

Graphene for Defense and Security

Andre U. Sokolnikov

CRC Press, 2017

282 pages, \$175.96 (e-book \$197.96)

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This book is focused on the physics of an interesting material, graphene, with its unique two-dimensional crystal structure that confers special electrical, thermal, optical, and mechanical properties with a wide palette of possible applications. It contains nine chapters, out of which the first two familiarize the reader with some specific phenomena, such as the Landau level effect and the quantum Hall effect, particularly interesting for graphene developments. The next three chapters deal with the physical properties and quantum mechanics of graphene, while chapters 6–8 report on sources and methods for producing graphene and characterization techniques for graphene-based materials. The last 50 pages of the final chapter are devoted to applications.

The book develops the basic concepts for understanding the versatility of graphene related to its electronic band structure, which may be engineered by various methods able to break graphene's lattice symmetry, such as defect generation, water adsorption, and interaction with

gases. In this context, some of graphene's special properties are explained in detail. Micrometer-sized samples of graphene show some of the best electron mobility values ever measured. As the optical response of graphene nanoribbons may extend into the THz range by using an applied magnetic field, a practical application may be a graphene-based Bragg grating, which is a one-dimensional photonic crystal that is capable of excitation of surface electromagnetic waves in a periodic structure. Such phenomena may contribute to different devices and their improvements: fiber lasers, mode-locking, microwave saturable absorbers, polarizers, modulators in the microwave range, and broadband wireless access networks.

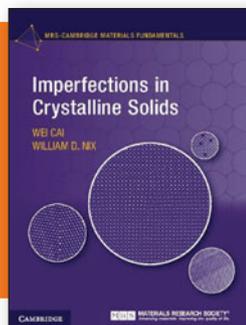
The plasmonic dynamics may exploit optical properties of graphene to design a solid-state laser in the THz range with high efficiency at room temperature. Thermal properties of graphene are also different from those of other carbon materials, such as graphite, nanotubes, or diamond, and

the nature of conductivity at the charge-neutrality point has been discussed in connection with graphene-based device fabrication. Moreover, graphene is one of the strongest materials from a mechanical point of view. For instance, graphene exhibits more than 100 times greater breaking strength than steel. The ease of shaping and the firmness of thin graphene layers may facilitate making lighter vehicles and airplanes that use less fuel and generate less pollution. It is expected that graphene could replace silicon technology in many applications by 2020.

The title is a little misleading, as the book is not specific to graphene's applications in defense and security, but it covers applications tangential to these areas, such as those mainly used in electronic devices: a new generation of high-frequency transistors, ultrafast photodetectors, optical modulators, memory devices, energy generation, and energy storage.

In order to take advantage of the information provided in this book, one needs a deep knowledge of quantum physics in solid materials and related phenomena. This monograph based on up-to-date references may be useful for PhD students and specialists in physical engineering and applied electronics.

Reviewer: Aurelia Meghea is an Emeritus Professor at the University Politehnica of Bucharest, Romania.



Imperfections in Crystalline Solids

Wei Cai and William D. Nix

Materials Research Society
and Cambridge University Press, 2016

532 pages, \$64.99 (e-book \$52.00)

ISBN 9781107123137

In the interest of transparency, MRS is a co-publisher of this title. However, this review was requested and reviewed by an independent Book Review Board.

This book by two acclaimed experts contains an excellent account of the

origins and implications of imperfections in crystalline materials, and offers a vivid introduction to the behavior of defects in crystalline materials. The presentation of concepts is superb and is guided by a thorough description of the fundamentals of the chemistry, mechanics, and

thermodynamics of defects in solids. The book is distinguished from other solid-state physics and chemistry approaches by illustrating the influence of atomic and microstructural irregularities on macroscopic properties. The contextual elaborations are refreshing and easy to grasp due to descriptive illustrations and an intuitive style reinforced by mathematical derivations. The authors emphasize the importance of the book in preparing materials science and engineering students to understand the behavior of defects in crystalline compounds, but the book is equally suited as a well-configured introduction to specialists and researchers working in the field of materials science and related disciplines.



The book begins with an introductory chapter on the fundamentals of crystal chemistry as an effective way to describe not only the crystal systems, but also to reinforce critical interdependence of composition and microstructure on the properties manifested by engineered materials. The book then divides into four thematic sections.

Part I describes the basic principles and equations underlying stress, strain, and elasticity in solids that are critically important in the study of imperfections. Part II focuses on theoretical background and fundamental principles of thermodynamics and statistical mechanics governing the distribution and motion of defects in solid matter under external or internal stresses and their implications on material properties. For instance, the flow of vacancies gives rise to creep deformation of crystalline materials. Part III introduces the geometrical properties of dislocations and the rules

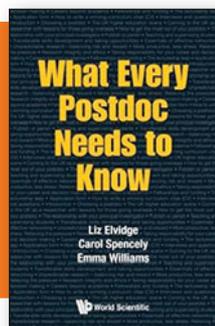
governing dislocation mechanics. In particular, the chapters in this section rationalize the understanding of the orientational relationships and energy of dislocations responsible for dislocation mobility. Part IV advances the relationship between dislocations and intergranular arrangements in polycrystalline materials to discuss the orientation, energies, and elastic fields of grain boundaries and their influence in modifying material behavior.

Through its well-chosen selection of topics and explanation of theoretical principles with practical insights, this book serves as a useful resource for students and researchers engaged in materials science and engineering. Each chapter includes a summary and an elaborate exercise section for the reader to analyze and apply the concepts. The book's figures and tables are well done. References are adequate, although they do not include recent work from the past four or five years regarding new insights into

coupled grain-boundary motion in metals that results in structural multiplicity for similar chemical compositions.

For future editions, the authors might consider including sections on the role and response of defects in governing the performance of functional materials (conductivity, light absorption, catalytic activity) and engineering concepts to create defects (doping, strain, laser patterning, high energy radiation) that would make this book more comprehensive and an enlightening resource for research scientists and engineers alike. However, this minor limitation does not affect the importance and impact of this authoritative book that excels at all levels of presentation due to its integrated and comprehensive approach to the subject matter. This book was a delight to read.

Reviewer: *Sanjay Mathur* of the Institute of Inorganic and Materials Chemistry, University of Cologne, Germany.



What Every Postdoc Needs to Know

Liz Elvidge, Emma Williams,
and Carol Spencely

World Scientific, 2017

280 pages, \$68.00 (softcover \$28.00)

ISBN 978-1-78634-234-8

This book is a survival guide for first-time postdocs coming to or leaving the United Kingdom (UK) and revolves around the UK academic system. Nevertheless, it portrays the academic career system in general, not limited to the UK. The book is divided into 21 chapters, preceded by a Foreword and Introduction and followed by an Index. The authors have consolidated their postdoc experiences in the book.

Chapters 1–3 introduce the concept of a postdoctoral position and provide tips on applying for positions. Chapters 4–6 guide the reader not only at a professional level but also on a social level by providing the dos and don'ts of the job, including how to relate to one's supervisor. Chapters 7–9 go beyond the tasks of a basic postdoc, but

are nevertheless useful in developing one's academic career; they talk about transferable skills through teaching and supervision and the benefits of networking.

Sometimes a postdoctoral topic can be risky and stressful. Chapters 10–12 bring out the bright side of the situation by encouraging postdocs to change their research topics. In fact, research can also be rewarding by diversifying one's experience and managing stress when things get tough, all of which is well explained. The authors are realistic in their approach: all postdocs should have a plan B in case their plan A or main research topic supported by a grant does not reach its goal.

Chapter 13 reinforces research ethics, which is generally introduced during a PhD program. Chapter 14 helps the reader

to understand the options after a postdoc, the challenges one faces in obtaining a job after this period, and how to decide on what is best in today's job market. Chapters 15–17 expand on chapter 14 and propose academia options, such as working as a research fellow or taking the more traditional academic career path of lectureship specific to the UK or British academic systems. Chapter 18 provides tips for writing a good CV. This chapter could have been introduced earlier in the book, as writing a CV is important at all career stages. Chapter 19 provides probable interview questions, and Chapter 20 sums up the concepts provided in the book.

This book is well written and easy to follow not only by future postdocs but also by a more general readership. It highlights the pros and cons of a postdoctoral position and stresses the important fact that a postdoctoral position is not a career in itself, but prepares one for the next step in one's career. The book also has numerous sketches and illustrations that are self-explanatory and amusing.

Reviewer: *Protima Rauwel* of Tallinn University of Technology, Estonia.