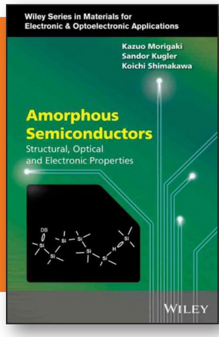


Amorphous Semiconductors: Structural, Optical, and Electronic Properties

Kazuo Morigaki, Sándor Kugler, and Koichi Shimakawa

Wiley, 2017
286 pages, $140.00 (e-book $112.99)
ISBN 978-1-118-75792-5

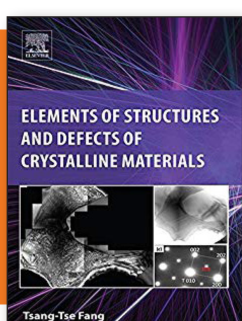
Amorphous solids are topologically disordered systems that have semiconducting behaviors. In contrast to crystalline semiconductors, the physical nature and theory of amorphous semiconductors are far from understood. Amorphous semiconductors are still a growing field and are in an early stage of development.

This book provides an introduction to amorphous semiconductors, including structural, electronic, and optical properties and their applications. The book comprises eight chapters and 286 pages. Chapter 1 introduces amorphous semiconductors. Chapter 2 illustrates techniques commonly used for growth of amorphous semiconductors, including *a*-Si:H films and amorphous chalcogenides. Chapter 3 is devoted to structural properties of *a*-Si:H films and amorphous chalcogenides, where both experimental measurements and computer simulations are involved. Chapter 4 discusses the electronic structure of several kinds of amorphous semiconductors. In chapters 5 and 6, the authors present the electronic and optical properties of amorphous silicon and amorphous chalcogenides, respectively. These two chapters are the main content of the book. The electronic and optical properties are related to the band structure, defects, and external actions, such as light irradiation, humidity, and temperature. Chapter 7 provides an overview of other amorphous materials, such as amorphous carbon and related materials, amorphous oxide semiconductors, and metal-containing amorphous chalcogenides. Chapter 8 discusses possible applications (e.g., displays and solar cells) of amorphous semiconductors, such as amorphous silicon and amorphous chalcogenides.

This book reflects the general current understanding of amorphous semiconductors and observations of the technological progress in the field. Several typical amorphous semiconductors are introduced. Amorphous oxide semiconductors (AOSs) have attracted more attention in recent years, with the potential for practical applications in transparent electronics and flexible electronics. The book would certainly be better if AOSs had been described in more detail.

The authors have put together a comprehensive set of structural, electronic, and optical properties of amorphous semiconductors. The contents have been organized and presented in a logical way. The figures and tables are useful to understand the materials, and the references are adequate and up to date. I recommend this book to postgraduate students, researchers, and technologists, especially those who are interested in microelectronics, photonics, and optoelectronics, as well as printed electronics, transparent electronics, and flexible electronics.

***Reviewer: Jianguo Lu** is an associate professor at Zhejiang University, China.*



Elements of Structures and Defects of Crystalline Materials

Tsang-Tse Fang

Elsevier, 2018
230 pages, $126.00 (e-book $126.00)
ISBN 978-0-12-814268-4

Many properties such as mechanical strength, thermal conductivity, electrical resistivity, and the performance of materials are determined by defects. To understand defects, it is necessary to understand ideal structures.

This book lays the foundation for structures and defects at the most basic level, with treatments similar to those found in introductory materials science and engineering textbooks. These include electron configurations, chemical bond types, and basic structures of metallic, covalent, and ionic materials. The book builds from this foundation by covering topics in greater depth and employing more sophisticated tools for its explanations, such as vector calculus, chemical and phase thermodynamics, and statistical mechanics.

The book is divided into six chapters, starting with a chapter on the properties of electron orbitals and their relation to the periodic table. The rules applied to the order in which electron orbitals are filled are described.

Chapter 2 recounts various types of chemical bonds that form in solids—the familiar ionic, covalent, and metallic bonds. The nature of bonding forces between point charges (Coulombic), permanent dipoles, induced dipoles, and the sharing of electrons between atoms are described. The dependence between electronic energy levels and the elastic modulus, melting temperature, and thermal properties are shown.

Chapter 3 describes a wide variety of crystal structures that solids form, as well as the rules and geometric constraints governing the structures. The structures of metal oxide compounds are covered in-depth. Specific structures of metal oxide compounds of technological relevance

https://doi.org/10.1557/mrs.2018.312 Published online by Cambridge University Press

such as zinc oxide, titanium oxide, spinel, and perovskites are discussed.

Point defects, including the solubility of impurities and the equilibrium between cation and anion vacancies, interstitials, and mobile charges, are thoroughly covered in chapter 4. The equations controlling defect reactions such as the requirements of mass balances and electroneutrality are described and illustrated with several specific examples. Fang points out that incorporating even small concentrations of impurities into crystals inevitably reduces the material's Gibbs free energy, which is why it becomes difficult to attain high purities.

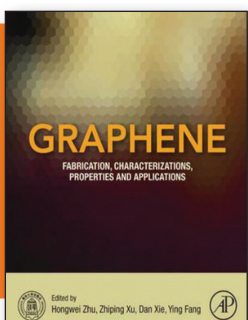
Chapter 5 describes the structure of dislocations, the stress fields they create, their strain energies, and how they interact with externally applied forces and each other.

Chapter 6 covers two-dimensional defects, including grain boundaries, phase boundaries, and surfaces. Three-dimensional defects, including inclusions and pores, typically due to the formation of a second phase, are also covered. The tendency of a secondary phase to form at grain-boundary junctions is explained in terms of surface and interfacial energies.

Stylistically, the book is highly organized and logically sequenced. The author favors short passages and lists of key concepts. Then, the eight essential features of edge dislocations—the definition, the relative positions of its Burgers and sense vectors, and its response to stress—are given in a list in its subsection. The most significant concepts are depicted in plain schematic line drawings; there are very few images of actual materials.

This is a good advanced treatment of the relationships between structures and defects. The bibliography lists 76 books and journal articles ranging from 1953 to 2015, and includes many classic materials science and engineering textbooks on thermodynamics, ceramics, and crystal structures. Although it does not contain any problems, it is nevertheless a good textbook, as it has the breadth and depth necessary to provide an excellent foundation on these essential materials science and engineering topics.

Reviewer: J.H. Edgar*, Department of Chemical Engineering, Kansas State University, USA.*



Graphene: Fabrication, Characterizations, Properties and Applications

Hongwei Zhu, Zhiping Xu, Dan Xie, and Ying Fang, Editors

Academic Press (Elsevier), 2017
272 pages, $150.00 (e-book $150.00)
ISBN 9780128126516

The English version of this book is an update to the Chinese version published in 2011. A wide range of books on graphene dealing with fundamentals to more advanced levels have appeared in the market after the award of the Nobel Prize to A. Geim and K.S. Novoselov. Some of those books focus on either science or technology, but this one concentrates on materials science and engineering, giving a comprehensive review of the subject.

The first chapter discusses the basic structure and properties of graphene. It contains short descriptions of carbon allotropes, with a historical account of the discovery of graphene, which is followed by illustrations on the structure and properties of graphene. Chapter 2 limits the discussions to the physical properties of graphene, such as refraction, thermal, and electrical conductivities, and introduces graphene structural information as derived from optical microscopy, electron microscopy, scanning probe microscopy, and Raman spectroscopy.

Chapter 3 covers multidimensional assemblies of graphene, with a predominant focus on oxides. It then discusses one-dimensional (1D), 2D, and 3D structural materials, large-scale synthesis of graphene films, template-directed methods, graphene-based macrostructures, and chemical and electrochemical reduction of graphene oxides. Chapter 4 depicts electronic, optical, mechanical, thermal, and chemical properties of graphene. Chapter 5 describes electronic devices, including solar cells and photodetectors.

Chapters 6 and 7 orient the reader to graphene-based sensors and flexible energy-storage devices. The advantages of graphene for gas sensing are well discussed; however, the literature coverage is not exhaustive. Chapter 8 covers graphene composites made with either polymer or non-polymeric matrices. Chapter 9 discusses biomedical applications such as graphene-based biosensors, graphene derivative-based functional carriers, and biosafety. The last chapter focuses on potential applications. Several exciting areas such as self-powered micromotors, knitted textiles, sensors and actuators, superhydrophobic surfaces, evolution of new 2D structures, and the need for low-cost synthesis of graphene are emphasized.

This is a specialized book reviewing the developments in select areas of graphene. There is a subject index at the end of the book for easy selection of topics. Although the book contains a number of illustrative figures, they are in black and white with limited clarity, and the text contains some structural errors (e.g., Chapter 1 starts with "… as mentioned in the previous chapter" when there is no chapter preceding it). The book aims to stimulate graduate students in materials science and engineering for further research in graphene. It is a good supplemental book for graduate students and for those interested in the area of graphene.

Reviewer: K.S.V. Santhanam *is a professor in the School of Chemistry and Materials Science at Rochester Institute of Technology, USA.*

https://doi.org/10.1557/mrs.2018.312 Published online by Cambridge University Press