

Properties of Solids

Structure and Bonding

Introduction

Looking for patterns in the properties of different substances can help us understand *how* and *why* atoms join together to form compounds.

What kinds of forces hold atoms together? How does the nature of the forces holding atoms together influence the properties of a material?

Concepts

- Chemical bonds
- Ionic bonding
- Covalent bonding
- Metallic bonding

Background

Groups of atoms are held together by attractive forces that we call *bonds*. The origin of chemical bonds is reflected in the relationship between force and energy in the physical world. Think about the force of gravity—in order to overcome the force of attraction between an object and the Earth, we have to supply energy. Whether we climb a mountain or throw a ball high into the air, we have to supply energy. Similarly, in order to break a bond between two atoms, energy must be added to the system, usually in the form of heat, light, or electricity. The opposite is also true: whenever a bond is formed, energy is released.

The term *ionic bonding* is used to describe the attractive forces between oppositely charged ions in an ionic compound. An ionic compound is formed when a metal reacts with a nonmetal to form positively charged cations and negatively charged anions, respectively. The oppositely charged ions arrange themselves in a tightly packed, extended three-dimensional structure called a crystal lattice (see Figure 1). The net attractive forces between oppositely charged ions in the crystal structure are called ionic bonds.

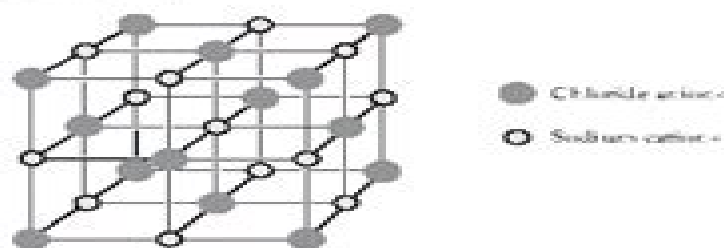


Figure 1. Crystal structure of sodium chloride.

Covalent bonding represents another type of attractive force between atoms. Covalent bonds are defined as the net attractive forces resulting from pairs of electrons that are shared between atoms (the shared electrons are attracted to the nuclei of both atoms in the bond). A group of atoms held together by covalent bonds is called a molecule. Atoms may share one, two, or three pairs of electrons between them to form single, double and triple bonds, respectively. Substances held together by covalent bonds are usually divided into two groups based on whether individual (discrete) molecules exist or not. In a *molecular solid*, individual molecules in the solid state are attracted to each other by relatively weak intermolecular forces between the molecules. Covalent *network solids*, on the other hand, consist of atoms forming covalent bonds with each other in all directions. The result is an almost infinite network of strong covalent bonds—there are no individual molecules.

Covalent bonds may be classified as polar or nonpolar (see Figure 2). The element chlorine, for example, exists as a diatomic molecule, Cl_2 . The two chlorine atoms are held together by a single covalent bond, with the two electrons in the bond equally shared between the two identical chlorine atoms. This type of bond is called a *nonpolar covalent bond*. The compound hydrogen chloride (HCl) consists of a hydrogen atom and a chlorine atom that also share a pair of electrons between them. Because the two atoms are different, however, the electrons in the bond are not equally shared between the atoms. Chlorine has a greater *electronegativity* than hydrogen—it attracts the bonding electrons more strongly than hydrogen. The covalent bond between hydrogen and chlorine is an example of a *polar bond*. The distribution of bonding electrons in a nonpolar versus polar bond is shown in Figure 2. Notice that the chlorine atom in HCl has a partial negative charge (δ^-) while the hydrogen atom has a partial positive charge (δ^+).

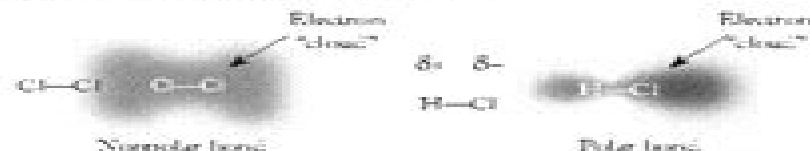


Figure 2. Nonpolar versus polar covalent bonds.

Properties Of Solids Structure And Bonding Answers

Mr. Rohit Manglik



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Physics of Solids Mr. Rohit Manglik, 2024-06-24 Examines solid state physics including crystal structures electronic properties and thermal behavior with applications in materials science

Solid-State Chemistry Frank Hoffmann, 2023-08-07 This book invites you on a tour through the most relevant topics of solid state chemistry It provides an up to date overview about fascinating structures of inorganic matter and new research developments The reader will also gain crucial insights into many aspects of material science from ceramics to superconductors One chapter is specifically dedicated to the most rapidly evolving field of material science metal organic frameworks MOFs The book contains a chapter which is often neglected in others due to its complexity the intermetallic phases A concise but very didactic introduction to crystallographic specifications ensures that the reader will gain a deeper understanding of the crystal structures presented in the book The book places special emphasis on the graphical illustrations which were specifically designed to promote real insights into the structural features Instead of having to decipher hard to distinguish graphics the reader has an eye opening experience A further added value is that many references to the original research publications are given which enables easy follow up for more detailed study

Introduction to solid state physics 1 Prof. Yosry Moustafa, The material of this book was chosen in a simple manner to clarify the basic concepts of crystallography structure properties of crystalline materials and the dependence of these properties on crystal structure However its contents were presented in terms of educational way to facilitate the handling of its scientific concepts This book contains seven chapters covering one semester course in solid state physics The sequence of content is a brief review of bonding in solid materials the characteristics of the solid state crystal structure the types of structural defects in crystalline materials concept and various experimental methods for X ray diffraction in crystalline materials lattice vibrations and phonon concept and more than 1300 solved MCQs MMCQs and True and False questions in addition to solved examples exercises and problems This book can be considered as a useful reference for students of faculties of science and also for students studying materials science in the faculties of engineering or higher technical institutes

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Materials Principles and Practice deals with materials science in the technological context of making and using materials. Topics covered include the nature of materials such as crystals, an atomic view of solids, temperature effects on materials, and the mechanical and chemical properties of materials. This book is comprised of seven chapters and begins with an overview of the properties of different kinds of material, the ways in which materials can be shaped, and the uses to which they can be put. The next chapter describes the state of matter as a balance between the tendencies of atoms to stick together by chemical bonding or rattle apart by thermal agitation, paying particular attention to ionic bonds and ionic crystals, the structure and properties of polymers, and transition metals. The reader is also introduced to how the structure of materials, especially microstructure, can be manipulated to give desired properties via thermal, mechanical, and chemical agents of change. This text concludes by describing the chemistry of processing and service of various materials. Exercises and self-assessment questions with answers are given at the end of each chapter, together with a set of objectives. This monograph will be a valuable resource for students of materials science and the physical sciences.

Solvents and Solutions: Structure and Properties Keshra Sangwal, 2021-08-06. A UNIQUE BOOK ON THE PRESENT STATUS OF SOLVENTS AND SOLUTIONS WITH IMPORTANT PROBLEMS RELATED TO THEIR STRUCTURE AND PROPERTIES. The literature on the properties of solvents and solutions used in academic research and in a wide range of industries has grown enormously during the last four decades and is scattered in different specialized journals. Solvents and Solutions is a groundbreaking text that offers a systematic compilation of important problems related to selected properties of solvents and solutions based on the literature published so far. The author places emphasis on explaining the basic concepts involved in understanding the properties and behavior of various solvents and solutions of electrolytes and nonelectrolytes in a consistent manner. After a description of the general characteristics of structure of solvents and solutions and the solubility of electrolytes and nonelectrolytes under normal temperature and pressure conditions, the book first deals with different aspects of the density and the refractive index of solvents and dilute as well as concentrated solutions and finally with the transport, i.e., viscosity and electric conductivity, and thermal properties of solvents and solutions. Solvents and Solutions is the first text devoted to the description and discussion of their properties since the publication of a monograph on the physical properties of aqueous electrolyte solutions more than three decades ago. The main features of this book are: Reflects developments in the investigation of solvents and solutions during the last three decades. Outlines basic concepts involved in understanding the properties and behavior of solvents and solutions. Describes and discusses different properties of ionic liquids as solvents and the behavior of their mixtures with other commonly used solvents. Contents of different chapters are not only self-contained but the contents are practically independent of each other. Written as a practical guide for researchers who are looking for an up-to-date overview of the physical and transport properties of solvents and solutions and as a reference source for workers in chemical industries and related fields and for graduate students of chemical engineering and physical chemistry.

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Technical Aerospace Reports, 1979 **Solid State Chemistry and its Applications** Anthony R. West, 2014-03-17 Solid State Chemistry and its Applications 2nd Edition Student Edition is an extensive update and sequel to the bestselling textbook Basic Solid State Chemistry the classic text for undergraduate teaching in solid state chemistry worldwide Solid state chemistry lies at the heart of many significant scientific advances from recent decades including the discovery of high temperature superconductors new forms of carbon and countless other developments in the synthesis characterisation and applications of inorganic materials Looking forward solid state chemistry will be crucial for the development of new functional materials in areas such as energy catalysis and electronic materials This revised edition of Basic Solid State Chemistry has been completely rewritten and expanded to present an up to date account of the essential topics and recent developments in this exciting field of inorganic chemistry Each section commences with a gentle introduction covering basic principles progressing seamlessly to a more advanced level in order to present a comprehensive overview of the subject This new Student Edition includes the following updates and new features Expanded coverage of bonding in solids including a new section on covalent bonding and more extensive treatment of metallic bonding Synthetic methods are covered extensively and new topics include microwave synthesis combinatorial synthesis mechano synthesis atomic layer deposition and spray pyrolysis Revised coverage of electrical magnetic and optical properties with additional material on semiconductors giant and colossal magnetoresistance multiferroics LEDs fibre optics and solar cells lasers graphene and quasicrystals Extended chapters on crystal defects and characterisation techniques Published in full colour to aid comprehension Extensive coverage of crystal structures for important families of inorganic solids is complemented by access to CrystalMaker visualization software allowing readers to view and rotate over 100 crystal structures in three dimensions Solutions to exercises and supplementary lecture material are available online Solid State Chemistry and its Applications 2nd Edition Student Edition is a must have textbook for any undergraduate or new research worker studying solid state chemistry

Structure and Dynamics of Solutions Hideyuki Ohtaki, H. Yamatera, 2013-10-22 Recent advances in the study of structural and dynamic properties of solutions have provided a molecular picture of solute solvent interactions Although the study of thermodynamic as well as electronic properties of solutions have played a role in the development of research on the rate and mechanism of chemical reactions such macroscopic and microscopic properties are insufficient for a deeper understanding of fast chemical and biological reactions In order to fill the gap between the two extremes it is necessary to know how molecules are arranged in solution and how they change their positions in both the short and long range This book has been designed to meet these criteria It is possible to develop a sound microscopic picture for reaction dynamics in solution without molecular level knowledge of how reacting ionic or neutral species are solvated and how rapidly the molecular environment is changing with time A variety of actual examples is given as to how and when modern molecular approaches can be used to solve specific solution problems The following tools are discussed x ray and neutron diffraction

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