applications, have drawn global attention. However, with concerns around safety and cost-effectiveness, advanced research in this area shows promise in conquering technique issues in conventional uses of lithium-based batteries. This will be the authoritative textbook for those who want to enter the field of electrochemical energy storage research. Chapters will first cover the fundamental knowledge needed in order to perform research in the field of chemistry and materials for electrochemical energy storage, before moving onto recent findings which are important to the field. This book will be suitable for advanced undergraduates and postgraduate students studying electrochemical energy storage, electrochemistry, materials science and engineering, as well as researchers new to the subject.

Carbon Nanofibers
Lithium-Ion Batteries: Fundamentals and Applications offers a comprehensive treatment of the principles, background, design, production, and use of lithium-ion batteries. Based on a solid foundation of long-term research work, this authoritative monograph: Introduces the underlying theory and history of lithium-ion batteries. Describes the key components of lithium-ion batteries, including negative and positive electrode materials, electrolytes, and separators. Discusses electronic conductive agents, binders, solvents for slurry preparation, positive thermal coefficient (PTC) materials, current collectors, and cases. Examines the assembly processes and electrochemical performance of lithium-ion batteries. Explores applications in power tools, electric vehicles, aerospace, and more. Lithium-Ion Batteries: Fundamentals and Applications delivers a systematic overview of lithium-ion batteries, from physical properties to manufacturing technologies. The book also supplies valuable insight into potential growth opportunities in this exciting market.

Lithium-Ion Supercapacitors

In the last few decades, metamaterials have revolutionized the ways in which waves are controlled, and applied in physics and practical situations. The extraordinary properties of metamaterials, such as their locally resonant structure with deep subwavelength band gaps and their ranges of frequency where propagation is impossible, have opened the way to a host of applications that were previously unavailable. Acoustic metamaterials have been able to replace traditional treatments in several sectors, due to their better performance in targeted and tunable frequency ranges with strongly reduced dimensions. This is a training book composed of nine chapters written by experts in the field, giving a broad overview of acoustic metamaterials and their uses. The book is divided into three parts, covering the state-of-the-art, the fundamentals and the real-life applications of acoustic metamaterials.

Mathematical Modeling of Lithium Batteries

Volume 3 of a 4-volume series is a concise, authoritative and an eminently readable and enjoyable experience related to lithium ion battery design, characterization and usage for portable and stationary power. Although the major focus is on lithium metal oxides or transition metal oxides as alloys, the discussion of fossil fuels is also presented where appropriate. This monograph is written by recognized experts in the field, and is both timely and appropriate as this decade will see application of lithium as an energy carrier, for example in the transportation sector. This Volume focuses on the fundamentals related to batteries using the latest research in the field of battery physics, chemistry, and electrochemistry. The research summarised in this book by leading experts is laid out in an easy-to-understand format to enable the layperson to grasp the essence of the technology, its pitfalls and current challenges in high-power Lithium battery research. After introductory remarks on policy and battery safety, a series of monographs are offered related to fundamentals of lithium batteries, including, theoretical modeling, simulation and experimental techniques used to characterize electrode materials, both at the material composition, and also at the device level. The different properties specific to each component of the batteries are discussed in order to offer tradeoffs between power and energy density, energy cycling, safety and where appropriate end-of-life disposal. Parameters affecting battery performance and cost, longevity using newer metal oxides, different electrolytes are also reviewed in the context of safety concerns and in relation to the solid-electrolyte interface. Separators, membranes, solid-state electrolytes, and electrolyte additives are also reviewed in light of safety, recycling, and high energy endurance issues. The book is intended for a wide audience, such as scientists who are new to the field, practitioners, as well as students in the STEM and STEP fields, as well as students working on batteries. The sections on safety and policy would be of great interest to engineers.
Nanomaterials for Lithium-ion Batteries

The Li-ion battery market is growing fast due to its ever increasing number of applications, from electric vehicles to portable devices. These devices are in demand due to safety reasons, energy efficiency, high power density and long life duration, which drive the need for more efficient electrochemical energy storage systems. The aim of this book is to provide the challenges and perspectives for Li-ion batteries (chapters 1 and 2), at the negative electrode as well as at the positive electrode, and for technologies beyond the Li-ion with the emerging Na-ion batteries and multivalent (Mg, Al, Ca, etc) systems (chapters 4 and 5). The aim is also to alert on the necessity to develop the recycling methods of the millions of produced batteries which are going to further flood our societies (chapter 3), and also to continuously increase the safety of the energy storage systems. For the latter challenge, it is interesting to seriously consider polymer electrolytes and batteries as an alternative (chapter 6). This book will take readers inside recent breakthroughs made in the electrochemical energy systems. It is a collaborative work of experts from the most known teams in the batteries field in Europe and beyond, from academics as well as from manufacturers. Contents: Negative Electrodes for Li-Ion Batteries: Beyond Carbon (Phoebe K Allan, Nicolas Louvain and Laure Monconduit) Li-Rich Layered Oxides: Still a Challenge, but a Very Promising Positive Electrode Material for Li-Ion Batteries (Ségolène Pajot, Loïc Simonin and Laurence Croguenec) Recycling of Li-Ion Batteries and New Generation Batteries (Jean Scoyer) Na-Ion Batteries — State of the Art and Prospects (Patrik Johansson, Patrick Rozier and M Rosa Palacin) Battery Systems Based on Multivalent Metals and Metal Ions (Doron Aurbach, Romain Berthelot, Alexandre Ponrouch, Michael Salama and Ivgeni Shterenberg) Lithium Polymer Electrolytes and Batteries (Gebrekidan Gebresilassie Eshetu, Michel Armand and Stefano Passerini) Readership: Researchers and professionals in electrochemistry, materials chemistry/nanochemistry, inorganic chemistry, solid state chemistry and physical chemistry. Keywords: Battery; Li-ion; Na-ion; Mg-ion; Li Polymer; Energy; Recycling; Electrochemistry

Review: Key Features: Prominent authors or contributors who for some of them belong to the European Research Institute, Alistore ERI (headed by Dr M R Palacin (ICMAB, CSIC, Barcelona, Spain) and by Dr P Simon (CIRIMAT, University Paul Sabatier, Toulouse, France)), and more generally to prestigious European Institutes and Universities developing high level research in the field of the electrochemical energy storage. Selected topics which highlight the main trends in the battery field, focusing especially on the emerging research axes Original approach with fundamental aspects (understanding of the mechanisms and failure mechanisms in batteries through the use of advanced characterization tools, often operandi during the cycling of the battery), as well as industrial concerns such as the recycling

Carbon Nanomaterials for Electrochemical Energy Technologies

This unique book covers fundamentals of organolithium compounds and gives a comprehensive overview of the latest synthetic advances and developments in the field. Part I covers computational and spectroscopic aspects as well as structure-reactivity relationships of organolithiums, whereas Part II deals with new lithium-based synthetic methodologies as well as novel synthetic applications of functionalized lithium compounds. A useful resource for newcomers and active researchers involved in organic synthesis, whether working in academia or industry!
Fundamentals and Applications of Lithium-ion Batteries in Electric Drive Vehicles

Includes details of the fundamental phenomenological theories of solar cells, Li ion/ Li-air/Li-S batteries, fuel cells and their energy storage mechanisms. Discusses properties of various energy materials in addition to their device operation and evaluation. Includes details of the fundamental phenomenological theories of solar cells, Li ion/ Li-air/Li-S batteries, fuel cells and their energy storage mechanisms. Discusses properties of various energy materials in addition to their device operation and evaluation.

Metal-Air and Metal-Sulfur Batteries

The Lithium Air Battery

Rechargeable Lithium Batteries: From Fundamentals to Application provides an overview of rechargeable lithium batteries, from fundamental materials, though characterization and modeling, to applications. The market share of lithium ion batteries is fast increasing due to their high energy density and low maintenance requirements. Lithium air batteries have the potential for even higher energy densities, a requirement for the development of electric vehicles, and other types of rechargeable lithium battery are also in development. After an introductory chapter providing an overview of the main scientific and technological challenges posed by rechargeable Li batteries, Part One of this book reviews materials and characterization of rechargeable lithium batteries. Part Two covers performance and applications, discussing essential aspects such as battery management, battery safety and emerging rechargeable lithium battery technologies as well as medical and aerospace applications. Expert overview of the main scientific and technological challenges posed by rechargeable lithium batteries. Address the important topics of analysis, characterization, and modeling in rechargeable lithium batteries. Key analysis of essential aspects such as battery management, battery safety, and emerging rechargeable lithium battery technologies.

Fundamentals and Applications of Acoustic Metamaterials

Polymer electrolytes are electrolytic materials that are widely used in batteries, fuel cells and other applications such as supercapacitors, photoelectrochemical and electrochromic devices. Polymer electrolytes: Fundamentals and applications provides an important review of this class of ionic conductors, their properties and applications. Part one reviews the various types of polymer electrolyte compounds, with chapters on ceramic polymer electrolytes, natural polymer-based polymer electrolytes, composite polymer electrolytes, lithium-doped hybrid polymer electrolytes, hybrid inorganic-organic polymer electrolytes. There are also chapters on ways of characterising and modelling polymer electrolytes. Part two discusses applications such as solar cells, supercapacitors, electrochromic and electrochemical devices, fuel cells and batteries. With its distinguished editors and international team of contributors, Polymer electrolytes: Fundamentals and applications is a standard reference for all those researching and using polymer electrolytes in such areas as battery and fuel cell technology for automotive and other applications. Provides an important review of this class of ionic conductors, their properties and applications in practical devices. Explores categories of polymer electrolytes and conductivity measurements. Features a comprehensive analysis of current developments in polymer electrolytes and highlights a new type of polymer electrolyte.
Lithium-Ion Batteries: Basics and Applications

Safety of Lithium Batteries describes how best to assure safety during all phases of the life of Lithium ion batteries (production, transport, use, and disposal). About 5 billion Li-ion cells are produced each year, predominantly for use in consumer electronics. This book describes how the high-energy density and outstanding performance of Li-ion batteries will result in a large increase in the production of Li-ion cells for electric drive train vehicle (xEV) and battery energy storage (BES or EES) purposes. The high-energy density of Li battery systems comes with special hazards related to the materials employed in these systems. The manufacturers of cells and batteries have strongly reduced the hazard probability by a number of measures. However, absolute safety of the Li system is not given as multiple incidents in consumer electronics have shown. Presents the relationship between chemical and structure material properties and cell safety Relates cell and battery design to safety as well as system operation parameters to safety Outlines the influences of abuses on safety and the relationship to battery testing Explores the limitations for transport and storage of cells and batteries Includes recycling, disposal and second use of lithium ion batteries

Fundamentals and Applications of Ultrasonic Waves

The handbook focuses on a complete outline of lithium-ion batteries. Just before starting with an exposition of the fundamentals of this system, the book gives a short explanation of the newest cell generation. The most important elements are described as negative / positive electrode materials, electrolytes, seals and separators. The battery disconnect unit and the battery management system are important parts of modern lithium-ion batteries. An economical, faultless and efficient battery production is a must today and is represented with one chapter in the handbook. Cross-cutting issues like electrical, chemical, functional safety are further topics. Last but not least standards and transportation themes are the final chapters of the handbook. The different topics of the handbook provide a good knowledge base not only for those working daily on electrochemical energy storage, but also to scientists, engineers and students concerned in modern battery systems.

Fuel Cells

Rechargeable Batteries with high energy density are in great demand as energy sources for various purposes, e.g. handies, zero emission electric vehicles, or load leveling in electric power. Lithium batteries are the most promising to fulfill such needs because of their intrinsic discharbe voltage with relatively light weight. This volume has been conceived keeping in mind selected fundamental topics together with the characteristics of the lithium ion battery on the market. It is thus a comprehensive overview of the new challenges facing the further development of lithium ion batteries from the standpoint of both materials science and technology. It will be useful for any scientist involved in the research and development of batteries in academia and industry, and also for graduate students entering the field, since it covers important topics from both fundamental and application points of view.

New Fluorinated Carbons: Fundamentals and Applications

The book provides a comprehensive understanding of the principles for operating lithium-ion supercapacitors (LISCs), their challenges, technological trends and perspectives. LISC technology has high potential to replace conventional rechargeable batteries such as lead-acid
and nickel metal hydride batteries for automotive, portable electronics, and stationary applications. The book offers detailed analysis of LISCs at the material, component, and system levels to evaluate the different approaches to their integration. It also discusses economics, market, manufacture, and commercialization status of LISCs. It is an up-to-date study of an emerging field, written by experts, ideal for those in academia and industry who want a detailed explanation of the technology.

Energy Storage

The book provides a comprehensive understanding of the principles for operating lithium-ion supercapacitors, their challenges, technological trends and perspectives. This LISC technology has high potential to replace conventional main rechargeable batteries such as lead-acid and nickel metal hydride batteries for automotive, portable electronics, and stationary applications. The book offers detailed analysis of LISCs at the material, component, and system levels to evaluate the different approaches to their integration. It also discusses economics, market, manufacture, and commercialization status of LISCs.

Lithium Ion Batteries

Carbon Dioxide Reduction through Advanced Conversion and Utilization Technologies covers fundamentals, advanced conversion technologies, economic feasibility analysis, and future research directions in the field of CO2 conversion and utilization. This book emphasizes principles of various conversion technologies for CO2 reduction such as enzymatic conversion, mineralization, thermochemical, photochemical, and electrochemical processes. It addresses materials, components, assembly and manufacturing, degradation mechanisms, challenges, and development strategies. Applications of conversion technologies for CO2 reduction to produce useful fuels and chemicals in energy and industrial systems are discussed as solutions to reduce greenhouse effects and energy shortages. Particularly, the advanced materials and technology of high temperature co-electrolysis of H2O and CO2 to produce sustainable fuels using solid oxide cells (SOCs) are reviewed and the introduction, fundamentals, and some significant topics regarding this CO2 conversion process are discussed. This book provides a comprehensive and clear picture of advanced technologies in CO2 conversion and utilization. Written in a clear and detailed manner, it is suitable for students as well as industry professionals, researchers, and academics.

Lithium-Ion Batteries

This book covers the fundamentals and applications of Carbon Nanofiber (CNF). In the first section, the initial chapter on the fundamentals of CNF is by Professor Maheshwar Sharon, the recognized “Father of Carbon Nanotechnology in India”, which powerfully provides a succinct overview of CNFs. This is followed by a chapter on biogenics that have produced unique morphologies of CNF that makes them suitable to various applications. This is followed by a chapter that mainly focuses on nanocomposites, especially those involving nanocomposites of CNF. The role of nanocatalysts and composites in promoting and enhancing the synthesis and application of CNF is then covered, followed by an important chapter on the characterization of CNF. The second section of the book encompasses the various applications of CNF, such as its use as a possible superconductor to adsorb and store hydrogen, and as a microwave absorber. The application of CNF for environmental concerns is also detailed by assessing its usefulness in dye and heavy metal removal from polluted water. The applications that are addressed
include lithium-ion battery, solar cell, antenna, cosmetics, usefulness in regenerative medicine, as well as various aspects of agrotechnology.

**Structure-property Relationships of Lithium Thiophosphates**

This book is unique to be the only one completely dedicated for battery modeling for all components of battery management system (BMS) applications. The contents of this book compliment the multitude of research publications in this domain by providing coherent fundamentals. An explosive market of Li ion batteries has led to aggressive demand for mathematical models for battery management systems (BMS). Researchers from multi-various backgrounds contribute from their respective background, leading to a lateral growth. Risk of this runaway situation is that researchers tend to use an existing method or algorithm without in depth knowledge of the cohesive fundamentals—often misinterpreting the outcome. It is worthy to note that the guiding principles are similar and the lack of clarity impedes a significant advancement. A repeat or even a synopsis of all the applications of battery modeling albeit redundant, would hence be a mammoth task, and cannot be done in a single offering. The authors believe that a pivotal contribution can be made by explaining the fundamentals in a coherent manner. Such an offering would enable researchers from multiple domains appreciate the bedrock principles and forward the frontier. Battery is an electrochemical system, and any level of understanding cannot ellipse this premise. The common thread that needs to run across—from detailed electrochemical models to algorithms used for real time estimation on a microchip—is that it be physics based. Build on this theme, this book has three parts. Each part starts with developing a framework—often invoking basic principles of thermodynamics or transport phenomena—and ends with certain verified real time applications. The first part deals with electrochemical modeling and the second with model order reduction. Objective of a BMS is estimation of state and health, and the third part is dedicated for that. Rules for state observers are derived from a generic Bayesian framework, and health estimation is pursued using machine learning (ML) tools. A distinct component of this book is thorough derivations of the learning rules for the novel ML algorithms. Given the large-scale application of ML in various domains, this segment can be relevant to researchers outside BMS domain as well. The authors hope this offering would satisfy a practicing engineer with a basic perspective, and a budding researcher with essential tools on a comprehensive understanding of BMS models.

**Proceedings of the Symposia on Fundamentals of Electrochemical Process Design**

"Thoroughly updated and expanded, 'Fundamentals of Medium/Heavy Duty Commercial Vehicle Systems, Second Edition' offers comprehensive coverage of basic concepts building up to advanced instruction on the latest technology, including distributed electronic control systems, energy-saving technologies, and automated driver-assistance systems. Now organized by outcome-based objectives to improve instructional clarity and adaptability and presented in a more readable format, all content seamlessly aligns with the latest ASE Medium-Heavy Truck Program requirements for MTST." --Back cover.

**Lithium-Ion Batteries**

**Carbon Dioxide Reduction through Advanced Conversion and Utilization Technologies**
New Fluorinated Carbons: Fundamentals and Applications is the second volume in Alain Tressaud’s Progress in Fluorine Science series. This volume provides an overview of cutting-edge research and emerging applications using new fluorinated carbon materials such as fullerenes, carbon nanotubes, polycyclic aromatic molecules, carbon nanofibers, and graphenes. Edited by recognized experts Olga Boltalina and Tsuyoshi Nakajima, this book includes valuable chapters on syntheses, structure analyses, and chemical and physical properties of fluorinated carbons written by leaders in each respective field. The work also explores the diverse practical applications of these functional materials—from energy storage and energy conversion devices to molecular electronics and lubricants. Features contributions by leading experts in the field. Includes fundamental and current research on synthesis, chemical, and physical properties of fluorinated carbons. Explores practical applications in energy, electronics, and lubricants. Examines a range of new fluorinated carbon materials.

Polymer Electrolytes

A theoretical and technical guide to the electric vehicle lithium-ion battery management system. Covers the timely topic of battery management systems for lithium batteries. After introducing the problem and basic background theory, it discusses battery modeling and state estimation. In addition to theoretical modeling it also contains practical information on charging and discharging control technology, cell equalisation and application to electric vehicles, and a discussion of the key technologies and research methods of the lithium-ion power battery management system. The author systematically expounds the theory knowledge included in the lithium-ion battery management systems and its practical application in electric vehicles, describing the theoretical connotation and practical application of the battery management systems. Selected graphics in the book are directly derived from the real vehicle tests. Through comparative analysis of the different system structures and different graphic symbols, related concepts are clear and the understanding of the battery management systems is enhanced. Contents include: key technologies and the difficulty point of vehicle power battery management system; lithium-ion battery performance modeling and simulation; the estimation theory and methods of the lithium-ion battery state of charge, state of energy, state of health and peak power; lithium-ion battery charge and discharge control technology; consistent evaluation and equalization techniques of the battery pack; battery management system design and application in electric vehicles. A theoretical and technical guide to the electric vehicle lithium-ion battery management system. Using simulation technology, schematic diagrams and case studies, the basic concepts are described clearly and offer detailed analysis of battery charge and discharge control principles. Equips the reader with the understanding and concept of the power battery, providing a clear cognition of the application and management of lithium ion batteries in electric vehicles. Arms audiences with lots of case studies. Essential reading for Researchers and professionals working in energy technologies, utility planners and system engineers.

Electrochemical Power Sources: Fundamentals, Systems, and Applications

This book covers the most recent advances in the science and technology of nanostructured materials for lithium-ion application. With contributions from renowned scientists and technologists, the chapters discuss state-of-the-art research on nanostructured anode and cathode materials, some already used in commercial batteries and others still in development. They include nanostructured anode materials based on Si, Ge, Sn, and other metals and metal oxides together with cathode materials of olivine, the hexagonal and spinel crystal structures.

Lithium Ion Batteries
Lithium-Ion Battery Chemistries: A Primer offers a simple description on how different lithium-ion battery chemistries work, along with their differences. It includes a refresher on the basics of electrochemistry and thermodynamics, and an understanding of the fundamental processes that occur in the lithium-ion battery. Furthermore, it reviews each of the major chemistries that are in use today, including Lithium-Iron Phosphate (LFP), Lithium-Cobalt Oxide (LCO), Lithium Manganese Oxide (LMO), Lithium-Nickel Manganese Cobalt (NMC), Lithium-Nickel Cobalt Aluminium (NCA), and Lithium-Titanate Oxide (LTO) and outlines the different types of anodes, including carbon (graphite, hard carbon, soft carbon, graphene), silicon, and tin. In addition, the book offers performance comparisons of different chemistries to help users select the right battery for the right application and provides explanations on why different chemistries have different performances and capabilities. Finally, it offers a brief look at emerging and beyond-lithium chemistries, including lithium-air, zinc-air, aluminum air, solid-state, lithium-sulfur, lithium-glass, and lithium-metal. Presents a refresher on the basics of electrochemistry and thermodynamics, along with simple graphics and images of complex concepts Provides a clear-and-concise description of lithium-ion chemistries and how they operate Covers the fundamental processes that occur in lithium-ion batteries Includes a detailed review of current and future chemistries

Lithium Batteries

The book focuses on the solid-state physics, chemistry and electrochemistry that are needed to grasp the technology of and research on high-power Lithium batteries. After an exposition of fundamentals of lithium batteries, it includes experimental techniques used to characterize electrode materials, and a comprehensive analysis of the structural, physical, and chemical properties necessary to insure quality control in production. The different properties specific to each component of the batteries are discussed in order to offer manufacturers the capability to choose which kind of battery should be used: which compromise between power and energy density and which compromise between energy and safety should be made, and for which cycling life. Although attention is primarily on electrode materials since they are paramount in terms of battery performance and cost, different electrolytes are also reviewed in the context of safety concerns and in relation to the solid-electrolyte interface. Separators are also reviewed in light of safety issues. The book is intended not only for scientists and graduate students working on batteries but also for engineers and technologists who want to acquire a sound grounding in the fundamentals of battery science arising from the interaction of electrochemistry, solid state materials science, surfaces and interfaces.

Fundamentals of Medium/Heavy Duty Commercial Vehicle Systems

A theoretical and technical guide to the electric vehicle lithium-ion battery management system Covers the timely topic of battery management systems for lithium batteries. After introducing the problem and basic background theory, it discusses battery modeling and state estimation. In addition to theoretical modeling it also contains practical information on charging and discharging control technology, cell equalisation and application to electric vehicles, and a discussion of the key technologies and research methods of the lithium-ion power battery management system. The author systematically expounds the theory knowledge included in the lithium-ion battery management systems and its practical application in electric vehicles, describing the theoretical connotation and practical application of the battery management systems. Selected graphics in the book are directly derived from the real vehicle tests. Through comparative analysis of the different system structures and different graphic symbols, related concepts are clear and the understanding of the battery management systems is enhanced. Contents include: key technologies and the difficulty point of vehicle power battery management system; lithium-ion battery performance modeling and
simulation; the estimation theory and methods of the lithium-ion battery state of charge, state of energy, state of health and peak power; lithium-ion battery charge and discharge control technology; consistent evaluation and equalization techniques of the battery pack; battery management system design and application in electric vehicles. A theoretical and technical guide to the electric vehicle lithium-ion battery management system Using simulation technology, schematic diagrams and case studies, the basic concepts are described clearly and offer detailed analysis of battery charge and discharge control principles Equips the reader with the understanding and concept of the power battery, providing a clear cognition of the application and management of lithium ion batteries in electric vehicles Arms audiences with lots of case studies Essential reading for Researchers and professionals working in energy technologies, utility planners and system engineers.

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