

# Lectures 21-22

## Solid state materials. Electronic structure and conductivity

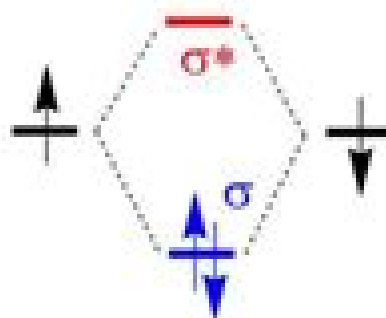
### 1) Band theory

- 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.

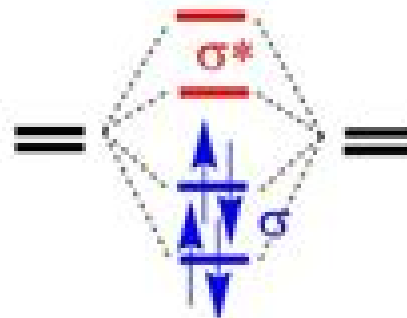
Consider qualitatively bonding between  $N$  metal atoms of  $ns^1$  configuration (Li, Na etc) arranged in a *chain*;  $N = 2, 4, N_A$ . Assume that  $X=1$  for simplicity.

- 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**.

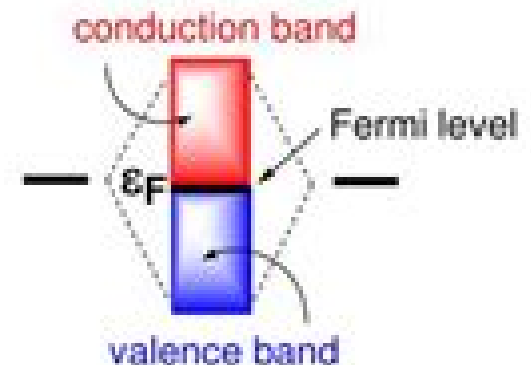
$N = 2$  Li atoms



4 Li atoms



$N_A$  Li atoms



# Electronics Of Solids

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A red circular graphic with a gradient, appearing as a stylized arrow or a partial circle, located to the right of the company name.

## Electronics Of Solids:

*Fundamentals Of Solid-state Electronics: Solution Manual* Chih Tang Sah, 1996-09-30 This Solution Manual a companion volume of the book *Fundamentals of Solid State Electronics* provides the solutions to selected problems listed in the book. Most of the solutions are for the selected problems that had been assigned to the engineering undergraduate students who were taking an introductory device core course using this book. This Solution Manual also contains an extensive appendix which illustrates the application of the fundamentals to solutions of state of the art transistor reliability problems which have been taught to advanced undergraduate and graduate students. This book is also available as a set with *Fundamentals of Solid State Electronics* and *Fundamentals of Solid State Electronics Study Guide*      **Understanding Solid State**

**Electronics** Don L. Cannon, 1997-05 For devices courses found in electronics technology and electronics engineering technology departments. Written in an engaging personable style this guide to solid state electronic devices explores the latest in semiconductor theory and applications showing how semiconductors fit within circuits how circuits and logic gates make decisions and how to properly adapt solid state devices into a circuit design. Designed with the non technical student in mind it requires minimal mathematical knowledge and goes out of its way to explain new ideas and concepts step by step in a clear succinct and easily understandable manner      **Introduction to Solid State Electronics** F.F.Y. Wang, 2012-12-02 This

textbook is specifically tailored for undergraduate engineering courses offered in the junior year providing a thorough understanding of solid state electronics without relying on the prerequisites of quantum mechanics. In contrast to most solid state electronics texts currently available with their generalized treatments of the same topics this is the first text to focus exclusively and in meaningful detail on introductory material. The original text has already been in use for 10 years. In this new edition additional problems have been added at the end of most chapters. These problems are meant not only to review the material covered in the chapter but also to introduce some aspects not covered in the text. An amended Solutions Manual is in preparation      Solid State Electronic Devices Ben G. Streetman, 1980      **Solid State Physical Electronics** Aldert

Van der Ziel, 1976      **Introduction to Solid-state Electronics** Ija P. Ipatova, Vladimir Vasil'evich Mitin, 1996-01

*Introduction to Solid State Electronics* combines a modern presentation of semiconductor physics with a description of the principles of semiconductor devices. It unites the authors extensive teaching and research experience with the requirements of an introductory graduate course in Solid State Electronics for engineering students. Since a crystal is an object of high symmetry some simple techniques which do not require knowledge of the mathematical groups at the professional level are used for the application of symmetry to the analysis of band structures. The textbook outlines the properties of low dimensional structures in parallel with those of bulk materials. The authors have made the mathematical derivations both as self contained and as simple as possible without using arguments of the type it can be easily shown that. This technique is just one of many that enables the book to provide a clear comprehensive understanding of the main properties of semiconductors.

and their relations to device structures      **Solid-State Electronic Devices** Christo Papadopoulos, 2013-11-19 A modern and concise treatment of the solid state electronic devices that are fundamental to electronic systems and information technology is provided in this book The main devices that comprise semiconductor integrated circuits are covered in a clear manner accessible to the wide range of scientific and engineering disciplines that are impacted by this technology Catering to a wider audience is becoming increasingly important as the field of electronic materials and devices becomes more interdisciplinary with applications in biology chemistry and electro mechanical devices to name a few becoming more prevalent Updated and state of the art advancements are included along with emerging trends in electronic devices and their applications In addition an appendix containing the relevant physical background will be included to assist readers from different disciplines and provide a review for those more familiar with the area Readers of this book can expect to derive a solid foundation for understanding modern electronic devices and also be prepared for future developments and advancements in this far reaching area of science and technology      **Electronic Structure and the Properties of Solids** Walter A. Harrison, 1989-07-01 Should be widely read by practicing physicists chemists and materials scientists Philosophical Magazine In this comprehensive and innovative text Professor Harrison Stanford University offers a basic understanding of the electronic structure of covalent and ionic solids simple metals transition metals and their compounds The book illuminates the relationships of the electronic structures of these materials and shows how to calculate dielectric conducting and bonding properties for each Also described are various methods of approximating electronic structure providing insight and even quantitative results from the comparisons Dr Harrison has also included an especially helpful Solid State Table of the Elements that provides all the parameters needed to estimate almost any property of any solid with a hand held calculator using the techniques developed in the book Designed for graduate or advanced undergraduate students who have completed an undergraduate course in quantum mechanics or atomic and modern physics the text treats the relation between structure and properties comprehensively for all solids rather than for small classes of solids This makes it an indispensable reference for all who make use of approximative methods for electronic structure engineering semiconductor development and materials science The problems at the ends of the chapters are an important aspect of the book They clearly show that the calculations for systems and properties of genuine and current interest are actually quite elementary Prefaces Problems Tables Appendixes Solid State Table of the Elements Bibliography Author and Subject Indexes Will doubtless exert a lasting influence on the solid state physics literature Physics Today      *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

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Ceramic Materials for Electronics, Third Edition Relva C. Buchanan, 2004-06-25 The Third Edition of Ceramic Materials for Electronics studies a wide range of ceramic materials including insulators conductors piezoelectrics and ferroelectrics through detailed discussion of their properties characterization fabrication and applications in electronics The author summarizes the latest trends and advancements in the field and explores important topics such as ceramic thin film functional device technology and thick film technology Edited by a leading expert on the subject this new edition includes more than 150 pages of new information restructured reference materials figures and tables as well as additional device application oriented segments

Basic Electronics BL Theraja, 2006-12 Aims of the Book The foremost and primary aim of the book is to meet the requirements of students pursuing following courses of study 1 Diploma in Electronics and Communication Engineering ECE 3 year course offered by various Indian and foreign polytechnics and technical institutes like city and guilds of London Institute CGLI 2 B E Elect Comm 4 year course offered by various Engineering Colleges efforts have been made to cover the papers Electronics I II and Pulse and Digital Circuits 3 B Sc Elect 3 Year vocationalised course recently introduced by Approach

*Electronic Materials* H.L. Kwok, 2010-01-14 Volume is indexed by Thomson Reuters BCI WoS The electronic properties of solids have become of increasing importance in the age of information technology The study of solids and materials while having originated from the disciplines of physics and chemistry has evolved independently over the past few decades The classical treatment of solid state physics which emphasized classifications theories and fundamental physical principles is no longer able to bridge the gap between materials advances and applications In particular the more recent developments in device physics and technology have not necessarily been driven by new concepts in physics or new materials but rather by the ability of engineers to control crystal structures and properties better via advances in crystal growth and patterning techniques In many cases new applications simply arise from the adaption of conventional ideas to interdisciplinary areas One example is that of recent advances which rely heavily upon the availability of the sub micron technology developed by the semiconductor industry Another example is the emergence of nanotechnology

**Basic solid-state electronics** Van Valkenburgh, Nooger & Neville, Inc, 1992

**Solid State Physics and Electronics** RK Puri | VK Babbar, 2008 The present edition is brought up to incorporate the useful suggestions from a number of readers and teachers for the benefit of students

A topic on common collector configuration is added to the chapter XIII A new chapter on logic gates is introduced at the end Keeping in view the present style of university Question papers a number of very short short and long thoroughly revised and corrected to remove the errors which crept into earlier editions

**Organic Electronic Materials** R. Farchioni, 2001-05-22 This review and tutorial offers a well balanced survey of the fundamental ideas and relevant trends in modern research on both conducting polymers and organic molecular crystals The reviews provide a more complete understanding of the underlying physics of the materials through the discussion of selected interconnected topics The volume constitutes an insightful treatise and handy reference for researchers and students in the field

*DDC Retrieval and Indexing Terminology* Defense Documentation Center (U.S.), 1975

**Band Theory and Electronic Properties of Solids** John Singleton, 2001-08-30 This textbook attempts to reveal in a quantitative and fairly rigorous fashion how band theory leads to the everyday properties of materials

**Solid State Physics, Solid State Device And Electronics.** C M Kachhava, 2003 This Book Is Designed To Cater The Need Of Students Of B Sc Pass And Hons Students Of Various Indian Universities On The Basis Of Model Curriculum Recently Proposed By Cdc Of Ugc The Book Comprises 569 Figures 266 Examples 233 Problems And 336 Objective Questions Distributed In 13 Chapters Each Problem Is Followed By Its Answer The Inclusion Of A Large Number Of Problems And Review Questions Are Aimed At Evaluating The Degree Of Conceptual Comprehension A Student Has Acquired As A Result Of Studying The Book The Solved Examples Are Targetted To Illustrate The Theoretical Ideals Described In The Text Although The Book Is Aimed To Target B Sc Students Yet Chemists Material Scientists And Electrical Engineers Would Find It Useful Not Only In Pursuing Their Studies But Also In Professional Applications The Existence Of Sufficient Number Of Objective Questions Are Framed To Help The Student Immensely To Encounter Competitive Examinations Like Net Slet Ics And State Civil Services

SOLID STATE DEVICES NAIR, B. SOMANATHAN, DEEPA, S. R., 2018-11-01 Designed as a text for undergraduate students of engineering in Electrical Electronics and Computer Science and IT disciplines as well as undergraduate students B Sc of physics and electronics as also for postgraduate students of physics and electronics this compact and accessible text endeavours to simplify the theory of solid state devices so that even an average student will be able to understand the concepts with ease The authors Prof Somanathan Nair and Prof S R Deepa with their rich and long experience in teaching the subject provide a detailed discussion of such topics as crystal structures of semiconductor materials Miller indices energy band theory of solids energy level diagrams and mass action law Besides they give a masterly analysis of topics such as direct and indirect gap materials Fermi Dirac statistics electrons in semiconductors Hall effect PN junction diodes Zener and avalanche breakdowns Schottky barrier diodes bipolar junction transistors MOS field effect transistors Early effect Shockley diodes SCRs TRIAC and IGBTs In the Second Edition two new chapters on opto electronic devices and electro optic devices have been added The text has been thoroughly revised and updated A number of solved problems and objective type questions have been included to help students develop grasp of the

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