

Lectures 21-22

Solid state materials. Electronic structure and conductivity

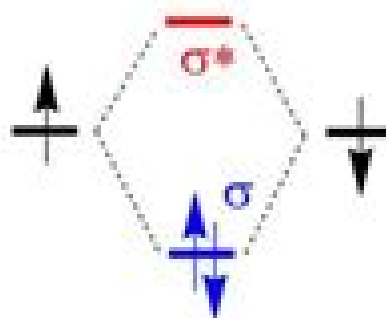
1) Band theory

- The electronic structure of **solids** can also be described by MO theory.
- A solid can be considered as a **supermolecule**.
- One mole of atoms (N_A), each with X orbitals in the valence shell contributes X moles of atomic orbitals producing X moles of MO's.

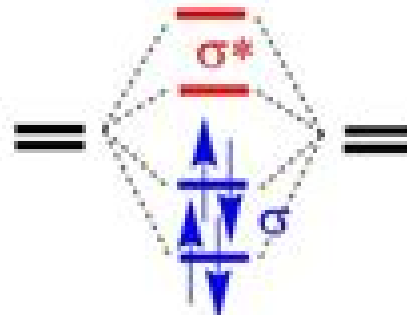
Consider qualitatively bonding between N *metal atoms* of ns^1 configuration (Li, Na etc) arranged in a *chain*; $N = 2, 4, N_A$. Assume that $X=1$ for simplicity.

- In the case of $N \sim N_A$ atoms they form not **bonds** but **bands**.
- The band appearing in the *bonding* region is called **valence band**. The *antibonding* region is called **conduction band**.
- In the case of metals the **valence** and **conduction** bands are immediately **adjacent**.

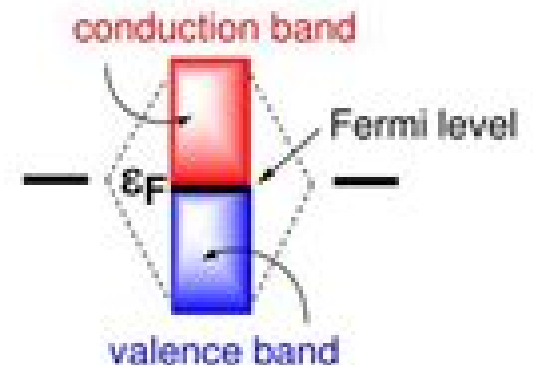
$N = 2$ Li atoms



4 Li atoms



N_A Li atoms



Electrical Conduction In Solids An Introduction

**Theodore L. Bergman, Adrienne S.
Lavine, Frank P. Incropera, David P.
DeWitt**



Electrical Conduction In Solids An Introduction:

Electrical Conduction in Solids Daniel D. Pollock, 1985 *Electrical Conduction in Solids* Daniel P. Pollock, 1985-01-01

Introductory Solid State Physics with MATLAB Applications Javier E. Hasbun, Trinanjan Datta, 2019-10-08 Solid state physics the study and prediction of the fundamental physical properties of materials forms the backbone of modern materials science and has many technological applications The unique feature of this text is the MATLAB based computational approach with several numerical techniques and simulation methods included This is highly effective in addressing the need for visualization and a direct hands on approach in learning the theoretical concepts of solid state physics The code is freely available to all textbook users Additional Features Uses the pedagogical tools of computational physics that have become important in enhancing physics teaching of advanced subjects such as solid state physics Adds visualization and simulation to the subject in a way that enables students to participate actively in a hand on approach Covers the basic concepts of solid state physics and provides students with a deeper understanding of the subject matter Provides unique example exercises throughout the text Obtains mathematical analytical solutions Carries out illustrations of important formulae results using programming scripts that students can run on their own and reproduce graphs and or simulations Helps students visualize solid state processes and apply certain numerical techniques using MATLAB making the process of learning solid state physics much more effective Reinforces the examples discussed within the chapters through the use of end of chapter exercises Includes simple analytical and numerical examples to more challenging ones as well as computational problems with the opportunity to run codes create new ones or modify existing ones to solve problems or reproduce certain results

Electrical Conduction in Solid Materials J. P. Suchet, 2013-10-22 *Electrical Conduction in Solid Materials* Physicochemical Bases and Possible Applications investigates the physicochemical bases and possible applications of electrical conduction in solid materials with emphasis on conductors semiconductors and insulators Topics range from the interatomic bonds of conductors to the effective atomic charge in conventional semiconductors and magnetic transitions in switching semiconductors Comprised of 10 chapters this volume begins with a description of electrical conduction in conductors and semiconductors metals and alloys as well as interatomic bonds and the resistivity of magnetic conductors Subsequent chapters focus on conventional semiconductors including intrinsic semiconductors and binary and ternary compounds compounds containing ordered or disordered atomic magnetic moments showing paramagnetism of ferro ferri or antiferromagnetism and magnetic and crystallographic transitions in switching semiconductors Organic and inorganic insulators are also considered along with possible applications of conductors semiconductors and insulators Finally the special magnetoelectric effects and magneto optical effects of magnetic semiconductors are analyzed This book will be a valuable resource for students of physical chemistry **Electrons in Solids** Richard Bube, 2012-12-02 *Electronics in Solids* An Introductory Survey presents a modern picture of electrons in solids using wave properties as the integrating theme of

the conceptual background It looks at lattice waves light waves and electron waves along with their particle like correlatives phonons photons and electrons The first chapters of the book provide a background on wave equations boundary conditions and general wave properties for the student so that the transition to the nonclassical world of quantum mechanics can be more easily assimilated The last chapters examine optical properties electrical properties junctions and magnetic properties of solids This book is written for students of quantum mechanics and those examining the electrical optical and magnetic properties of solids without relying too much on advanced knowledge on atomic or solid state physics **Journal of the Optical Society of America** Optical Society of America,1920 Separately paged supplements accompany a few issues

Introduction to Solid State Physics for Materials Engineers Emil Zolotoyabko,2021-04-13 A concise accessible and up to date introduction to solid state physics Solid state physics is the foundation of many of today s technologies including LEDs MOSFET transistors solar cells lasers digital cameras data storage and processing Introduction to Solid State Physics for Materials Engineers offers a guide to basic concepts and provides an accessible framework for understanding this highly application relevant branch of science for materials engineers The text links the fundamentals of solid state physics to modern materials such as graphene photonic and metamaterials superconducting magnets high temperature superconductors and topological insulators Written by a noted expert and experienced instructor the book contains numerous worked examples throughout to help the reader gain a thorough understanding of the concepts and information presented The text covers a wide range of relevant topics including propagation of electron and acoustic waves in crystals electrical conductivity in metals and semiconductors light interaction with metals semiconductors and dielectrics thermoelectricity cooperative phenomena in electron systems ferroelectricity as a cooperative phenomenon and more This important book Provides a big picture view of solid state physics Contains examples of basic concepts and applications Offers a highly accessible text that fosters real understanding Presents a wealth of helpful worked examples Written for students of materials science engineering chemistry and physics Introduction to Solid State Physics for Materials Engineers is an important guide to help foster an understanding of solid state physics [Journal of the Optical Society of America](#) ,1920

Introduction to Solid-State Theory Otfried Madelung,2012-12-06 Introduction to Solid State Theory is a textbook for graduate students of physics and materials science It also provides the theoretical background needed by physicists doing research in pure solid state physics and its applications to electrical engineering The fundamentals of solid state theory are based on a description by delocalized and localized states and within the concept of delocalized states by elementary excitations The development of solid state theory within the last ten years has shown that by a systematic introduction of these concepts large parts of the theory can be described in a unified way This form of description gives a pictorial formulation of many elementary processes in solids which facilitates their understanding **Electrons in Solids** Richard H. Bube,1992-09-03 This Third Edition of ELECTRONS IN SOLIDS AN INTRODUCTORY SURVEY is the result of a thorough re

examination of the entire text incorporating suggestions and corrections by students and professors who have used the text. Explanations and descriptions have been expanded and additional information has been added on high T_c superconductors, diamond films, buckminsterfullerenes and thin magnetic materials. Adopted by many colleges and universities, this text has proven to be a solid introduction to the electrical, optical and magnetic properties of materials. Contains comprehensive coverage of electronic properties in metals, semiconductors and insulators at a fundamental level. Stresses the use of wave properties as an integrating theme for the discussion of phonons, photons and electrons. Includes a complete set of illustrative problems along with exercises and answers. Features a careful indication of both Gaussian and SI unit systems.

INTRODUCTION TO SOLID STATE PHYSICS, Second Edition KUMAR, ARUN, 2015-10-01. Introduction to Solid State Physics in its Second Edition provides a comprehensive introduction to the physical properties of crystalline solids. It explains the structure of crystals, theory of crystal diffraction and the reciprocal lattice. As the book advances, it describes different kinds of imperfections in crystals, bonding in solids and vibration in one-dimensional monoatomic and diatomic linear lattices. Different theories of specific heat, thermal conductivity of solids and lattice thermal conductivity are thoroughly dealt with. Coverage also includes the free electron theory, band theory of solids and semiconductors. In addition, the book also describes in detail the magnetic properties of solids and superconductivity. Finally, the book includes discussions on lasers, nanotechnology and the basic principles of fibre optics and holography. Some new topics like cellular method, quantum Hall effect, de Haas-van Alphen effect, Pauli paramagnetism and semiconductor laser have been added in the present edition of the book to make it more useful for the students. The book is designed to meet the requirements of undergraduate and postgraduate students of physics for their courses in solid state physics, condensed matter physics and material science. **KEY FEATURES** Puts a conceptual emphasis on the subject. Includes numerous diagrams and figures to clarify the concepts. Gives step-by-step explanations of theories. Provides chapter-end exercises to test the knowledge acquired. **Introduction to**

Organic Electronic and Optoelectronic Materials and Devices Sam-Shajing Sun, Larry R. Dalton, 2008-05-29. Reflecting rapid growth in research and development on organic polymeric electronic and photonic materials and devices, *Introduction to Organic Electronic and Optoelectronic Materials and Devices* provides comprehensive coverage of the state of the art in an accessible format. The book presents fundamentals, principles and mechanisms. Introduction to Heat Transfer

Theodore L. Bergman, Adrienne S. Lavine, Frank P. Incropera, David P. Dewitt, 2011-06-13. Completely updated, the sixth edition provides engineers with an in-depth look at the key concepts in the field. It incorporates new discussions on emerging areas of heat transfer, discussing technologies that are related to nanotechnology, biomedical engineering and alternative energy. The example problems are also updated to better show how to apply the material. And as engineers follow the rigorous and systematic problem-solving methodology, they'll gain an appreciation for the richness and beauty of the discipline. Fundamentals of Solid State Engineering Manijeh Razeghi, 2009-03-03. Fundamentals of Solid State

Engineering 3rd Edition provides a multi disciplinary introduction to solid state engineering combining concepts from physics chemistry electrical engineering materials science and mechanical engineering Revised throughout this third edition includes new topics such as electron electron and electron phonon interactions in addition to the Kane effective mass method A chapter devoted to quantum mechanics has been expanded to cover topics such as the harmonic oscillator the hydrogen atom the quantum mechanical description of angular momentum and the origin of spin This textbook also features an improved transport theory description which now goes beyond Drude theory discussing the Boltzmann approach Introducing students to the rigorous quantum mechanical way of thinking about and formulating transport processes this textbook presents the basic physics concepts and thorough treatment of semiconductor characterization technology designed for solid state engineers

Introductory Solid State Physics, Second Edition H.P. Meyers,H.P. Myers,1997-04-26 Assuming an elementary knowledge of quantum and statistical physics this book provides a comprehensive guide to principal physical properties of condensed matter as well as the underlying theory necessary for a proper understanding of their origins The subject matter covers the principal features of condensed matter physics but with particular accent on the properties of metal alloys Relevance to technical applications is recognized

Solid-State Physics Nikhil Lakhani,2025-02-20 Solid State Physics Core Principles delves into recent advancements particularly in quantum materials Edited by experts we cover both foundational concepts and cutting edge research We begin with basics like crystal structures and electronic properties of solids then explore exciting areas such as topological insulators and superconductors A key theme is discovering new quantum materials with unique properties We examine how these materials are created studied and their potential use in future technologies like quantum computing Another important aspect is the advanced techniques used to understand these materials We discuss complex experiments and computer modeling that allow scientists to manipulate materials at the atomic level Additionally we highlight how solid state physics connects to other fields like materials science and nanotechnology emphasizing interdisciplinary collaboration for future breakthroughs Solid State Physics Core Principles is a valuable resource for researchers and students interested in the latest developments in solid state physics We provide a comprehensive overview of the field while looking towards future directions and the potential of quantum materials to revolutionize technology

Introduction to Contemporary Physics Karl Kelchner Darrow,1926

Solid State Physics ,1961-01-01 Solid State Physics

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