Ceramic Electrolytes For All Solid State Li Batte

Along with numerous illustrative examples, this text provides an overview of the dynamic behavior of dislocations and its relation to plastic deformation. It introduces the general properties of dislocations and treats the dislocation dynamics in some detail.

Membrane reactors are increasingly replacing conventional separation, process

and conversion technologies across a wide range of applications. Exploiting advanced membrane materials, they offer enhanced efficiency, are very adaptable and have great economic potential. There has therefore been increasing interest in membrane reactors from both the scientific and industrial communities, stimulating research and development. The two volumes of the Handbook of membrane reactors draw on this research to provide an authoritative review of this important field. Volume 2 reviews reactor types and

industrial applications, beginning in part one with a discussion of selected types of membrane reactor and integration of the technology with industrial processes. Part two goes on to explore the use of membrane reactors in chemical and large-scale hydrogen production from fossil fuels. Electrochemical devices and transport applications of membrane reactors are the focus of part three, before part four considers the use of membrane reactors in environmental engineering, biotechnology and medicine. Finally, the book concludes

with a discussion of the economic aspects of membrane reactors. With its distinguished editor and international team of expert contributors, the two volumes of the Handbook of membrane reactors provide an authoritative guide for membrane reactor researchers and materials scientists, chemical and biochemical manufacturers, industrial separations and process engineers, and academics in this field. Discusses integration of membrane technology with industrial processes Explores the use of

membrane reactors in chemical and large-scale hydrogen production from fossil fuels Considers electrochemical devices and transport applications of membrane reactors

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

Demands for electric vehicles and flexible electronics have escalated research in developing high-performance lithium batteries based on solid-state chemistry. The present work is to develop highly-conductive and flexible solid electrolyte for such applications. Lithium aluminum titanate phosphate (LATP or $Li_{1.3}Al_{0.3}Ti_{1.7}(PO_4)_3$), both in ceramic

pellets and free-standing composite membranes, have been fabricated. The crystal structure, surface morphology, and ionic conductivity are systematically studied. LATP pellets are prepared using solid state reaction approach. The results indicate that calcine temperature has significant impacts on the phase impurity and sintering temperature and duration have more impacts on the grain size and porosity of LATP pellets. At the optimal conditions, the highest bulk conductivity of LATP electrolyte reaches 1.5*10-3 S/cm

at room temperature with an activation energy of 0.206 eV. The as-prepared LATP has high conductivities comparable with liquid electrolytes, which is feasible for applications to all-solid-state lithium batteries. Ceramic electrolyte can be composited with polymer electrolyte to enable flexible battery design. In this study, LATP-based electrolyte membranes are fabricated in composite with a lithiated polymer, i.e. polyvinylidene fluoride (PVDF) dissolved with lithium perchlorate (LiClO4), via the casting method. It is found curing temperature has influences on ionic conductivities of the composite membrane and high casting temperature can cause the decomposition of PVDF. Appropriate LATP composition can increase the ionic conductivity, mechanical strength while maintaining the flexibility of the composite membrane. Raman spectroscopic analysis suggests there exists certain interactions among the three components in the composite membrane.

Fundamentals and Applications

All Solid State Thin-Film Lithium-Ion Batteries

Prospects For Li-ion Batteries And Emerging Energy Electrochemical Systems

Ceramic Electrolytes for All-Solid-State Li Batteries

Dislocation Dynamics During Plastic Deformation

Increasing pressure on global reserves of petroleum at a time of growing demand for personal transport in developing countries, together with concerns over atmospheric pollution and carbon dioxide emissions, are leading to a requirement for more sustainable forms of road transport. Major improvements in the efficiency of all types of road vehicles are called for, along with the use of fuels derived from alternative sources, or entirely new fuels. Towards Sustainable Road Transport first describes the evolution of vehicle designs and propulsion technologies over the past two centuries, before looking forward to possible new forms of energy to substitute for petroleum. The book also discusses the political and socio-economic drivers for change, investigates barriers to their broad implementation, and outlines the state-of-the-art of candidate power sources, advanced vehicle design, and associated infrastructure. The comprehensive technical informationsupplied by an expert author team ensures that Towards Sustainable Road Transport will provide readers with a clear understanding of the ongoing progress in this field and the challenges still to be faced. Drivers of technological change in road transport and the infrastructure requirements Discussion of alternative fuels for internal combustion engines and fuel conversion technologies Detailed exploration of current and emerging options for vehicle propulsion, with emphasis on hybrid/ battery electric traction, hydrogen, and fuel cells Comparative analysis of vehicle design requirements, primary power source efficiency, and energy storage systems Solid-state batteries hold the promise of providing energy storage with high volumetric and gravimetric energy densities at high power densities, yet with far less safety issues relative to those associated with conventional liquid or gel-based lithium-ion batteries. Solid-state batteries are envisioned to be useful for a broad spectrum of energy storage applications, including powering automobiles and portable electronic devices, as well as stationary storage and load-leveling of renewably generated energy. This comprehensive handbook covers a wide range of topics related to solid-state batteries, including advanced enabling characterization techniques, fundamentals of solid-state systems, novel solid electrolyte systems, interfaces, cell-level studies, and three-dimensional architectures. It is directed at physicists, chemists, materials scientists, electrochemists, electrical engineers, battery technologists, and evaluators of present and future generations of power sources. This handbook serves as a reference text providing state-of-the-art reviews on solid-state battery technologies, as well as providing insights into likely future developments in the field. It is extensively annotated with comprehensive references useful to the student and practitioners in the field.

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 Croguennec) 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 Palacín) 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;ElectrochemistryReview: 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
With the rise of electric vehicles and increasing dependence on mobile electronics, the demands for lithium-ion batteries have followed in tandem for their high energy and power densities. However, traditional lithium-ion batteries

consisting of liquid electrolytes have limited operating temperatures and are susceptible to ignition and subsequent fires. Recently, battery research has diverged into solid state chemistry to address the aforementioned issues. In this research, we systematically investigate a series of ceramic/polymer lithium-ion conducting composite electrolytes, i.e. Li1.4Al0.4Ge1.6(PO4)3 /lithiated polyethylene oxide (LAGP/PEO). Lithiated PEO was prepared with two different lithium salts, LiBF4 and LITFSI. The impacts of the LAGP on the electrical, thermal, and mechanical properties of the two lithiated PEO systems are assessed. When LAGP is homogenously distributed in PEO-LiTFSI films, ionic conductivities and thermal properties remain relatively uninhibited; the elastic modulus and ultimate strength increased up to 450% and 200%, respectively. When LAGP was added to PEO-LiBF4 films, it increased the elastic strength nearly 200% without compromising the ultimate strength and thermal properties, but at the sacrifice of ionic conductivity. The ceramic/polymeric electrolytes have potential applications to flexible all solid state lithium-ion batteries.

Li-s Batteries: The Challenges, Chemistry, Materials, And Future Perspectives

Polymer Electrolytes

SYNTHESIS AND CHARACTERIZATION OF HYBRID ELECTROLYTES WITH TETHERED IONIC LIQUID FOR LITHIUM ION BATTERIES.

A Unified Approach to Processing of Metals, Ceramics and Polymers

Cold Sintering Process for Materials and

Their Integration Enabling All-Solid-State Li-ion Batteries

High-performance secondary batteries, also called rechargeable or storage batteries, are a key component of electric automobiles, power storage for renewable energies, load levellers of electric power lines, base stations for mobile phones, and emergency power supply in hospitals, in addition to having application in energy security and realization of a low-carbon and resilient society. A detailed understanding of the physics and chemistry that occur in secondary batteries is required for developing next-generation secondary batteries with

improved performance. Among various types of secondary batteries, lithium-ion batteries are most widely used because of their high energy density, small memory effect, and low self-discharge rate. This book introduces lithium-ion batteries, with an emphasis on their overview, roadmaps, and simulations. It also provides extensive descriptions of ion beam analysis and prospects for in situ diagnostics of lithium-ion batteries. The chapters are written by specialists in cutting-edge research on lithium-ion batteries and related subjects. The book will be a great reference for advanced undergraduate- and graduate-level students, researchers, and engineers in electrochemistry, nanotechnology, and diagnostic methods and instruments. Lithium-sulfur (Li-S) batteries give us an alternative to the more prevalent lithium-ion (Li-ion) versions, and are known for their observed high energy densities. Systems using Li-S batteries are in early stages of development and commercialization however could potentially provide higher, safer levels of energy at significantly lower cost. In this book the history, scientific background, challenges and future perspectives of the lithium-sulfur system are presented by experts in the field. Focus is on past and recent advances of each cell compartment responsible for the performance of the Li-S battery, and includes analysis of characterization tools, new designs and computational modeling. As a comprehensive review of current state-of-play, it is ideal for undergraduates, graduate students, researchers, physicists, chemists and materials scientists interested in energy storage, material science and electrochemistry.

Electrolytes for Electrochemical Supercapacitors provides a state-of-the-art overview of the research and development of novel electrolytes and electrolyte configurations and systems to increase the energy density of electrochemical supercapacitors. Comprised of chapters written by leading international scientists active in supercapacitor research and manufacturing, this authoritative text: Describes a variety of electrochemical supercapacitor electrolytes and their properties, compositions, and systems Compares different electrolytes in terms of their effects on electrochemical supercapacitor performance Examines the interplay between the electrolytes, active electrode materials, and inactive components of the supercapacitors Discusses the design and optimization of electrolyte systems for improving electrochemical supercapacitor performance Explores the challenges electrochemical supercapacitors currently face, offering unique insight into next-generation supercapacitor applications Thus, Electrolytes for Electrochemical Supercapacitors is a valuable resource for the research and development activities of academic researchers, graduate/undergraduate students, industry professionals, and manufacturers of electrode/electrolyte systems and electrochemical energy devices such as batteries, as well as for end users of the technology. Showcasing recent developments in inorganic materials in an area of societal interest and importance, this book provides an up-to-date introduction to the contemporary use of functional solids in emerging technologies. Energy Storage and Conversion Materials describes the application of inorganic materials in the storage and conversion of energy, with an emphasis on how solid-state chemistry allows development of new functional solids for energy applications. Dedicated chapters cover co-electrolysis, low temperature fuel cells, oxide thermoelectric devices for energy conversion, solid-state Li batteries and thermochemical energy conversion. Edited and written by world-renowned scientists, this book will provide a comprehensive introduction for advanced undergraduates, postgraduates and researchers wishing to learn about the topic.

Ceramic Electrolytes for All-solid-state Li Batteries

Energy Storage and Conversion Materials
Overview, Simulation, and Diagnostics
Ceramic and Specialty Electrolytes for Energy Storage Devices
Trends in the New Millennium : Langkawi, Malaysia, 15-19 December 2002

A comprehensive overview of the main characterization techniques of polymer electrolytes and their applications in electrochemical devices Polymer Electrolytes is a comprehensive and up-to-date guide to the characterization and applications of polymer electrolytes. The authors ? noted experts on the topic ? discuss the various characterization methods, including impedance spectroscopy and thermal characterization. The authors also provide information on the myriad applications of polymer electrolytes in electrochemical devices, lithium ion batteries, supercapacitors, solar cells and electrochromic windows. Over the past three decades, researchers have been developing new polymer electrolytes and assessed their application potential in electrochemical and electrical power generation, storage, and conversion systems. As a result, many new polymer electrolytes have been found, characterized, and applied in electrochemical and electrical devices. This important book: -Reviews polymer electrolytes, a key component in electrochemical power sources, and thus benefits scientists in both academia and industry -Provides an interdisciplinary resource spanning electrochemistry, physical chemistry, and energy applications -Contains detailed and comprehensive information on characterization and applications of polymer electrolytes Written for materials scientists, physical chemists, solid state chemists, electrochemists, and chemists in industry professions, Polymer

Electrolytes is an essential resource that explores the key characterization techniques of polymer electrolytes and reveals how they are applied in electrochemical devices.

Rechargeable lithium ion batteries are revolutionary energy storage systems widely used in portable electronic devices (e.g., mobile phones, laptops) and more recently electrical vehicles. The conventional liquid electrolytes in the lithium ion battery brought about safety problems such as fire and explosion. Related safety accidents (e.g., cell phone explosion, laptop fire, plane smoldering, etc.) have been reported many times. This also eliminates the possibility of using lithium metal as anode material which has much higher theoretical specific capacity in comparison with commercial graphite electrode because of the growth of uncontrolled lithium dendrites can lead to short circuit and other serious accidents. Solid polymer electrolytes have many advantages over conventional liquid electrolytes. They are light-weighted, non-volatile and have much better safety features than liquid electrolyte. Meanwhile, they are also better than the ceramic electrolyte in terms of their excellent flexibility and processability. Currently, low ionic conductivity of solid polymer electrolytes (e.g., polyethylene oxide (PEO)) at ambient temperature still hinders their practical application. Ionic liquids (ILs) are non-flammable and have negligible volatility. Its ionic conductive nature, excellent chemical stability, and good electrochemical stability enable them to be regarded as useful components for next generation battery electrolytes. In this thesis work, focus will be placed on synthesis and characterization of ionic liquid tethered organic/inorganic hybrid polymer electrolyte with high room temperature ionic conductivity. Moreover, their electrochemical properties and prototype battery performances were also looked into. The use of highly conductive solid-state electrolytes to replace conventional liquid organic electrolytes enables radical improvements in reliability, safety and performance of lithium batteries. Here in chapter 2, we report the synthesis and characterization of a new class of nonflammable solid electrolytes based on the grafting of ionic liquids onto octa-silsesquioxane. The electrolyte exhibits outstanding room-temperature ionic conductivity (~4.8 10-4 S/cm), excellent electrochemical stability (up to 5 V relative to Li+/Li) and high thermal stability. All-solid-state Li metal batteries using the prepared electrolyte membrane are successfully cycled with high coulombic efficiencies at ambient temperature. Good cycling stability of the electrolyte against lithium has been demonstrated. This work provides a new platform of solid polymer electrolyte for the application of room-temperature lithium batteries. In chapter 3, an organic-inorganic hybrid solid electrolyte with ionic liquid moieties tethered onto dumbbell-shaped octasilsesquioxanes through oligo(ethylene glycol) spacers was synthesized. The hybrid electrolyte is featured by its high room-temperature ionic conductivity (1.210-4 S/cm at 20 oC with LiTFSI salt), excellent electrochemical stability (4.6 V vs Li+/Li), and great thermal stability. Excellent capability of the hybrid electrolyte to mediate electrochemical deposition and dissolution of lithium has been demonstrated in the symmetrical lithium cells. No short circuit has been observed after more than 500 hrs in the polarization tests.

Decent charge/discharge performance has been obtained in the prepared electrolyte based all-solid-state lithium battery cells at ambient temperature. In chapter 4, hybrid polymer electrolyte network (XPOSS-IL) synthesized by crosslinking the individual dendritic POSS-IL was investigated. To be specific, after grafting mono-broninated hexaethylene glycol to the POSS cage, 1-vinyl imidazole was adopted for the subsequent quarternization reaction. Then the chain end double bonds underwent free radical crosslinking process to produce XPOSS-IL. The ionic conductivity of LiTFSI dissolved XPOSS-IL is 5.4 10-5 S/cm at 30 . By adding a small fraction of ionic liquid 1-ethyl-3-methylimidazolium bis(trifluoromethylsulfonyl)imide (EMITFSI), the ionic conductivity increases to 1.4 10-4 S/cm at room temperature. It is also found that

EMITFSI will enhance the anodic stability of XPOSS-IL. The Li/LTO and Li/LFP cell assembled with X-POSS-IL-LiTFSI/EMITFSI demonstrates capability of delivering high specific capacities at room temperature and elevated temperature.

The current book contains twenty-two chapters and is divided into three sections. Section I consists of nine chapters which discuss synthesis through innovative as well as modified conventional techniques of certain advanced ceramics (e.g. target materials, high strength porous ceramics, optical and thermo-luminescent ceramics, ceramic powders and fibers) and their characterization using a combination of well known and advanced techniques. Section II is also composed of nine chapters, which are dealing with the aqueous processing of nitride ceramics, the shape and size optimization of ceramic components through design methodologies and manufacturing technologies, the sinterability and properties of ZnNb oxide ceramics, the grinding optimization, the redox behaviour of ceria based and related materials, the alloy reinforcement by ceramic particles addition, the sintering study through dihedral surface angle using AFM and the surface modification and properties induced by a laser beam in pressings of ceramic powders. Section

III includes four chapters which are dealing with the deposition of ceramic powders for oxide fuel cells preparation, the perovskite type ceramics for solid fuel cells, the ceramics for laser applications and fabrication and the characterization and modeling of protonic ceramics. This handbook provides comprehensive treatment of the current state of glass science from the leading experts in the field. Opening with an enlightening contribution on the history of glass, the volume is then divided into eight parts. The first part covers fundamental properties, from the current understanding of the thermodynamics of the amorphous state, kinetics, and linear and nonlinear optical properties through colors, photosensitivity, and chemical durability. The second part provides dedicated chapters on each individual glass type, covering traditional systems like silicates and other oxide systems, as well as novel hybrid amorphous materials and spin glasses. The third part features detailed descriptions of modern characterization techniques for understanding this complex state of matter. The fourth part covers modeling, from first-principles calculations through molecular dynamics simulations, and statistical modeling. The fifth part presents a range of laboratory and industrial glass processing methods. The remaining parts cover a wide and representative range of applications areas from optics and photonics through environment, energy, architecture, and sensing. Written by the leading international experts in the field, the Springer Handbook of Glass represents an invaluable resource for graduate students through academic and industry researchers working in photonics, optoelectronics, materials science, energy, architecture, and more.

Solid State Electrochemistry

Characterization Techniques and Energy Applications

Electrochemical Energy Storage for Renewable Sources and Grid Balancing

Advances in Ceramics

Reactor Types and Industrial Applications

This book discusses the roles of nanostructures and nanomaterials in the development of battery materials for state-of-the-art electrochemical energy storage systems, and provides detailed insights into the fundamentals of why batteries need nanostructures and nanomaterials. It explores the advantages offered by nanostructure electrode materials, the challenges of using nanostructured materials in batteries, as well as the rational design of nanostructures and nanomaterials to achieve optimal battery performance. Further, it closely examines the latest advances in the application of nanostructures and nanomaterials for future rechargeable batteries, including high-energy and high-power lithium ion batteries, lithium metal batteries (Li-O2, Li-S, Li-Se, etc.), all-solid-state batteries, and other metal batteries (Na, Mg, Al, etc.). It is a valuable reference resource for readers interested in or involved in research on energy storage, energy materials, electrochemistry and nanotechnology.

Solid state electrolytes for lithium ion batteries : performance requirements and ion transportation mechanism in solid polymer electrolytes / Jabeen Fatima M. J, Abhijith P. P, Jishnu N. S, Akhila Das, Neethu T.M. Balakrishnan, Jou-Hyeon Ahn, Raghavan Prasanth.

Solid electrolytes have great potential to address the safety issues of Li-ion batteries, but better synthesis methods are still required for ceramics electrolytes such as lithium lanthanum titanate (LLTO) and lithium lanthanum zirconate (LLZO). Pellets made from ceramic nanopowders using conventional sintering can be porous due to the agglomeration of nanoparticles (NPs). Electrospinning is a simple and versatile technique for preparing oxide ceramic nanowires (NWs) and was used to prepare electrospun LLTO and LLZO NWs. Pellets prepared from the electrospun LLTO NWs had higher density, less void space, and higher Li+ conductivity compared to those comprised of LLTO prepared with conventional sol-gel methods, which demonstrated the potential that electrospinning can provide towards improving the properties of sol-gel derived ceramics.

Cubic phase LLZO was stabilized at room temperature in the form of electrospun NWs without extrinsic dopants. Bulk LLZO with tetragonal structure was transformed to the cubic phase using particle size reduction via ball milling. Heating conditions that promoted particle coalescence and grain growth induced a transformation from the cubic to tetragonal phase in both types of nanostructured LLZO. Composite polymer solid electrolyte was fabricated using LLZO NWs as the filler and showed an improved ionic conductivity at room temperature. Nuclear magnetic resonance studies show that LLZO NWs partially modify the polymer matrix and create preferential pathways for Li+ conduction through the modified polymer regions. Doping did not have significant effect on improving the overall conductivity as the interfaces played a predominant role. By comparing fillers with different morphologies and intrinsic conductivities, it was found that both NW morphology and high intrinsic conductivity are desired.

In this book, the development of next-generation batteries is introduced. Included are reports of investigations to realize high energy density batteries: Li-air, Li-sulfur, and all solid-state and metal anode (Mg, Al, Zn) batteries. Sulfide and oxide solid electrolytes are also reviewed. A number of relevant aspects of all solid-state batteries with a carbon anode or Li-metal anode are discussed and described: The formation of the cathode; the interface between the cathode (anode) and electrolyte; the discharge and charge mechanisms of the Li-air battery; the electrolyte system for the Li-air battery; and cell construction. The Li-sulfur battery involves a critical problem, namely, the dissolution of intermediates of sulfur during the discharge process. Here, new electrolyte systems for the suppression of intermediate dissolution are discussed. Li-metal batteries with liquid electrolytes also present a significant problem: the dendrite formation of lithium. New separators and electrolytes are introduced to improve the safety and rechargeability of the Li-metal anode. Mg, Al, and Zn metal anodes have been also applied to rechargeable batteries, and in this book, new metal anode batteries are introduced as the generation-after-next batteries. This volume is a summary of ALCA-SPRING projects, which constitute the most extensive research for next-generation batteries in Japan. The work presented in this book is highly informative and useful not only for battery researchers but also for researchers in the fields of electric vehicles and energy storage.

Synthesis and Characterization, Processing and Specific

Applications
Solid Electrolytes for Advanced Applications
Handbook Of Solid State Batteries (Second Edition)
Fabrication and Characterizations of Lithium Aluminum Titanate Phosphate Solid Electrolytes for Li-based Batteries
Solid Electrolytes and Their Applications

The main motivation for the organization of the Advanced Research Workshop in Belgirate was the promotion of discussions on the most recent issues and the future perspectives in

the field of Solid State lonics. The location was chosen on purpose since Belgirate was the place were twenty years ago, also then under the sponsorship of NATO, the very first international meeting on this important and interdisciplinary field took place. That meeting was named "Fast Ion Transport in Solids" and gathered virtually everybody at that time having been active in any aspect of motion of ions in solids. The original Belgirate

Meeting made for the first time visible the technological potential related to the phenomenon of the fast ionic transport in solids and, accordingly, the field was given the name "Solid State lonics". This field is now expanded to cover a wide range of technologies which includes chemical sensors for environmental and process control, electrochromic windows, mirrors and displays, fuel cells, high performance rechargeable batteries for *stationary applications and electrotraction, chemotronics, semiconductor ionics, water electrolysis cells for hydrogen economy and other applications. The main idea for holding an anniversary meeting was that of discussing the most recent issues and the future perspectives of Solid State lonics just twenty years after it has started at the same location on the lake Maggiore in North Italy.*

All-solid-state batteries have gained much attention as the next-generation batteries. This book is about various Li ion ceramic electrolytes and their applications to all-solid-state battery. It contains a wide range of topics from history of ceramic electrolytes and ion conduction mechanisms to recent research achievements. Here oxide-type and sulfide-type ceramic electrolytes are described in detail. Additionally, *their applications to all-solid-state batteries, including Li-air battery and Li-S battery, are reviewed. Consisting of fundamentals and advanced technology, this book would be suitable for beginners in the research of ceramic electrolytes; it can also be used by scientists and research engineers for more advanced development.*

Ceramic and Specialty Electrolytes for Energy Storage Devices, Volume II, *investigates recent progress and challenges in a wide range of ceramic solid and quasi-solid electrolytes and specialty electrolytes for energy storage devices. The influence of these electrolyte properties on the performance of different energy storage devices is discussed in detail. Features: • Offers a detailed outlook on the performance requirements and ion transportation mechanism in solid polymer electrolytes • Covers solid-*

state electrolytes based on oxides (perovskite, anti-perovskite) and sulfide-type ion conductor electrolytes for lithium-ion batteries followed by solid-state electrolytes based on NASICON and garnet-type ionic conductors • Discusses electrolytes employed for high-temperature lithium-ion batteries, low-temperature lithium-ion batteries, and magnesium-ion batteries • Describes sodium-ion batteries, transparent electrolytes for *energy storage devices, non-platinum-based cathode electrocatalyst for direct methanol fuel cells, non-platinum-based anode electrocatalyst for direct methanol fuel cells, and ionic liquid-based electrolytes for supercapacitor applications • Suitable for readers with experience in batteries as well as newcomers to the field This book will be invaluable to researchers and engineers working on the development of next-generation* *energy storage devices, including materials and chemical engineers, as well as those involved in related disciplines.*

This volume presents a comprehensive collection of state-of-the-art advances in the field of solid state ionic materials and the design, fabrication and performance of devices that use them, such as lithium batteries, gas sensors, fuel cells, supercapacitors and electrochromic displays. These *electrochemical devices are becoming pervasive in our technologically driven lifestyles.The book includes research activities being carried out in the new millennium, through special keynote addresses, as well as invited and contributed papers, related to experimental and theoretical modeling in solid state ionics. The excellent coverage of topics arranged in such a fashion helps students and beginners to understand the field with enthusiasm.*

It also encompasses various experimental techniques often employed in solid state ionics research, such as XRD, XPS, hole-burning spectroscopy, EDAX, EXAFS, SEM, thermal analysis techniques, ac-impedance spectroscopy and other electrochemical techniques such as cyclic voltammetry, galvanostatic and potentiostatic electrochemical techniques. Theoretical and applied aspects of mixed conduction for applications mainly in solid oxide *fuel cells occupy a portion of the text. Finally, this volume demonstrates the amount of research activities being carried out in this application-oriented field.Solid State Ionics will be of interest to all in the solid state ionics community, including chemists, physicists, materials scientists and electrochemists, both in industry and in research.*

Handbook of Membrane Reactors

Fast Ion Transport in Solids

Fabrication and Characterizations of LAGP/PEO Composite Electrolytes for All Solid-state Lithium-ion Batteries
Ceramic Materials for Energy Applications
Na-β"-alumina Ceramic Electrolytes for High-temperature and All-solid-state Batteries

A comprehensive, accessible introduction to modern all-solid-state lithium-ion batteries. All-solid-state thin-film lithium-ion batteries present a special and especially important version of lithium-ion ones.

They are intended for battery-powered integrated circuit cards (smart-cards), radio-frequency identifier (RFID) tags, smart watches, implantable medical devices, remote microsensors and transmitters, Internet of Things systems, and various other wireless devices including smart building control and so on. Comprising four chapters the monograph explores and provides: The fundamentals of rechargeable batteries, comparison of lithium-ion batteries with other kinds, features of thin-film batteries. A description of functional materials for all-solid-state thin-film batteries. Various methods for applying functional layers of an all-solid-state thin-film lithium-ion battery. Diagnostics of functional

layers of all-solid-state thin-film lithium-ion batteries. The monograph is intended for teachers, researchers, advanced undergraduate students, and post-graduate students of profile faculties of universities, as well as for developers and manufacturers of thin-film lithium-ion batteries. This new volume covers the latest developments in the field of electrochemistry. It addresses a variety of topics including new materials development, materials synthesis, processing, characterization, property measurements, structure-property relationships, and device performance. A broader view of various electrochemical energy conversion devices make this book a critical read for scientists

and engineers working in related fields. Papers from the symposium at the 102nd Annual Meeting of The American Ceramic Society, April 29-May 3, 2000, Missouri and the 103rd Annual Meeting, April 22-25, 2001, Indiana.

Electricity from renewable sources of energy is plagued by fluctuations (due to variations in wind strength or the intensity of insolation) resulting in a lack of stability if the energy supplied from such sources is used in 'real time'. An important solution to this problem is to store the energy electrochemically (in a secondary battery or in hydrogen and its derivatives) and to make use of it in a controlled fashion at some time after it has been

initially gathered and stored. Electrochemical battery storage systems are the major technologies for decentralized storage systems and hydrogen is the only solution for long-term storage systems to provide energy during extended periods of low wind speeds or solar insolation. Future electricity grid design has to include storage systems as a major component for grid stability and for security of supply. The technology of systems designed to achieve this regulation of the supply of renewable energy, and a survey of the markets that they will serve, is the subject of this book. It includes economic aspects to guide the development of technology in the right direction. Provides state-of-

the-art information on all of the storage systems together with an assessment of competing technologies Features detailed technical, economic and environmental impact information of different storage systems Contains information about the challenges that must be faced for batteries and hydrogen-storage to be used in conjunction with a fluctuating (renewable energy) power supply

All Solid-state Batteries (ASSBs), enabled by solid electrolytes (SEs) possessing lithium ion conductivities greater than those of the liquid electrolytes at room temperature, have the potential of achieving higher energy and power densities than the conventional liquid electrolyte-based battery *systems by the integration of lithium metal anode. In addition, SEs are non-flammable which improves the safety and abuse tolerances of ASSBs. ASSBs, however, face challenges that include interfacial resistance towards the cathode and lithium metal anode, compatibility with high voltage cathode, chemical and mechanical stability against lithium dendrite growth, among others. This thesis focuses on the understanding, design, and optimization of the interface between the cathode and the SE in two ASSB systems. Thio-LISICON Li10GeP2S12 equivalent Li10SnP2S12 (LSPS) is comparable in ionic conductivity yet at a lower cost as an electrolyte for ASSBs. ASSBs with LSPS SE, lithium-indium alloy* *anode, and LiCoO2 (LCO) cathode were successfully fabricated and their electrochemical performance at 60 °C was examined. Atomic layer deposition (ALD) of Li3NbO4 on LCO was applied to improve the interfacial stability. The Li3NbO4 coating significantly improves the cycle stability of the ASSB, which retains about 85% of the initial capacity after 70 cycles at a current density of 0.13 mA/cm2, while the ASSB with uncoated LCO retains ~ 60% of the initial capacity after 70 cycles. Electrochemical impedance spectroscopy (EIS) tests indicate a rapid growth of charge transfer resistance upon cycling for the cell with the uncoated LCO, primarily due to the surface instability and build-up of a space charge*

layer between LSPS and LCO. However, the ASSBs with Li3NbO4 coated LCO show a more stable interface with a negligible impedance increase upon cycling, attributable to the 'buffering' and 'passivating' roles of the Li3NbO4 coating. The interfacial microstructure was analyzed to elucidate the underlying reasons for the impedance increase and the pivotal role of the Li3NbO4 coating. Our study indicates that surface coating significantly improves the cycle stability of the ASSBs with LSPS as the electrolyte mostly due to an improvement of the charge transfer mechanism. The coating reduced the interphase thickness and interfacial resistance Rsei to about a third of the uncoated one after 10

cycles. Using this knowledge in ASSBs, the previously unstudied Li2MCl4 (M=V, Cr, Fe, Mn, Co) were tested as an option for thick electrode/power batteries due to their high ionic conductivity (1.2 x 10−5 S/cm for Li2FeCl4 (LFC) vs. 5.0 x 10−5 S/cm for LiFePO4 at 25°C1), similar theoretical capacity (165 mAh/g for 1.2 Li+ out of Li2FeCl4 vs. 170 mAh/g for 1 Li+ from LiFePO42), and higher working voltage (3.7 V for LFC vs. 3.4 V for LiFePO41), and higher working voltage (3.7 V for LFC vs. 3.4 V for LiFePO4). These cathode materials were successfully synthesized by solid state reactions, as well as ball milling, using LiCl and MCl2 as the precursors. The crystal structure was determined by x-ray diffraction and confirmed with

Rietveld refinements. Dissolution experiments were performed to find a suitable liquid electrolyte for these cathode materials, but the use of solid electrolytes seems necessary. Polymer electrolytes are similarly shown to have adverse reactions with the cathode material, making the use of ceramic solid electrolytes necessary. When using LSPS SE, LFC exhibited a reversible discharge capacity of 200-250 mAh/g, corresponding to 1.25-1.75 Li+ ions per formula unit, but it seems to correspond to a conversion reaction. Further experiments were performed to determine the reaction mechanisms. A judicious SE selection became imperative to establish the electrochemical properties of LFC and the rest of

the Li2MCl4 family of materials. To that end, a SE in the halide family of electrolytes was synthesized and studied. The ionic conductivity of the recently discovered halide solid electrolyte Li3YCl6 (LYC) was studied as a function of its crystal structure. When the sample was quenched from 450 °C it exhibits a hexagonal phase, as opposed to the orthorhombic phase it presents when quenched from 350 °C. The high temperature hexagonal phase has an ionic conductivity of 0.05 mS/cm, while that for the lower temperature orthorhombic phase is twice as high at 0.10 mS/cm. Conversely, ball milling the sample, as reported by Asano et al. gives a room temperature ionic conductivity of 0.46 mS/cm, which is highly

encouraging for the scalability of this cheap, soft, relatively safe SE. LFC is finally explored as a cathode material for ASSBs using LYC SE. This previously unstudied cathode material was cycled at a C/10 rate, or 0.195 mA/cm2 at 25 °C, obtaining a discharge capacity of about 118 mAh/g, and it reached 80% discharge capacity at the 180th cycle. LFC is able to deliver 112 mAh/g, 106 mAh/g, 81 mAh/g, 40 mAh/g of the initial specific discharge capacity when tested at a rate of C/5, C/3, 1C, and 2C, respectively. EIS studies showed that the biggest contributor to impedance was the solid electrolyte layer, followed by the interface between the cathode and the solid electrolyte. The interphase was

confirmed through computational studies to be mainly composed of LiCl, FeCl2 and YCl3, which are either ionically (LiCl), or electronically conductive (FeCl2), and therefore, not detrimental to the impedance of the cell.

Realization of High Energy Density Rechargeable Batteries

Polymer and Ceramic Electrolytes for Energy Storage Devices, Two-Volume Set

Proceedings of the 8th Asian Conference on Solid State Ionics

Materials for Electrochemical Energy Conversion and Storage

Garnets and Competitors

This book is a collection of papers from The American Ceramic Society's 35th International Conference on Advanced Ceramics and Composites, held in Daytona Beach, Florida, January 23-28, 2011. This issue includes papers presented in the Ceramics for Electric Energy Generation, Storage and Distribution; Advanced Ceramics and Composites for Nuclear and Fusion Applications; and Advanced Materials and Technologies for Rechargeable Batteries symposia.

All-solid-state Li batteries (ASSB) have *attracted much attention as a next-generation battery system providing high energy density, improved safety, long cycle-life. However, there are a number of challenges to overcome in regard to the practical performance and fabrication process for large scale manufacturing and commercialization, such as low energy density due to low active materials fraction in the electrode composite, poor microstructures with high porosity, high interfacial resistances, the requirement of high temperature and long-time* *sintering process, and so forth. In this study, the cold sintering process was explored to densify the composite electrodes, solid-state electrolyte at low temperatures for achieving high volumetric capacity and ionic conductivity, respectively. Moreover, the integration process of the composite electrode and solid-state electrolyte layers for an all-solid-state Li-ion battery was developed to demonstrate its feasibility to co-sinter the multilayer solid-state full cell as a low-temperature fabrication* *process. Cold sintering process was a successful approach to densify cathode and anode composites, which are based on LiFePO4 (LFP) and Li4Ti5O12 (LTO), respectively, for achieving high volumetric capacity density. The cold sintered composite electrodes were demonstrated to have a high density of over 80 % of relative density with good microstructures and to provide high volumetric capacities relative to conventional electrodes fabricated by calendering process. Moreover, the cold* *sintering process was applied to fabricate the binder-free thin composite electrode tape with high active material fraction and successfully demonstrated to enable a highly densified and thin electrodes with not only high volumetric capacity, but also high rate capability. With regard to the solid-state electrolytes, the cold sintering process was explored to densify the pure Li1.5Al0.5Ge1.5(PO4)3 (LAGP) ceramics and demonstrated its possibility for the high-density LAGP ceramics with excellent microstructures. However, the* *ionic conductivity of the cold sintered electrolyte was not so promising as expected. The poor ionic conductivity of the cold sintered LAGP ceramics was attributed to the grain boundary with high resistance due to incongruent dissolution and resulting off-stoichiometry and poor crystallinity phases. To overcome this challenge of cold sintering for LAGP, various kinds of strategies for the cold sintering process of LAGP was considered like composite electrolytes mixed with a liquid electrolyte and/or a polymer and a* *salt. Additionally, the thin solid-state electrolyte tape was cold sintered for practical applications of ASSB. All the cold sintered composites layer can offer low areal resistance with high conductivity, showing the effectiveness of the cold sintering approach to fabricate solid-state electrolyte separator at low temperatures. Furthermore, the garnet Li7Lr3Zr2O12 (LLZO) electrolyte material was investigated to apply cold sintering to develop high conductivity LLZO electrolyte. The LLZO-based composites* *were cold sintered using dimethylformamide (DMF, C3H7NO). In this composite electrolyte study, a polymer-salt bridge was employed to form active phases between the LLZO grains for achieving high conductivity. The good microstructures with well-developed grain boundaries were characterized. Also, the high conductivity of the cold sintering LLZO composite in the broad temperature range compared to other ceramic or composite electrolytes were demonstrated. An all-solid-state Li-ion battery with a configuration of*

LTO/LLZO/LFP was fabricated by applying the cold sintering process to co-sinter and integrate three components. The cold sintering process was successfully demonstrated for co-sintering of the multilayered solid battery cell with limited defects. The cold sintered solid full cell was demonstrated to have dense microstructures and good interfaces between different materials developed by employing the polymer-salt composite. The cold sintered battery cell can offer high electrochemical performances such as low *internal cell resistance, high capacity, rate capability, and long cyclability. This cold sintering approach is a promising approach to enable all-solid-state batteries fabricated by co-sinter at low temperatures in large scale manufacturing.*

This book highlights the state of the art in solid electrolytes, with particular emphasis on lithium garnets, electrolyte-electrode interfaces and all-solid-state batteries based on lithium garnets. Written by an international group of *renowned experts, the book addresses how garnet-type solid electrolytes are contributing to the development of safe high energy density Li batteries. Unlike the flammable organic liquid electrolyte used in existing rechargeable Li batteries, garnet-type solid electrolytes are intrinsically chemically stable in contact with metallic lithium and potential positive electrodes, while offering reasonable Li conductivity. The book's respective chapters cover a broad spectrum of topics related to solid* *electrolytes, including interfacial engineering to resolve the electrolyte-electrode interfaces, the latest developments in the processing of thin and ultrathin lithium garnet membranes, and fabrication strategies for the high-performance solid-state batteries.This highly informative and intriguing book will appeal to postgraduate students and researchers at academic and industrial laboratories with an interest in the advancement of high energy-density lithium metal batteries*

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Next Generation Batteries

NA-ß"-Alumina Ceramic Electrolytes for High-temperature and All-solid-state Batteries

Encyclopedia of Glass Science, Technology, History, and Culture Two Volume Set

Materials Processing

Materials, Technology, and Diagnostics

Materials Processing is the first textbook to bring the fundamental concepts of materials processing together in a unified approach that highlights the overlap in scientific and engineering principles. It teaches students the key principles involved in the processing of engineering materials, specifically metals, ceramics and polymers, from starting or raw materials through to the final functional forms. Its self-contained approach is based on the state of matter most central to the shaping of the material: melt, solid, powder, dispersion and solution, and vapor. With this approach, students learn processing fundamentals and appreciate the similarities and differences between the materials classes. The book uses a consistent nomenclature that allow for easier comparisons between various materials and processes. Emphasis is on fundamental principles that gives students a strong foundation for understanding processing and manufacturing methods. Development of connections between processing and structure builds on students' existing knowledge of structure-property relationships. Examples of both standard and newer additive manufacturing methods throughout provide students with an overview of the methods that they will likely encounter in their careers. This book is intended primarily for upper-level undergraduates and beginning graduate students in Materials Science and Engineering who are already schooled in the structure and properties of metals, ceramics and polymers, and are ready to apply their knowledge to materials processing. It will also appeal to students from other engineering disciplines who have completed an introductory materials science and engineering course. Coverage of metal, ceramic and polymer processing in a single text provides a self-contained approach and consistent nomenclature that allow for easier comparisons between various materials and processes Emphasis on fundamental principles gives students a strong foundation for understanding processing and manufacturing methods Development of connections between processing and structure builds on students’ existing knowledge of structure - property relationships Examples of both standard and newer additive manufacturing methods throughout provide students with an overview of the methods that they will likely encounter in their careers

Defect solid state has been an area of major scientific and technological interest for the last few decades, the resulting important applications sus taining this interest. Solid electrolytes represent one area of defect solid state. The early work on defect ionic crystals and, in particular, the classic results of Kiukkola and Wagner in 1957 on stabilized zirconia and doped thoria laid the foundation for a systematic study of solid electrolytes. In the same year, Ure reported on the ionic conductivity of calcium fluoride. Since then, intense worldwide research has advanced our understanding of the defect structure and electrical conductivity of oxygen ion conductors such as doped zirconia and thoria and of the fluorides. This paved the way for thermo dynamic and kinetic studies using these materials and for technological applications based on the oxygen ion conductors. In the last few years we have seen the emergence of two new classes of solid electrolytes of great signifi cance: the fJ-aluminas and the silver ion conductors. The significance of these discoveries is that now (i) solid electrolytes are available which at room temperature exhibit electrical conductivity comparable to that of liquid electrolytes, (ii) useful electrical conductivity values can be achieved over a wide range of temperature and ambient conditions, and

(iii) a wide variety of ions are available as conducting species in solids. The stage is therefore set for a massive effort at developing applications.
Polymer and Ceramic Electrolytes for Energy Storage Devices features two volumes that focus on the most recent technological and scientific accomplishments in polymer, ceramic, and specialty electrolytes and their applications in lithium-ion batteries. These volumes cover the fundamentals in a logical and clear manner for students, as well as researchers from different disciplines, to follow. The set includes the following volumes: Polymer Electrolytes for Energy Storage Devices, Volume I, offers a detailed explanation of recent

progress and challenges in polymer electrolyte research for energy storage devices. Ceramic and Specialty Electrolytes for Energy Storage Devices, Volume II, investigates recent progress and challenges in a wide range of ceramic solid and quasi-solid electrolytes and specialty electrolytes for energy storage devices. These volumes will be invaluable to researchers and engineers working on the development of next-generation energy storage devices, including materials and chemical engineers, as well as those involved in related disciplines.

This Encyclopedia begins with an introduction summarizing itsscope and content. Glassmaking;

Structure of Glass, GlassPhysics,Transport Properties, Chemistry of Glass, Glass and Light,Inorganic Glass Families, Organic Glasses, Glass and theEnvironment, Historical and Economical Aspect of Glassmaking,History of Glass, Glass and Art, and outlinepossible newdevelopments and uses as presented by the best known people in thefield (C.A. Angell, for example). Sections and chapters arearranged in a logical order to ensure overall consistency and avoiduseless repetitions. All sections are introduced by a briefintroduction and attractive illustration. Newly investigatedtopics will be addresses, with the goal of ensuring that thisEncyclopedia remains a reference work

for years to come.
Electrolytes for Electrochemical Supercapacitors
Interfacial Engineering in All Solid-sate Lithium Ion Batteries
Electrospinning of Ceramic Solid Electrolyte Nanowires for Lithium-ion Batteries with Enhanced Ionic Conductivity
Nanostructures and Nanomaterials for Batteries
Lithium-Ion Batteries