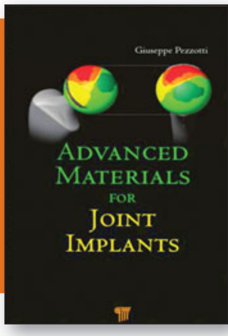


Advanced materials for joint implants

Giuseppe Pezzotti

Pan Stanford Publishing, 2013
604 pages, $179.95
ISBN 9789814316880

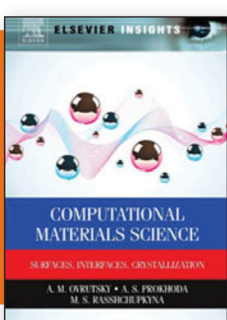
The performance of joint implants is determined by the interplay among designs, materials, manufacturing processes, and the way patients use them. This is similar for many implantable medical devices. Because of the statistical nature of manufacturing processes and human use conditions, the product performance is a statistical function of not only the relevant parameters and their interactions, but also the variations that those parameters can have under the normal processing and use conditions. It has been a goal of many scientists to develop a transfer function to predict the product performance from the properties of materials. Pezzotti's book represents this effort.

This book begins with a review of joint implants and the common failure modes of each material used in the joints. An introduction to some analytical and characterization methods such as atomic force microscopy, Raman and infrared spectroscopy, cathodoluminescence spectroscopy, and tribology assessments is presented. Detailed descriptions of individual materials are provided next.

Alumina is best for load bearing and wear resistance. The weakness of this material is its brittleness, which is discussed in terms of pores, grain size, and inclusions. Methods to overcome this weakness such as using additives and hydraulic compression are presented. Zirconia has been used successfully for implants, but the phase transition from the tetragonal to monoclinic polymorph has been a problem. The book discusses the methods and mechanisms to inhibit this transition, such as the addition of yttrium oxide. Compounding alumina with zirconia is presented. The use of gamma irradiation to improve the current ultrahigh-molecular-weight polyethylene (UHMWPE) is also detailed. Different methods for treating gamma-irradiated UHMWPE parts for reducing free radicals and therefore improving wear resistance are discussed using products available in market as examples. In addition, using additives such as vitamin E and antioxidants for reducing radiation-induced free-radical oxidation of UHMWPE is described. A free-radical depth profile and correlation with wear properties are presented using Raman spectroscopy and wear test data. In the last chapter, new materials, designs, and testing methods are discussed as future technologies.

Overall, this is a good reference of joint implant research. Extensive literature papers have been cited, though a number of them are by the author. An area of improvement can be to include other important research topics and tools. for example, use of electron spin resonance to monitor free-radical oxidation of UHMWPE.

Reviewer: ***SuPing Lyu*** *is a Principal Researcher at Medtronic Inc., Mounds View, Minn., USA.*



Computational materials science: Surfaces, interfaces, crystallization

A.M. Ovrutsky, A.S. Prokhoda, and M.S. Rasshchupkyna

Elsevier, 2013
388 pages, $125.00
ISBN 9780124202078

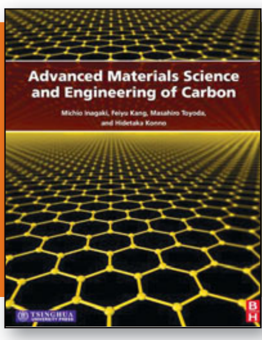
This book is an excellent summary of principles of computational modeling of physical phenomena in materials science, especially in surfaces, interfaces, and crystallization. Modern technology development allows people to simulate highly complicated systems with lots of variables and nonlinearities associated with design, synthesis, processing, characterization, and utilization. The field is very broad to include everything in one book, thus this book is specifically focused on establishing kinematics and dynamics models at a molecular level, which should attract a large number of readers who specialize in such fields, for providing appropriate guidance for their studies and research.

The book comprises nine chapters. Chapter 1 is an overview of the scope of computational modeling and the two simulation methods: Monte Carlo and molecular dynamics. The mathematical algorithms, boundary conditions, and their applications are introduced. This chapter clearly defines how to apply each model to different applications. Chapter 2 summarizes high-level thermodynamics of one-component and multicomponent systems, including phase transformation, solution, crystallization, and a little bit of interfacial tension. This chapter contains most equations necessary for solving thermodynamics problems, but the chapter title, "Basic Concepts of Theory of Phase Transformations," is slightly narrower than the content it covers. Chapter

3 introduces kinetics theories during the crystal growth process. Chapters 4, 5, and 6 cover the intermolecular reactions on surfaces. Chapter 7 continues the introduction of nucleation of crystals from surface energy and kinetics standpoints, mainly using the Monte Carlo method. Chapter 8 gives a good introduction to the application of molecular dynamics to nucleation, crystal growth, and defects for short- and long-range ordered structures. Finally, chapter 9 presents many examples on how to apply those theories to mathematical models. Each example includes detailed background and the necessary programming codes for the model. Some recommended experiments are also given to illustrate each example.

The book does not cover all aspects of simulation in materials science, but the authors have successfully focused and condensed the content on atomic surface phenomena and processes of crystallization by incorporating computational simulation methods. The highly concentrated content in each chapter and well-illustrated examples make it a useful handbook or textbook for researchers or postgraduate students with a certain level of materials physics and chemistry background.

Reviewer: Yan Hong *of General Electric, USA.*



Advanced materials science and engineering of carbon
Michio Inagaki, Feiyu Kang, Masahiro Toyoda, and Hidetaka Konno

Butterworth-Heineman, 2013
434 pages, $149.95
ISBN 978-0-12-407789-8

This book gives an excellent introduction to carbon materials for researchers in this field. Carbon is an interesting and functional element forming many important materials, such as diamond, graphite, amorphous carbon, fullerenes, carbon nanotubes, and graphene. In this book, the authors present a comprehensive review of carbon materials, aiming at understanding the advanced materials science and engineering of carbon.

The book comprises 17 chapters and 434 pages. It is divided into three parts. The first part (chapter 1) gives an introduction to carbon materials; the second part (chapters 2–10) is concerned with the formation and preparation of carbon materials; the third part (chapters 11–17) deals with applications of carbon materials. Appropriate references are listed at the end of each chapter.

Chapter 1 gives an overview of carbon materials and an outline of the book. Chapters 2 and 3 review carbon nanotubes and graphene, respectively, with emphasis on their formation and mechanism. Chapters 4–10 go into processes with specific procedures and the resultant carbon materials, including carbonization under pressure (chapter 4), graphitization under high pressure and stress (chapter 5), glass-like carbons with focus on their activation and graphitization (chapter 6), template carbonization to control morphology and pore structure (chapter 7), carbon nanofibers synthesized by electrospinning (chapter 8), carbon foams with new applications (chapter 9), and nanoporous carbon membranes and webs (chapter 10).

Chapters 11–17 cover several applications of carbon materials, such as electrochemical capacitors (chapter 11), lithium-ion rechargeable batteries (chapter 12), photocatalysis (chapter 13), spilled-oil recovery (chapter 14), adsorption of molecules and ions (chapter 15), highly oriented graphite with high thermal conductivity (chapter 16), and isotropic high-density graphite for nuclear applications (chapter 17).

This book provides a concise and comprehensive introduction to carbon materials, from material fabrication to practical applications. It is neither too advanced nor too elementary, so it is useful as a foundation for materials research. The authors have succeeded in providing a comprehensive summary and review of published results.

This book is written in a clear manner and can be well understood. I recommend this book without hesitation to all interested in carbon materials, particularly to those entering the field. It is written at a level appropriate to researchers with a chemistry, physics, or materials background. Also, it is a good book for advanced undergraduate and graduate students.

Reviewer: Jianguo Lu *is an Associate Professor at Zhejiang University, China.*

See ad on page 1020.