

## Ragone Thermodynamics Of Materials Volume 2 Solution

"In response to the growing economic and technological importance of polymers, ceramics, and semi-conductors, many materials science and engineering as they apply to all the classes of materials."--Back Cover.

Materials play a central role in society. Beyond the physical and chemical properties of materials, their cultural properties have often been overlooked in anthropological studies: finished products have been perceived as 'social' yet the materials which comprise them are considered 'raw' or natural'. The Social Life of Materials proposes a new perspective in this interdisciplinary field. Diverting attention from the consumption of objects, the book looks towards the properties of materials and how these exist through many transformations in a variety of cultural contexts. Human societies have always worked with materials. However, the customs and traditions surrounding this differ according to the place, the time and the material itself. Whether or not the material is man-made, materials are defined by social intervention. Today, these constitute one of the most exciting areas of global scientific research and innovation, harboring the potential to act as key vehicles of change in the world. But this 'materials revolution' has complex social implications. Smart materials are designed to anticipate our actions and needs, yet we are increasingly unable to apprehend the composite materials which comprise new products. Bringing together ethnographic studies of cultures from around the world, this collection explores the significance of materials by moving beyond questions of what may be created from them. Instead, the text argues that the materials themselves represent a shifting ground around which relationships, identities and powers are constantly formed and dissolved in the act of making and remaking.

The development of new high-tech applications and devices has created a seemingly insatiable demand for novel functional materials with enhanced and tailored properties. Such materials can be achieved by three-dimensional structuring on the nanoscale, giving rise to a significant enhancement of particular functional characteristics which stems from the ability to access both surface/interface and bulk properties. The highly ordered, bicontinuous double-gyroid morphology is a fascinating and particularly suitable 3D nanostructure for this purpose due to its highly accessible surface area, connectivity, narrow pore diameter distribution and superb structural stability. The presented study encompasses a wide range of modern nanotechnology techniques in a highly versatile bottom-up nanopatterning strategy that splits the fabrication process into two successive steps: the preparation of mesoporous double-gyroid templates utilizing diblock copolymer self-assembly, and their replication with a functional material employing electrochemical deposition and atomic layer deposition. The double-gyroid structured materials discussed include metals, metal oxides, and conjugated polymers, which are applied and characterized in high-performance devices, such as electrochromic displays, supercapacitors, chemical sensors and photovoltaics. This publication addresses a wide range of readers, from researchers and specialists who are professionally active in the field, to more general readers interested in chemistry, nanoscience and physics.

This book introduces the main aspects of modern applied electrochemistry. Starting with the basics of electrochemical kinetics, the authors address the chemistry and types of corrosion, principles of electro- and biocatalysis, electrodeposition and its applications in industrial processes. The book later discusses the electrochemistry and photoelectrochemistry of semiconductors and their applications in solar energy conversion and photocatalysis.

Structure, Properties and Processing

Energy Storage

Applied Electrochemistry

Vehicle Propulsion Systems

Advances in Sintering Science and Technology

Kinetics in Materials Science and Engineering

Designed to provide students with the core understanding necessary to pursue the subject of ceramics as it now exists and to be prepared for any surprises likely to emerge. Key concepts are developed in a sequence which builds on firm foundations, using the material learned so that its significance is continuously reinforced. The nature of defects which intrudes upon the perfect geometry of ideal crystal structures, migration of matter and charge, chemical and phase equilibria are among the subjects discussed.

Materials Kinetics: Transport and Rate Phenomena provides readers with a clear understanding of how physical-chemical principles are applied to fundamental kinetic processes. The book integrates advanced concepts with foundational knowledge and cutting-edge computational approaches, demonstrating how diffusion, morphological evolution, viscosity, relaxation and other kinetic phenomena can be applied to practical materials design problems across all classes of materials. The book starts with an overview of thermodynamics, discussing equilibrium, entropy, and irreversible processes. Subsequent chapters focus on analytical and numerical solutions of the diffusion equation, covering Fick's laws, multicomponent diffusion, numerical solutions, atomic models, and diffusion in crystals, polymers, glasses, and polycrystalline materials. Dislocation and interfacial motion, kinetics of phase separation, viscosity, and advanced nucleation theories are examined next, followed by detailed analyses of glass transition and

relaxation behavior. The book concludes with a series of chapters covering molecular dynamics, energy landscapes, broken ergodicity, chemical reaction kinetics, thermal and electrical conductivities, Monte Carlo simulation techniques, and master equations. Covers the full breadth of materials kinetics, including organic and inorganic materials, solids and liquids, theory and experiments, macroscopic and microscopic interpretations, and analytical and computational approaches Demonstrates how diffusion, viscosity microstructural evolution, relaxation, and other kinetic phenomena can be leveraged in the practical design of new materials Provides a seamless connection between thermodynamics and kinetics Includes practical exercises that reinforce key concepts at the end of each chapter

Starting from physical and electrochemical foundations, this textbook explains working principles of energy storage devices. After a history of galvanic cells, different types of primary, secondary and flow cells as well as fuel cells and supercapacitors are covered. An emphasis lies on the general setup and mechanisms behind those devices to enable easy understanding for students from all technical and natural science disciplines.

The European Union's directive banning the use of lead-based (Pb) solders in electronic consumer products has created an urgent need for research on solder joint behavior under various driving forces in electronic manufacturing, and for development of lead-free solders. This book provides a comprehensive examination of advanced materials reliability issues related to copper-tin reaction and electromigration in solder joints, and presents methods for preventing common reliability problems.

Recent Advances in Graphene Research

Materials and Human History from the Stone Age to the Age of Silicon

Electric Vehicle Battery Systems

Thermodynamics of Materials, Volume 2

Materials Thermodynamics

Physical Ceramics

**Provides a unique, interdisciplinary perspective on state-of-the-art physical gels, highlighting recent developments and practical applications.**

**This 2006 book combines modern and traditional solid mechanics topics in a coherent theoretical framework.**

**Fuel Cells and Hydrogen: From Fundamentals to Applied Research provides an overview of the basic principles of fuel cell and hydrogen technology, which subsequently allows the reader to delve more deeply into applied research. In addition to covering the basic principles of fuel cells and hydrogen technologies, the book examines the principles and methods to develop and test fuel cells, the evaluation of the performance and lifetime of fuel cells and the concepts of hydrogen production. Fuel Cells and Hydrogen: From Fundamentals to Applied Research acts as an invaluable reference book for fuel cell developers and students, researchers in industry entering the area of fuel cells and lecturers teaching fuel cells and hydrogen technology.**

**Includes laboratory methods for fuel cell characterization and manufacture Outlines approaches in modelling components, cells and stacks Covers practical and theoretical methods for hydrogen production and storage**

**Provides engineers and technicians with detailed data and information on the characteristics, properties, performance, and uses of all types of electric batteries.**

**Lithium-ion Battery Materials and Engineering**

**Mechanics of Solids and Materials**

**Materials, Properties, Applications**

**Synthesis and Applications**

**Introduction to Modeling and Optimization**

**Physical Metallurgy**

Are You Looking for a Unified and Concise Approach to Teaching and Learning the Structure of Materials? Allen and Thomas present information in a manner consistent with the way future scientists and engineers will be required to think about materials' selection, design, and use.

Students will learn the fundamentals of three different states of condensed matter-glasses, crystals, and liquid crystals-and develop a set of tools for describing all of them. Above all, they'll gain a better understanding of the principles of structure common to all materials.

Key concepts, such as symmetry theory, are introduced and applied to provide a common viewpoint for describing structures of ceramic, metallic, and polymeric materials. Structure-sensitive properties of real materials are introduced. The text also includes a variety of

worked example problems. Other texts available in the MIT Series: Thermodynamics of Materials, Vol I, Ragone, 30885-4 Thermodynamics of Materials, Vol II: Kinetics, Ragone, 30886-2 Physical Ceramics: Principles for Ceramics Science and Engineering, Chiang, Birnie, Kingery,

59873-9 Electronic Properties of Engineering Materials, Livingston, 31627-X

This is a concise, up-to-date book that covers a wide range of important ceramic materials used in modern technology. Chapters provide essential information on the nature of these key ceramic raw materials including their structure, properties, processing methods and applications in engineering and technology. Treatment is provided on materials such as alumina, aluminates, Andalusite, kyanite, and sillimanite. The chapter authors are leading experts in the field of ceramic materials. An ideal text for graduate students and practising engineers in ceramic engineering, metallurgy, and materials science and engineering.

Crystal growth is an important process, which forms the basis for a wide variety of natural phenomena and engineering developments. This book provides a unique opportunity for a reader to gain knowledge about various aspects of crystal growth from advanced inorganic materials to inorganic/organic composites, it unravels some problems of molecular crystallizations and shows advances in growth of pharmaceutical crystals, it tells about biomineralization of mollusks and cryoprotection of living cells, it gives a chance to learn about statistics of chiral asymmetry in crystal structure.

Organized nanoassemblies of inorganic nanoparticles and organic molecules are building blocks of nanodevices, whether they are designed to perform molecular level computing, sense the environment or improve the catalytic properties of a material. The key to creation of these hybrid nanostructures lies in understanding the chemistry at a fundamental level. This book serves as a reference book for researchers by providing fundamental understanding of many nanoscopic materials.

Studies in Materials and Society

Materials Kinetics Fundamentals

The Social Life of Materials

Supercapacitors

Chemical Sensors ... : Proceedings of the Symposium

The Substance of Civilization

Electroceramics, Materials, Properties, Applications, Second Edition provides a comprehensive treatment of the many aspects of ceramics and their electrical applications. The fundamentals of how electroceramics function are carefully introduced with their properties and applications also considered. Starting from elementary principles, the physical, chemical and mathematical background of the subject are discussed and wherever appropriate, a strong emphasis is placed on the relationship between microstructure and properties. The Second Edition has been fully revised and updated, building on the foundation of the earlier book to provide a concise text for all those working in the growing field of electroceramics. fully revised and updated to include the latest technological changes and developments in the field includes end of chapter problems and an extensive bibliography an Invaluable text for all Materials Science students. a useful reference for physicists, chemists and engineers involved in the area of electroceramics.

A timely, applications-driven text in thermodynamics Materials Thermodynamics provides both students and professionals with the in-depth explanation they need to prepare for the real-world application of thermodynamic tools. Based upon an actual graduate course taught by the authors, this class-tested text covers the subject with a broader, more industry-oriented lens than can be found in any other resource available. This modern approach: Reflects changes rapidly occurring in society at large—from the impact of computers on the teaching of thermodynamics in materials science and engineering university programs to the use of approximations of higher order than the usual Bragg-Williams in solution-phase modeling Makes students aware of the practical problems in using thermodynamics Emphasizes that the calculation of the position of phase and chemical equilibrium in complex systems, even when properly defined, is not easy Relegates concepts like equilibrium constants, activity coefficients, free energy functions, and Gibbs-Duhem integrations to a relatively minor role Includes problems and exercises, as well as a solutions manual This authoritative text is designed for students and professionals in materials science and engineering, particularly those in physical metallurgy, metallic materials, alloy design and processing, corrosion, oxidation, coatings, and high-temperature alloys.

This issue of the Ceramic Transactions compiles 41 papers covering a rich diversity of the sintering science and technology topics. These papers were presented at the International Conference on Sintering, November 16-20, 2008 in La Jolla, California. The Ceramic Transactions series contains a collection of papers dealing with issues in both traditional ceramics (i.e., glass, whitewares, refractories, and porcelain enamel) and advanced ceramics. Topics covered in the area of advanced ceramic include bioceramics, nanomaterials, composites, solid oxide fuel cells, mechanical properties and structural design, advanced ceramic coatings, ceramic armor, porous ceramics, and more.

Physical metallurgy is one of the main fields of metallurgical science dealing with the development of the microstructure of metals in order to achieve

desirable properties required in technological applications. Physical Metallurgy: Principles and Design focuses on the processing–structure–properties triangle as it applies to metals and alloys. It introduces the fundamental principles of physical metallurgy and the design methodologies for alloys and processing. The first part of the book discusses the structure and change of structure through phase transformations. The latter part of the books deals with plastic deformation, strengthening mechanisms, and mechanical properties as they relate to structure. The book also includes a chapter on physical metallurgy of steels and concludes by discussing the computational tools, involving computational thermodynamics and kinetics, to perform alloy and process design.

Exploring Engineering

Thermodynamics of Materials

Solder Joint Technology

Chemical Sensors Four

The Structure of Materials

Physics and Chemistry of Batteries

"A pedagogical gem.... Professor Readey replaces 'black-box' explanations with detailed, insightful derivations. A wealth of practical application examples and exercise problems complement the exhaustive coverage of kinetics for all material classes." -Prof. Rainer Hebert, University of Connecticut "Prof. Readey gives a grand tour of the kinetics of materials suitable for experimentalists and modellers.... In an easy-to-read and entertaining style, this book leads the reader to fundamental, model-based understanding of kinetic processes critical to development, fabrication and application of commercially-important soft (polymers, biomaterials), hard (ceramics, metals) and composite materials. It is a must-have for anyone who really wants to understand how to make materials and how they will behave in service." --Prof. Bill Lee, Imperial College London, Fellow of the Royal Academy of Engineering "A much needed text filling the gap between an introductory course in materials science and advanced materials-specific kinetics courses. Ideal for the undergraduate interested in an in-depth study of kinetics in materials." -Prof. Mark E. Eberhart, Colorado School of Mines This book provides an in-depth introduction to the most important kinetic concepts in materials science, engineering, and processing. All types of materials are addressed, including metals, ceramics, polymers, electronic materials, biomaterials, and composites. The expert author with decades of teaching and practical experience gives a lively and accessible overview, explaining the principles that determine how long it takes to change material properties and make new and better materials. The chapters cover a broad range of topics extending from the heat treatment of steels, the processing of silicon integrated microchips, and the production of cement, to the movement of drugs through the human body. The author explicitly avoids "black box" equations, providing derivations with clear explanations.

Electric Vehicle Battery Systems provides operational theory and design guidance for engineers and technicians working to design and develop efficient electric vehicle (EV) power sources. As Zero Emission Vehicles become a requirement in more areas of the world, the technology required to design and maintain their complex battery systems is needed not only by the vehicle designers, but by those who will provide recharging and maintenance services, as well as utility infrastructure providers. Includes fuel cell and hybrid vehicle applications. Written with cost and efficiency foremost in mind, Electric Vehicle Battery Systems offers essential details on failure mode analysis of VRLA, NiMH battery systems, the fast-charging of electric vehicle battery systems based on Pb-acid, NiMH, Li-ion technologies, and much more. Key coverage includes issues that can affect electric vehicle performance, such as total battery capacity, battery charging and discharging, and battery temperature constraints. The author also explores electric vehicle performance, battery testing (15 core performance tests provided), lithium-ion batteries, fuel cells and hybrid vehicles. In order to make a practical electric vehicle, a thorough understanding of the operation of a set of batteries in a pack is necessary. Expertly written and researched, Electric Vehicle Battery Systems will prove invaluable to automotive engineers, electronics and integrated circuit design engineers, and anyone whose interests involve electric vehicles and battery systems. \* Addresses cost and efficiency as key elements in the design process \* Provides comprehensive coverage of the theory, operation, and configuration of complex battery systems, including Pb-acid, NiMH, and Li-ion technologies \* Provides comprehensive coverage of the theory, operation, and configuration of complex battery systems, including Pb-acid, NiMH, and Li-ion technologies

Master simple to advanced biomaterials and structures with this essential text. Featuring topics ranging from bionanoengineered materials to bio-inspired structures for spacecraft and bio-inspired robots, and covering issues such as motility, sensing, control and morphology, this highly illustrated text walks the reader through key scientific and practical engineering principles, discussing properties, applications and design. Presenting case studies for the design of materials and structures at the nano, micro, meso and macro-scales, and written by some of the leading experts on the subject, this is the ideal introduction to this emerging field for students in engineering and science as well as researchers.

In this completely revised edition, all the chapters have been updated to reflect the current state of crystal growth kinetics. At the same time, fifteen percent additional content now allows coverage of computer-assisted modeling of second-order phase changes, microstructure development, novel data and images of coarsening mechanisms, with the most significant single addition being breakthrough results on spinodal decomposition -- published here for the first time in book form. The refined didactical approach with a streamlined presentation now allows readers to grasp the kinetic concepts even more easily, coherently introducing the field of kinetic processes, especially those involved in crystal growth, and explaining such phenomena as diffusion, nucleation, segregation and phase transitions at a level accessible to graduate students. In addition to the basic kinetic concepts, the textbook presents modern applications where these processes play a major role, including ion implantation, plasma deposition and rapid thermal processing.

Principles for Ceramic Science and Engineering

Fuel Cells and Hydrogen

Bioinspired Structures and Design

Nanoscale Materials

Ceramic Materials

Thermodynamic Equilibrium and Stability of Materials

**This book "Recent Advances in Graphene Research" provides a state-of-the-art report of the knowledge accumulated in graphene research. It contains 12 chapters divided into three sections. Section 1 "Fundamentals of Graphene" deals with quantum hall effect in graphene, electronic properties of carbon nanostructures and spectral statistics of graphene nanoflakes. In Section 2 "Graphene Synthesis," the optimized synthesis procedures of graphene and its derivatives are presented. The application of graphene and its nanostructured-based materials for energy storage, conservation and other extensive applications are described in Section 3 "Application of Graphene and its Nanostructures". We believe that this book offers broader prospective to the readers in the recent advances in graphene research, starting from fundamental science to application.**

**An accessible textbook providing students with a working knowledge of the properties of defects in crystals, in a step-by-step tutorial style.**

**The authors of this text have written a comprehensive introduction to the modeling and optimization problems encountered when designing new propulsion systems for passenger cars. It is intended for persons interested in the analysis and optimization of vehicle propulsion systems. Its focus is on the control-oriented mathematical description of the physical processes and on the model-based optimization of the system structure and of the supervisory control algorithms.**

**"What Sass does—and does well—is convey the richness of the material world and the ingenuity of humankind in making use of it." —Kirkus Reviews**

**Kinetic Processes**

**Principles and Design**

**Double-Gyroid-Structured Functional Materials**

**Fundamentals, Materials and Applications**

**Physical Gels from Biological and Synthetic Polymers**

**Materials Kinetics**

Ceramic Materials: Science and Engineering is an up-to-date treatment of ceramic science, engineering, and applications in a single, integrated text. Building on a foundation of crystal structures, phase equilibria, defects and the mechanical properties of ceramic materials, students are shown how these materials are processed for a broad diversity of applications in today's society.

Concepts such as how and why ions move, how ceramics interact with light and magnetic fields, and how they respond to temperature changes are discussed in the context of their applications.

References to the art and history of ceramics are included throughout the text. The text concludes with discussions of ceramics in biology and medicine, ceramics as gemstones and the role of ceramics in the interplay between industry and the environment. Extensively illustrated, the text also includes questions for the student and recommendations for additional reading. KEY

FEATURES: Combines the treatment of bioceramics, furnaces, glass, optics, pores, gemstones, and point defects in a single text Provides abundant examples and illustrations relating theory to practical applications Suitable for advanced undergraduate and graduate teaching and as a reference for researchers in materials science Written by established and successful teachers and authors with experience in both research and industry

Designed specifically for material scientists, this volume presents the thermodynamics of solids, covering statistical thermodynamics as well as classical thermodynamics. The text should be relevant to thermodynamics/physical chemistry courses in both engineering and chemistry departments.

Gaining public attention due, in part, to their potential application as energy storage devices in cars, Lithium-ion batteries have encountered widespread demand, however, the understanding of lithium-ion technology has often lagged behind production. This book defines the most commonly encountered challenges from the perspective of a high-end lithium-ion manufacturer with two decades of experience with lithium-ion batteries and over six decades of experience with batteries of other chemistries. Authors with years of experience in the applied science and engineering of lithium-ion batteries gather to share their view on where lithium-ion technology stands now, what are the main challenges, and their possible solutions. The book contains real-life examples of how a subtle change in cell components can have a considerable effect on cell's performance. Examples are supported with approachable basic science commentaries. Providing a unique combination of practical know-how with an in-depth perspective, this book will appeal to graduate students, young faculty members, or others interested in the current research and development trends in lithium-ion technology.

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.

Materials, Properties, and Reliability

## Current Topics and Problems from the Manufacturing Perspective

Electrochemical Energy Storage

An Introduction to Engineering and Design

Electroceramics

Ceramic and Glass Materials

Introductory kinetics for the undergrad materials scientist *Materials Kinetics Fundamentals* is an accessible and interesting introduction to kinetics processes, with a focus on materials systems. Designed for the undergraduate student, this book avoids intense mathematics to present the theory and application of kinetics in a clear, reader-friendly way. Students are first introduced to the fundamental concepts of kinetics, with illustrated diagrams, examples, text boxes, and homework questions that impart a unified, intuitive understanding. Further chapters cover the application of these concepts in the context of materials science, with real-world examples including silicon processing and integrated circuit fabrication, thin-film deposition, carbon-14 dating, steel degassing, energy conversion, and more. Instructor materials including PowerPoint presentations, a test bank, and more are available through the companion website, providing a complete resource for the undergraduate materials science student. At its core, kinetics deals with rates, telling us how fast something will take place - for example, how fast water will evaporate, or how fast molten silicon will solidify. This book is designed to provide students with an introduction to kinetics' underlying principles, without rigorous math to distract from understanding. Understand universally important kinetic concepts like diffusion and reaction rate Model common kinetic processes both quantitatively and qualitatively Learn the mechanisms behind important and interesting materials systems Examine the behaviors, properties, and interactions of relevant solid materials There are a large number of books on chemical kinetics, but there are far fewer that focus on materials kinetics, and virtually none that provide an accessible, introductory-level treatment of the subject. *Materials Kinetics Fundamentals* fills that need, with clear, detailed explanations of these universal concepts.

Winner in its first edition of the Best New Undergraduate Textbook by the Professional and Scholarly Publishing Division of the American Association of Publishers (AAP), Kosky, et al is the first text offering an introduction to the major engineering fields, and the engineering design process, with an interdisciplinary case study approach. It introduces the fundamental physical, chemical and material bases for all engineering work and presents the engineering design process using examples and hands-on projects. Organized in two parts to cover both the concepts and practice of engineering: Part I, *Minds On*, introduces the fundamental physical, chemical and material bases for all engineering work while Part II, *Hands On*, provides opportunity to do design projects An Engineering Ethics Decision Matrix is introduced in Chapter 1 and used throughout the book to pose ethical challenges and explore ethical decision-making in an engineering context Lists of "Top Engineering Achievements" and "Top Engineering Challenges" help put the material in context and show engineering as a vibrant discipline involved in solving societal problems New to this edition: Additional discussions on what engineers do, and the distinctions between engineers, technicians, and managers (Chapter 1) New coverage of Renewable Energy and Environmental Engineering helps emphasize the emerging interest in Sustainable Engineering New discussions of Six Sigma in the Design section, and expanded material on writing technical reports Re-organized and updated chapters in Part I to more closely align with specific engineering disciplines new end of chapter exercises throughout the book

Energy - in the headlines, discussed controversially, vital. The use of regenerative energy in many primary forms leads to the necessity to store grid dimensions for maintaining continuous supply and enabling the replacement of fossil fuel systems. Chemical energy storage is one of the possibilities besides mechano-thermal and biological systems. This work starts with the more general aspects of chemical energy storage in the context of the geosphere and evolves to dealing with aspects of electrochemistry, catalysis, synthesis of catalysts, functional analysis of catalytic processes and with the interface between electrochemistry and heterogeneous catalysis. Top-notch experts provide a sound, practical, hands-on insight into the present status of energy conversion aimed primarily at the young emerging research front.

This edited volume *Supercapacitors: Theoretical and Practical Solutions* is a collection of reviewed and relevant research

chapters, offering a comprehensive overview of recent developments in the field of electronic devices and materials. The book comprises single chapters authored by various researchers and is edited by a group of experts. Each chapter is complete in itself but united under a common research study topic. This publication aims at providing a thorough overview of the latest research efforts by international authors on electronic devices and materials and opens new possible research paths for further novel developments.

Crystal Growth, Diffusion, and Phase Transitions in Materials

Thermodynamics of Materials, Volume 1

Transport and Rate Phenomena

Chemical Energy Storage

Imperfections in Crystalline Solids

Handbook of Batteries

*This is a textbook on thermodynamics of materials for junior/senior undergraduate students and first-year graduate students as well as a reference book for researchers who would like to refresh their understanding of thermodynamics. The textbook employs a plain language to explain the thermodynamic concepts and quantities. It embraces the mathematical beauty and rigor of Gibbs thermodynamics through the fundamental equation of thermodynamics from which all thermodynamic properties of a material can be derived. However, a reader with basic first-year undergraduate calculus skills will be able to get through the book without difficulty. One unique feature of this textbook is the descriptions of the step-by-step procedures for computing all the thermodynamic properties from the fundamental equation of thermodynamics and all the thermodynamic energies from a set of common, experimentally measurable thermodynamic properties, supplemented with ample numerical examples. Another unique feature of this textbook is its emphasis on the concept of chemical potential and its applications to phase equilibria in single component systems and binary solutions, chemical reaction equilibria, and lattice and electronic defects in crystals. The concept of chemical potential is introduced at the very beginning of the book together with temperature and pressure. It avoids or minimizes the use of terms such as molar Gibbs free energy, partial molar Gibbs free energy, or Gibbs potential because molar Gibbs free energy or partial molar Gibbs free energy is precisely the chemical potential of a material or a component. It is the chemical potential that determines the stability of chemical species, compounds, and phases and their tendency to chemically react to form new species, transform to new physical state, and migrate from one spatial location to another. Therefore, it is the chemical potential differences or gradients that drive essentially all materials processes of interest. A reader after finishing reading the book is expected to not only achieve a high-level fundamental understanding of thermodynamics but also acquire the analytical skills of applying thermodynamics to determining materials equilibrium and driving forces for materials processes.*

*Crystallization and Materials Science of Modern Artificial and Natural Crystals*

*From Fundamentals to Applied Research*

*Science and Engineering*

*Theoretical and Practical Solutions*