Molten Salts Chemistry From Lab To Applications

This volume updates and combines two National Academy Press bestsellers--Prudent Practices for Handling Hazardous Chemicals in Laboratories and Prudent Practices for Disposal of Chemicals from Laboratories--which have served for more than a decade as leading sources of chemical safety guidelines for the laboratory. Developed by experts from academia and industry, with specialties in such areas as chemical sciences, pollution prevention, and laboratory safety, Prudent Practices for Safety in Laboratories provides step-by-step planning procedures for handling, storage, and disposal of chemicals. The volume explores the current culture of laboratory safety and provides an updated guide to federal regulations. Organized around a recommended workflow protocol for experiments, the book offers prudent practices designed to promote safety and it includes practical information on assessing hazards, managing chemicals, disposing of wastes, and more. Prudent Practices for Safety in Laboratories is essential reading for people working with laboratory chemicals: research chemists, technicians, safety officers, chemistry educators, and students.

Molten Salts Handbook focuses on the features, properties, and structure of molten salts. This book presents several topics in annotated bibliographic table form, including phase equilibria, chemical syntheses, and molten salt electrolytes. Organized into six chapters, this book starts with a tabular presentation of data of the physical properties, thermodynamic properties, electrochemical properties, practical features, as well as spectroscopy and structure of molten salts. This text then illustrates the design features of different experimental assemblies and provides information on the technique through a liberally annotated bibliography. Other chapters provide a chemical index, which offers a ready guide to the status of data over the entire range of interests. This book presents as well the properties of viscosity, density, surface tension, refractive index, and electrical conductance for different compounds as single salt melts. This book is a valuable resource for scientists and researchers from diverse fields, including theoretical and applied electrochemistry, inorganic coordination chemistry, and transition metal chemistry.

A future, robust energy portfolio will include, together with fossil fuel technologies and nuclear systems, a mix of renewable energy systems. Within each type of system there will also be variants used to strengthen a nation's baseload and/or peak power requirements. Among renewable energies, solar thermal systems are particularly promising in terms of their capability of contributing to the base-load power generation by providing enough thermal storage for continuous operation. In particular, direct volumetric absorption of the solar heat into molten salts seems to be a promising technology, in terms of efficiency and greenhouse gases emission reduction, which combines the good properties of molten salts as heat storage media with high operating temperatures. Accordingly, the selection of molten salts for this application required knowledge of the salts chemical behavior as well as optical properties. The molten salt selection and characterization was the objective of this Thesis. The light attenuation coefficient of two reagent grade molten salt mixtures (KNO 3 - NaNO 3, 40- 60 wt% and NaCI-KCI, 50-50 wt%) was measured and characterized over the wavelength range 400nm- 800nm and for different operating temperature ranges: 250*C-5000C for the nitrate mixture and 700*C- 8000C for the chloride mixture. The measurements were performed using a unique custom built experimental apparatus based on the transmission technique which combines high accuracy and flexibility in terms of experimental conditions and temperatures with simple layout, use of common lab materials and low cost. The experimental apparatus was validated using published data for both a room temperature fluid (water) as well as a high temperature fluid (a nitrate/nitrate mixture

presenting a well known absorption edge shifting with temperature). No previous experimental works characterized molten salts in terms of light attenuation coefficient as a function of temperature and wavelength and under this point of view the obtained results represent unique and direct optical measurement for such a class of fluids. Furthermore, the obtained results are coherent to general theory on molten salts, described as semi-transparent liquids in the visible range and characterized by absorption edges in the ultra-violet and far-infrared regions. About 90% of the solar light emitted in the wavelength range 400nm-800nm is attenuated by 2m of nitrate salt, while about 80% of the solar light emitted in the wavelength range 400nm-800nm is attenuated by 2m of chloride salt. In addition, the chemical stability and material compatibility of molten salt mixtures (including nitrate/nitrite, chloride and carbonate salt mixtures) with common materials of interests were assessed partially through dedicated material compatibility tests and more extensively using a thermodynamic chemistry software, able to predict the equilibrium composition of systems of specified composition at different temperatures. The preliminary melting and material compatibility tests resulted in some of the previously identified salt mixture candidates to be discarded because of undesirable reactions with structural materials or air that made them not suitable for the CSPonD design project.

This second volume carries on the excellent work of its predecessor, ex tending its scope to other melts and to other techniques. It continues to present first-hand understanding and experience of this difficult and demanding field. There is ever present the trade-off or reconciliation between the novel chemistry of systems not dominated by the mediating influence of a supposedly indifferent solvent and the high temperatures required to effect the fluidity of the system. At the limit, the very high temperatures so increase the rates of all reactions as to dissolve the temporal difference between the thermodynamic and the kinetic view of chemistry. What can happen will happen and invariably does happen. Vessels corrode, the apparatus becomes a reactant, and the number of tolerant materials able to withstand the attack shrinks to graphite, boron carbide or, if all else fails, to frozen parts of the molten salt itself. It is probably true that there is no limit to man's ingenuity but I believe that God gave us molten salts just to test that thesis. If there is ever a Molten Salt Club, and Englishmen love clubs, its membership will be exclusive. It would certainly include the authors of this series. Graham Hills University of Strathclyde ix Preface In the first volume of this series, we expressed our contention that a real need existed for practical guidance in the field of molten salt experimentation.

Prudent Practices in the Laboratory--the book that has served for decades as the standard for chemical laboratory safety practice--now features updates and new topics. This revised edition has an expanded chapter on chemical management and delves into new areas, such as nanotechnology, laboratory security, and emergency planning. Developed by experts from academia and industry, with specialties in such areas as chemical sciences, pollution prevention, and laboratory safety, Prudent Practices in the Laboratory provides guidance on planning procedures for the handling, storage, and disposal of chemicals. The book offers prudent practices designed to promote safety and includes practical information on assessing hazards, managing chemicals, disposing of wastes, and more. Prudent Practices in the Laboratory will continue to serve as the leading source of chemical safety guidelines for people working with laboratory chemicals: research chemists, technicians, safety officers, educators, and students.

Operating at a high level of fuel efficiency, safety, proliferation-resistance, sustainability and cost, generation IV nuclear reactors promise enhanced features to an energy resource which is already seen as an outstanding source of reliable

base load power. The performance and reliability of materials when subjected to the higher neutron doses and extremely corrosive higher temperature environments that will be found in generation IV nuclear reactors are essential areas of study, as key considerations for the successful development of generation IV reactors are suitable structural materials for both in-core and out-of-core applications. Structural Materials for Generation IV Nuclear Reactors explores the current state-of-the art in these areas. Part One reviews the materials, requirements and challenges in generation IV systems. Part Two presents the core materials with chapters on irradiation resistant austenitic steels, ODS/FM steels and refractory metals amongst others. Part Three looks at out-of-core materials. Structural Materials for Generation IV Nuclear Reactors is an essential reference text for professional scientists, engineers and postgraduate researchers involved in the development of generation IV nuclear reactors. Introduces the higher neutron doses and extremely corrosive higher temperature environments that will be found in generation IV nuclear reactors and implications for structural materials Contains chapters on the key core and out-of-core materials, from steels to advanced micro-laminates Written by an expert in that particular area

This state-of-the-art volume presents the new developments in fundamental research and in industrial applications of Molten Salts. Special attention is placed on recent developments of special topics such as Electrodeposition of Refractory Metals (Niobium, Molybdenum), and Organic Chemistry and Electrochemistry in Molten Salts.

Several state-of-the-art applications of molten salts are presented, such as metal-molten salt systems, room temperature glass formation, and room temperature melts. Several recent examples of applications highlight the importance of molten salts in various industries (batteries, pyrochemical reprocessing of nuclear fuel, synthesis and catalysis). The basic concepts of the structure, dynamics, electrochemistry, interfacial and thermodynamic properties are detailed and relevant experimental methods described. Such fundamental concepts are essential for an in-depth understanding of the physicochemical properties of molten salts in general, including metal-molten salts, glass forming and low temperature melts. Experimental methods for investigating structural, dynamical, electrochemical thermodynamical and interfacial properties are detailed, as also are techniques for data collection and analysis. Scientists, engineers and technologists will find the volume a valuable reference source covering a wide spectrum of fundamental concepts and modern technologies.

Molten salts are of considerable significance to chemical technology. Applications range from the established ones, such as the production of aluminum, magnesium, sodium and fluorine, to those as yet to be fully exploited, such as molten salt batteries and fuel cells, catalysis, and solar energy. Molten salts are investigated for different purposes by many diverse techniques. There is a need to keep investigators working in different areas, such as metal production, power sources, and glass industry, aware of

progress in various specialties, as well as to familiarize new research workers with the fundamental aspects of the broad field of molten salt _ chemistry. This volume constitutes the plenary lectures presented at the NATO Advanced Study Institute on Molten Salt Chemistry, Camerino, Italy, August 3-15, 1986. The fundamentals and several selected applications of molten salt chemistry were addressed. The major fundamental topics covered at this ASI were the structure of melts, thermodynamics of molten salt mixtures, theoretical and experimental studies of transport processes, metal-metal salt solutions, solvent properties of melt systems, acid-base effects in molten salt chemistry, electronic absorption, vibrational, and nuclear magnetic resonance spectroscopy of melt systems, electrochemistry and electroanalytical chemistry in molten salts, and organic chemistry in molten salts. The applied aspects of molten salt chemistry included the chemistry of aluminum production, electrodeposition using molten salts, and molten salt batteries and fuel cells.

Molten Salt Reactors is a comprehensive reference on the status of molten salt reactor (MSR) research and thorium fuel utilization. There is growing awareness that nuclear energy is needed to complement intermittent energy sources and to avoid pollution from fossil fuels. Light water reactors are complex, expensive, and vulnerable to core melt, steam explosions, and hydrogen explosions, so better technology is needed. MSRs could operate safely at nearly atmospheric pressure and high temperature, yielding efficient electrical power generation, desalination, actinide incineration, hydrogen production, and other industrial heat applications. Coverage includes: Motivation -- why are we interested? Technical issues – reactor physics, thermal hydraulics, materials, environment, ... Generic designs -- thermal, fast, solid fuel, liquid fuel, ... Specific designs – aimed at electrical power, actinide incineration, thorium utilization, ... Worldwide activities in 23 countries Conclusions This book is a collaboration of 58 authors from 23 countries, written in cooperation with the International Thorium Molten Salt Forum. It can serve as a reference for engineers and scientists, and it can be used as a textbook for graduate students and advanced undergrads. Molten Salt Reactors is the only complete review of the technology currently available, making this an essential text for anyone reviewing the use of MSRs and thorium fuel, including students, nuclear researchers, industrial engineers, and policy makers. Written in cooperation with the International Thorium Molten-Salt Forum Covers MSR-specific issues, various reactor designs, and discusses issues such as the environmental impact, non-proliferation, and licensing Includes case studies and examples from experts across the globe

Lists citations with abstracts for aerospace related reports obtained from world wide sources and announces documents that have recently been entered into the NASA Scientific and Technical Information Database.

Environmental problems derived from the massive use of conventional energy resources are one of the main issues that our society has been facing in recent decades. Renewable energies (and particularly solar energy) have become a highly competitive means to meet the world’s increasing energy demands in a sustainable and clean manner. One of the key research challenges for the commercial deployment of several solar energy technologies is focused on the development of feasible and durable coatings that withstand appropriate optical and thermal performance over the lifetime of the solar facilities. This book addresses a number

of relevant aspects related to coatings for renewable energies, including a deep survey of coatings used in photovoltaic solar energy, the development of a superhydrophobic and thermal stable silica coating that is potentially suitable for various industrial applications related to renewable technologies, the development of coatings to improve the resistance of structural materials used in concentrating solar thermal technologies with molten salts, and several research works related to solar reflectors for concentrating solar thermal technologies (such us the advanced analysis of the corrosion, the suitability of anti-soiling coatings, and the development of top protective coatings for high-temperature secondary concentrators).

Molten Salts ChemistryFrom Lab to ApplicationsNewnes

Physico-Chemical Analysis of Molten Electrolytes includes selected topics on the measurement and evaluation of physico-chemical properties of molten electrolytes. It describes the features, properties, and experimental measurement of different physico-chemical properties of molten salt systems used as electrolytes for different metal production, metallic layer deposition, as a medium for reactions in molten salts. The physico-chemical properties such as phase equilibria, density (molar volume), enthalpy (calorimetry), surface tension, vapor pressure, electrical conductivity, viscosity, etc. are the most important parameters of electrolytes needed for technological use. For each property the theoretical background, experimental techniques, as well as examples of the latest knowledge and the processing of most important salt systems will be given. The aim of Physico-Chemical Analysis of Molten Electrolytes is not only to present the state of the art on different properties of molten salts systems and their measurement, but also to present the possibilities of modeling molten salt systems, to be able to forecast the properties of an electrolyte mixture from the properties of the pure components in order to avoid experimentally demanding, and in most cases also expensive measurements. This book fills a substantial gap in this field of science. Also documententing the latest research in molten salts chemistry and brings new results and new insights into the study of molten salts systems using the results of X-ray diffraction and XAFS methods, Raman spectroscopy, and NMR measurements. * This book fills a substantial gap in this field of science * Serves as a invaluable reference for all people working in the field of molten salts chemistry * Describes fundamentals of the various properties of molten electrolytes

Molten salts and fused media provide the key properties and the theory of molten salts, as well as aspects of fused salts chemistry, helping you generate new ideas and applications for fused salts. Molten Salts Chemistry: From Lab to Applications examines how the electrical and thermal properties of molten salts, and generally low vapour pressure are well adapted to high temperature chemistry, enabling fast reaction rates. It also explains how their ability to dissolve many inorganic compounds such as oxides, nitrides, carbides and other salts make molten salts ideal as solvents in electrometallurgy, metal coating, treatment of by-products and energy conversion. This book also reviews newer applications of molten salts including materials for energy storage such as carbon nano-particles for efficient super capacitors, high capacity molten salt batteries and for heat transport and storage in solar plants. In addition, owing to their high thermal stability, they are considered as ideal candidates for the development of safer nuclear reactors and for the treatment of nuclear waste, especially to separate actinides from lanthanides by electrorefining. Explains the theory and properties of molten salts to help scientists understand these unique liquids Provides an ideal introduction to this expanding field Illustrated text with key real-life applications of molten salts in synthesis, energy, nuclear, and metal extraction

Reviews the science and engineering of high-temperature corrosion and provides guidelines for selecting the best materials for an array of

system processes High-temperature corrosion (HTC) is a widespread problem in an array of industries, including power generation, aerospace, automotive, and mineral and chemical processing, to name a few. This book provides engineers, physicists, and chemists with a balanced presentation of all relevant basic science and engineering aspects of high-temperature corrosion. It covers most HTC types, including oxidation, sulfidation, nitridation, molten salts, fuel-ash corrosion, H2S/H2 corrosion, molten fluoride/HF corrosion, and carburization. It also provides corrosion data essential for making the appropriate choices of candidate materials for high-temperature service in process conditions. A form of corrosion that does not require the presence of liquids, high-temperature corrosion occurs due to the interaction at high temperatures of gases, liquids, or solids with materials. HTC is a subject is of increasing importance in many areas of science and engineering, and students, researchers, and engineers need to be aware of the nature of the processes that occur in high-temperature materials and equipment in common use today, especially in the chemical, gas, petroleum, electric power, metal manufacturing, automotive, and nuclear industries. Provides engineers and scientists with the essential data needed to make the most informed decisions on materials selection Includes up-to-date information accompanied by more than 1,000 references, 80% of which from within the past fifteen years Includes details on systems of critical engineering importance, especially the corrosion induced by low-energy radionuclides Includes practical guidelines for testing and research in HTC, along with both the European and International Standards for high-temperature corrosion engineering Offering balanced, in-depth coverage of the fundamental science behind and engineering of HTC, High Temperature Corrosion: Fundamentals and Engineering is a valuable resource for academic researchers, students, and professionals in the material sciences, solid state physics, solid state chemistry, electrochemistry, metallurgy, and mechanical, chemical, and structural engineers.

Written to record and report on recent research progresses in the field of molten salts, Molten Salts Chemistry and Technology focuses on molten salts and ionic liquids for sustainable supply and application of materials. Including coverage of molten salt reactors, electrodeposition, aluminium electrolysis, electrochemistry, and electrowinning, the text provides researchers and postgraduate students with applications include energy conversion (solar cells and fuel cells), heat storage, green solvents, metallurgy, nuclear industry, pharmaceutics and biotechnology.

Advances in Nuclear Fuel Chemistry presents a high-level description of nuclear fuel chemistry based on the most recent research and advances. Dr. Markus H.A. Piro and his team of global, expert contributors cover all aspects of both the conventional uranium-based nuclear fuel cycle and non-conventional fuel cycles, including mining, refining, fabrication, and long-term storage, as well as emerging nuclear technologies, such as accident tolerant fuels and molten salt materials. Aimed at graduate students, researchers, academics and practicing engineers and regulators, this book will provide the reader with a single reference from which to learn the fundamentals of classical thermodynamics and radiochemistry. Consolidates the latest research on nuclear fuel chemistry into one comprehensive reference, covering all aspects of traditional and non-traditional nuclear fuel cycles Includes contributions from world-renowned experts from many countries representing government, industry and academia Covers a variety of fuel designs, including conventional uranium dioxide, mixed oxides, research reactor fuels, and molten salt fuels Written by experts with hands-on experience in the development of such designs

This issue of ECS Transactions presents the latest research on systems and processes involving molten salts and room

temperature ionic liquids. The studies compiled include both basic and applied research covering a wide range of topics. The main topics discussed in this volume include solution properties; reactions and separations; biochemical, biomedical, and green processes; electrodeposition; electrochemical power; corrosion and other electrochemical processes; and nuclear chemistry.