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.

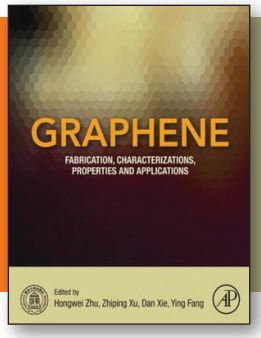
Chapter 5 describes the structure of dislocations, the stress fields they create, their strain energies, and how they interact with externally applied forces and each other.

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.*

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