CHAPTER 2

SOLID-STATE CHEMISTRY

Of the three states of matter, solids possess the most structural diversity. Whereas gases and liquids consist of discrete molecules that are randomly distributed due to thermal motion, solids consist of molecules, atoms, or ions that are statically positioned. To fully understand the properties of solid materials, one must have a thorough knowledge of the structural interactions between the subunit atoms, ions, and molecules. This chapter will outline the various types of solids, including structural classifications and nomenclature for both crystalline and amorphous solids. The material in this key chapter will set the groundwork for the rest of this textbook, which describes a variety of materials classes.

2.1. AMORPHOUS *VS.* CRYSTALLINE SOLIDS

A solid is a material that retains both its shape and volume over time. If a solid possesses long range, regularly repeating units, it is classified as a *crystalline* material. Crystalline solids are only produced when the atoms, ions, or molecules have an opportunity to organize themselves into regular arrangements, or *lattices*. For example, crystalline minerals found in nature have been formed through many years of extreme temperature and pressure, or slow evaporation processes. Most naturally occurring crystalline solids comprise an agglomeration of individual microcrystalline units; single crystals without significant defects are extremely rare in nature, and require special growth techniques (see p. 28).

If there is no long-range structural order throughout the solid, the material is best described as *amorphous*. Quite often, these materials possess considerable short-range order over distances of 1—10 nm or so. However, the lack of long-range translational order (periodicity) separates this class of materials from their crystalline counterparts. Since the majority of studies have been addressed to study crystalline solids relative to their amorphous counterparts, there is a common misconception that most solids are crystalline in nature. In fact, a solid product generated from many chemical reactions will be amorphous by default, unless special procedures are used to facilitate molecular ordering (*i.e.*, crystal formation). Although the crystalline state is more thermodynamically-favorable than the

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Walther Nernst

Chapter 2 Solid State Chemistry:

Solid State Electrochemistry II Vladislav V. Kharton,2012-12-21 The ideal addition to the companion volume on fundamentals methodologies and applications this second volume combines fundamental information with an overview of the role of ceramic membranes electrodes and interfaces in this important interdisciplinary and rapidly developing field Written primarily for specialists working in solid state electrochemistry this first comprehensive handbook on the topic focuses on the most important developments over the last decade as well as the methodological and theoretical aspects and practical applications This makes the contents equally of interest to material physical and industrial scientists and to physicists Also available as a two volume set *Synthesis Methods and Crystallization* Riadh Marzouki,2020-10-07 New crystalline materials organic inorganic hybrid are promising for various applications including electrical piezoelectric ferroelectric magnetic and catalytic processes In addition given their remarkable structural richness these materials exhibit several interesting physical properties such as ionic conduction ion exchange and others Crystal growth morphology and grain size are factors influencing these physical properties This book examines methods of synthesis of the most common crystalline materials and describes nucleation and crystal growth of various materials **Oxygen Compounds—Advances in Research and Application: 2012 Edition** ,2012-12-26 Oxygen Compounds Advances in Research and Application 2012 Edition is a ScholarlyEditions eBook that delivers timely authoritative and comprehensive information about Oxygen Compounds The editors have built Oxygen Compounds Advances in Research and Application 2012 Edition on the vast information databases of ScholarlyNews You can expect the information about Oxygen Compounds in this eBook to be deeper than what you can access anywhere else as well as consistently reliable authoritative informed and relevant The content of Oxygen Compounds Advances in Research and Application 2012 Edition has been produced by the world s leading scientists engineers analysts research institutions and companies All of the content is from peer reviewed sources and all of it is written assembled and edited by the editors at ScholarlyEditions and available exclusively from us You now have a source you can cite with authority confidence and credibility More information is available at http www ScholarlyEditions com

Pharmaceutical Powder and Particles Anthony J. Hickey,Stefano Giovagnoli,2025-03-03 This book in the AAPS book series concisely reviews important aspects of powder and particle systems and the critical quality attributes that should be used as a guide to future developments intended to maximize the control of product quality and performance Hickey and Giovagnoli have written an essential book for any scientists involved in powder or particle research and manufacturing It is appropriate for those just entering the field or as a rapid reference for the experienced pharmaceutical scientist The authors have both academic and industrial experience and the coverage includes solid state chemistry crystallization physical processes particle size and distribution particle interaction manufacturing processes quality by design and a general discussion of the industry Pharmaceutical Powder and Particles is intended to concisely review important aspects of powder

and particle systems and the critical quality attributes that should be used as a guide to future developments intended to maximize the control of product quality and performance Innovation in manufacturing has expanded the range of options available for solid dosage form manufacture while continuing to rely on first principles of solid state chemistry and characterization methods for powders and particles In this new edition the authors have expanded on existing chapters and added sections on new developments in the recent and evolving manufacturing processes including additive manufacturing technologies controlled crystallization spray freeze drying technology and more The editors have also comprehensively updated the references throughout the entire book **Treatise on Solid State Chemistry** N. Hannay,1976-08 The last quarter century has been marked by the extremely rapid growth of the solid state sciences They include what is now the largest subfield of physics and the materials engineering sciences have likewise flourished And playing an active role throughout this vast area of science and engineer ing have been very large numbers of chemists Yet even though the role of chemistry in the solid state sciences has been a vital one and the solid state sciences have in turn made enormous contributions to chemical thought solid state chemistry has not been recognized by the general body of chemists as a major subfield of chemistry Solid state chemistry is not even well defined as to content Some for example would have it include only the quantum chemistry of solids and would reject thermodynamics and phase equilibria this is nonsense Solid state chemistry has many facets and one of the purposes of this Treatise is to help define the field Perhaps the most general characteristic of solid state chemistry and one which helps differentiate it from solid state physics is its focus on the chemical composition and atomic configuration of real solids and on the relationship of composition and structure to the chemical and physical properties of the solid Real solids are usually extremely complex and exhibit almost infinite variety in their compositional and structural features **Experimental Techniques In Physics And Materials Sciences: Principles And Methodologies** R Srinivasan,T G Ramesh,G Umesh,C S Sundar,2023-10-12 There have been new developments in experimental techniques for preparing and characterizing materials and for measuring their properties These techniques are not being taught to students at the master s or even doctoral levels because there is no single book which deals with all these techniques at a basic level The present book is an attempt to overcome this problem The book is divided into five sections 1 Techniques for preparing materials in the bulk nanoscale and thin film forms 2 Techniques for characterizing materials like X ray and neutron powder diffraction ESCA Ellipsometry for thin films Ultrasonic techniques Electron microscopy Surface probe techniques and Positron annihilation for defect studies 3 Techniques for measurements at research level of the elastic thermal electrical dielectric and magnetic properties 4 Spectroscopic techniques such as NMR EPR spectroscopy IR Visible UV spectroscopy and Mossbauer spectroscopy and 5 Phase transitions In each of the above topics the basic principles are clearly laid out the experimental set ups are described and typical examples are cited to illustrate the physics revealed by these techniques The book can be used for a two semester course on experimental techniques in physics and materials

science at the master s and pre doctoral degree levels for students **Thermal Decomposition of Ionic Solids** A.K. Galwey,M.E. Brown,1999-02-25 The principal objective of this book is to stimulate interest in research that will extend available theory towards a greater understanding of the steps involved in solid state decompositions and the properties of solids that control reactivities Much of the activity in this field has been directed towards increasing the range of reactants for which decomposition kinetic data is available rather than extending insights into the fundamental chemistry of the reactions being studied The first part of the book Chapters 1 6 is concerned with theoretical aspects of the subject The second part Chapters 7 17 surveys groups of reactions classified by similarities of chemical composition The final Chapter 18 reviews the subject by unifying features identified as significant and proposes possible directions for future progress Studies of thermal reactions of ionic compounds have contributed considerably to the theory of solid state chemistry Furthermore many of these rate processes have substantial technological importance for example in the manufacture of cement the exploitation of ores and in the stability testing of drugs explosives and oxidizing agents Despite the prolonged and continuing research effort concerned with these reactions there is no recent overall review This book is intended to contribute towards correcting this omission The essential unity of the subject is recognized by the systematic treatment of reactions carefully selected to be instructive and representative of the subject as a whole The authors have contributed more than 200 original research articles to the literature many during their 25 years of collaboration Features of this book Gives a comprehensive in depth survey of a rarely reviewed subject Reviews methods used in studies of thermal decompositions of solids Discusses patterns of subject development perceived from an extensive literature survey This book is expected to be of greatest value and interest to scientists concerned with the chemical properties and reactions of solids including chemists physicists pharmacists material scientists crystallographers metallurgists and others This wide coverage of the literature dealing with thermal reactions of solids will be of value to both academic and industrial researchers by reviewing the current status of the theory of the subject It could also provide a useful starting point for the exploitation of crystalline materials in practical and industrial applications The contents will also be relevant to a wide variety of researchers including for example those concerned with the stabilities of polymers and composite materials the processing of minerals the shelf lives of pharmaceuticals etc **Advanced Inorganic Fluorides: Synthesis, Characterization and Applications** T. Nakajima,B. Žemva,A. Tressaud,2000-05-12 This book summarizes recent progresses in inorganic fluorine chemistry Highlights include new aspects of inorganic fluorine chemistry such as new synthetic methods structures of new fluorides and oxide fluorides their physical and chemical properties fluoride catalysts surface modifications of inorganic materials by fluorination process new energy conversion materials and industrial applications Fluorine has quite unique properties highest electronegativity very small polarizability In fact fluorine is so reactive that it forms fluorides with all elements except with the lightest noble gases helium neon and argon Originally due to its high reactivity fluoride chemistry faced many technical difficulties and

remained undeveloped for many years Now however a large number of fluorine containing materials are currently produced for practical uses on an industrial scale and their applications are rapidly extending to many fields Syntheses and structure analyses of thermodynamically unstable high oxidation state fluorides have greatly contributed to inorganic chemistry in this decade Fluoride catalysts and surface modifications using fluorine are developing a new field of fluorine chemistry and will enable new syntheses of various compounds The research on inorganic fluorides is now contributing to many chemical energy conversion processes such as lithium batteries Furthermore new theoretical approaches to determining the electronic structures of fluorine compounds are also progressing On the industrial front the use of inorganic fluorine compounds is constantly increasing for example in semi conductor industry Advanced Inorganic Fluorides Synthesis Characterization and Applications focuses on these new features in inorganic fluorine chemistry and its industrial applications The authors are outstanding experts in their fields and the contents of the book should prove to be of valuable assistance to all chemists graduates students and researchers in the field of fluorine chemistry **Comprehensive Chemical Kinetics: The practice and theory of kinetics** Charles Frank Howlett Tipper,C. H. Bamford,1969 *Comprehensive Chemical Kinetics: The practice and theory of kinetics. v. 1. The practice of kinetics* C. H. Bamford,Charles Frank Howlett Tipper,1969

Fundamentals of Solid-state Electronics Chih-Tang Sah,1991 This is perhaps the most comprehensive undergraduate textbook on the fundamental aspects of solid state electronics It presents basic and state of the art topics on materials physics device physics and basic circuit building blocks not covered by existing textbooks on the subject Each topic is introduced with a historical background and motivations of device invention and circuit evolution Fundamental physics is rigorously discussed with minimum need of tedious algebra and advanced mathematics Another special feature is a systematic classification of fundamental mechanisms not found even in advanced texts It bridges the gap between solid state device physics covered here with what students have learnt in their first two years of study Used very successfully in a one semester introductory core course for electrical and other engineering materials science and physics junior students the second part of each chapter is also used in an advanced undergraduate course on solid state devices The inclusion of previously unavailable analyses of the basic transistor digital circuit building blocks and cells makes this an excellent reference for engineers to look up fundamental concepts and data design formulae and latest devices such as the GeSi heterostructure bipolar transistors **The Hydrogen Series** ,1971 Crystal Structure Analysis for Chemists and Biologists Jenny Pickworth Glusker,Mitchell Lewis,Miriam Rossi,1994 This volume contains many examples of how crystallography is important to chemistry and biochemistry It explains the results of X ray diffraction analysis placing it in context with other methods of structural analysis such as solution studies and molecular modelling **An Introduction to the principles of physical chemistry from the standpoint of modern atomistics and thermodynamics** Edward Wight Washburn,1915 The Journal of Industrial and Engineering Chemistry ,1923 **Industrial & Engineering Chemistry**

,1925 *Theoretical Chemistry from the Standpoint of Avogadro's Rule and Thermodynamics* Walther Nernst,1904 *A Treatise on the Principles of Chemistry* Matthew Moncrieff Pattison Muir,1889 Physics of the Solid State ,1996 A Computational Exploration of Extended Solids Taken from Observation, Imagination, and Simulation Nicholas Mark Gerovac,2007

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