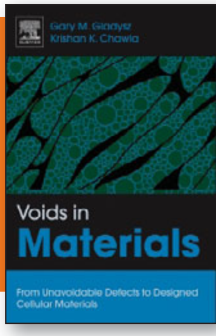


Voids in Materials: From Unavoidable Defects to Designed Cellular Materials

Gary M. Gladysz and Krishan K. Chawla

Elsevier, 2014
214 pages, $175.00
ISBN 978-0-444-56367-5

The properties of many naturally occurring and manufactured materials are defined by the extent to which they contain voids of various types, shapes, and sizes. The focus of this book is on voids in solid-state materials, including structural materials and biologically inspired hierarchical materials. The target audience is the materials scientist who is a non-expert on porous materials and is interested in an accessible, extended overview of the field.

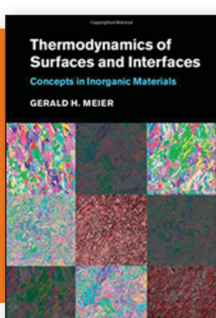
Unlike many other books on porous materials, which tend to focus on a particular materials class such as polymers where voids play an important role, the authors here introduce and define intentional versus unintentional voids across length scales in multiple classes of materials, including metals, ceramics, polymers, and cellular materials. There is brief discussion of carbon nanotubes, but other nanoporous materials, such as inorganic nanotubes, zeolites, and metal–organic hybrids, are not discussed.

The authors do a good job of highlighting the similarities among voids in these various types of materials and describing the ways in which voids impact their properties. Equations are given throughout, but, as the authors indicate in the preface, the emphasis is on a descriptive rather than a rigorous mathematical presentation. An extensive bibliography is provided so that the interested reader is able to follow up with the source material when greater depth is needed.

The authors next review the methods by which voids are introduced experimentally into materials, fibers, and powders. They further discuss the various ways in which these components can be combined to form composites with a hierarchical porous structure. These materials are distinct from solid-state cellular materials, or foams, which are described in their own chapter. Useful tables are included that list example materials and associated void sizes, along with associated applications and references, which help the reader rapidly navigate the material.

The book closes with a chapter on the applications of materials with voids of different scales and some of the most important methods by which voids are characterized experimentally. Computational materials science is primarily confined to a brief discussion of finite element modeling. This book is recommended to those who desire an accessible, introductory overview to porous materials.

Reviewer: Susan B. Sinnott *of the University of Florida, USA.*



Thermodynamics of Surfaces and Interfaces: Concepts in Inorganic Materials

Gerald H. Meier

Cambridge University Press and the Materials Research Society
251 pages, $120.00
ISBN 9780521879088

In the interest of transparency, MRS is a co-publisher of this publication. However, this review was commissioned by an independent Book Review Board.

This book's author, Gerald H. Meier, is the William Kepler Whiteford Professor of Materials Science at the University of Pittsburgh, where he has taught for over 40 years. The book is touted "as an auxiliary text for students and a self-study guide for industry practitioners and academic researchers." I fall into the latter category; 25 years after taking my last thermodynamics class, I read the book with the goal of brushing up on the fundamentals of surface-related work.

The book is true to its title and covers thermodynamics of materials surfaces with a focus on high-temperature, inorganic materials. Chapter 1 begins with basic bulk thermodynamics (e.g., the handling of multiphase equilibria and the Gibbs phase rule as applied to binary phase diagrams) and then expands to specific cases of surface phenomena. From there, surface quantities are introduced in chapter 2, and the concept of wetting, surfaces of crystalline solids, interphase interfaces, curved surfaces, adsorption, and adhesion are the topics of the following six chapters. Each chapter concludes with a few study questions. While the book preface promises not to have an "overwhelming amount of mathematics," most of the concepts are illustrated mainly with mathematical formulations, followed by simple illustrations.

An advantage of completing a book review is that you are compelled to read the full book. If you buy this book, I encourage you to do the same. Chapter 1 is pretty much all math. However, there may not be a non-mathematical means to explain thermodynamics, and Meier does a good job explaining the basic principles. With the cobwebs around thermodynamics cleared from my head by the end of chapter 1, the book then turned out to be a

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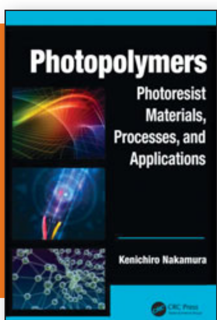
good read, with very complex phenomena explained in a fairly simple and straightforward way. As a whole, I enjoyed this book and learned quite a bit.

The examples draw mainly from high-temperature cases in thermodynamics, such as a droplet of molten nickel forming on the surface of an oxide layer. This is not surprising considering that Meier was trained as a metallurgical engineer. However, the reader could have benefited from more modern applications of thermodynamic surfaces, such as an ink droplet on a surface of graphene. The book lays a firm theoretical basis, so at the end of the book, you can extrapolate to more diverse research topics, but some broader examples would have been more helpful.

Unfortunately, the book does not include the answers to the study problems. For people who have been out of the classroom for a long time, these would be very helpful. The answers are available online as "instructor resources" from Cambridge, but they are locked for instructors. I attempted to sign up for an instructor resources account, but then stopped when they asked for my course name and my website for verification of my position as an instructor (which I am not). Having part of the book as a locked online resource seems to diminish both the long-term prospects for this as a hardcover book and the promise that the book could be a good self-study guide. While the book will certainly be a valuable tool for instructors looking for a lucid guide to classic surface thermodynamics, the lack of answers to the study problems creates an obstacle to readers outside the classroom.

Reviewer: Karen Swider Lyons *researches fuel-cell and battery materials and their integration into naval systems in Alexandria, Va., USA.*



Photopolymers: Photoresist Materials, Processes, and Applications
Kenichiro Nakamura

CRC Press, 2014
189 pages, $149.95
ISBN 978-1-4665-1728-8

This book is a toolbox for individuals needing practical knowledge in the area of photopolymers and photoresist materials. It contains practical guidance in chemistry, fabrication, and industrial reduction-to-practice of photopolymer technology. The volume is comprised of five chapters. A major theme of the book is the relationship between photopolymer technology and the increasing miniaturization of electronic and mechanical devices.

Chapter 1 discusses the basic idea of photopolymerization. After a brief introduction to photochemistry, there is a discussion of radical polymerization. The author gives extensive tables of monofunctional, bifunctional, and multifunctional monomers. There are similar lists of various initiators and inhibitors. There is also discussion of cationic polymerization, photocross-linking, and photoscission of polymers. Helpful tables giving representative photopolymer formulations are included. The chapter includes an extensive discussion of recommended polymers for various user needs, such as high or low refractive index, hardness, and hydrophobicity. If the reader has a specific application in mind, it is easy to search the chapter and find a system that will meet these requirements.

Chapters 2 and 3 address chemically amplified resists as a method for meeting the requirements for nanoscale resolution in photopolymerization. Chapter 2 provides a general discussion of the chemical amplification process parameters such as optical absorption coefficients, etching and dissolution rates, and their influence on pattern profiles. Tables of photoacid generators and their physical properties are included. Chapter 3 analyzes chemical amplification from the lithography perspective and describes the relationship between resolution and depth of focus as a function of numerical aperture and wavelength. The author then presents several lithography techniques, including immersion lithography, double patterning, extreme ultraviolet lithography, and direct self-assembly.

Chapter 4 describes nanoimprint techniques, detailing descriptions of thermal nanoprint and ultraviolet nanoimprint lithography as well as step and flash imprint lithography. Cationic polymerization of ultraviolet nanoimprinting is discussed, including monomers, photointiators, and stabilizers. Following a brief discussion of thiolene polymerization of ultraviolet nanoimprint lithography, the author describes the microcontact print method.

Chapter 5 focuses on industrial applications of photopolymer technology with descriptions of large-scale integrated circuits, transistors, and industrial reduction projection technology. Subsequently, there is a rundown of optical adhesives as ultraviolet hardening resins with many examples. A section on holography presents types of holography, recording materials, and recipes for fabrication. There is also a section on dental photopolymers followed by a discussion of microelectromechanical systems.

This short book has enough material to give a novice a good start in the field of photopolymer technology. It is written at a level appropriate for individuals with a chemistry or polymer engineering background.

Reviewer: Thomas M. Cooper *of the Materials and Manufacturing Directorate, US Air Force Research Laboratory, USA.*

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