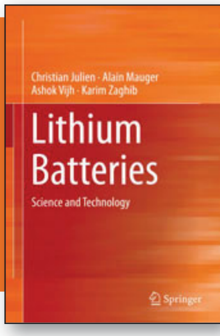


Lithium Batteries: Science and Technology

Christian Julien, Alain Mauger, Ashok Vijh, and Karim Zaghib
Springer, 2016
619 pages, $179.00 (e-book $139.00)
ISBN 978-3-319-19107-2

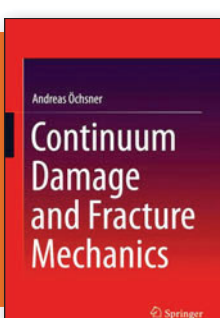
Lithium-ion batteries dominate mobile electronics: laptops, cell phones, e-readers, etc. Their role is expanding as electric propulsion, wearable electronics, and the Internet of things are being developed. However, they fall short of their potential: current technologies achieve only 20% of the theoretical energy densities. This situation has motivated much research. In the book reviewed here, four authors combine their expertise in solid-state physics and chemistry, electrochemistry, and battery technology to bring us up to date. Additionally, they discuss the fire problems that occur from time to time in lithium batteries and recent progress in the use of nanotechnology to improve performance.

The first two chapters include a lucid introduction to energy storage and lithium batteries. The third chapter includes a thermodynamic background and explains intercalation, the reversible process of introducing and extracting ions from the layers of the host structure. The next chapter explores the use of the rigid-bond model for intercalation in transition-metal chalcogenides and oxides, concluding that it "can only be rarely applied." The density functional theory, which has been used with considerable success, is not discussed. In contrast to other chapters, this chapter has no references after 2010. Chapters 5 to 9 discuss cathode materials, which have attracted a lot of attention. Layered structures such as lithium cobalt oxide, which is used commercially, and its potential replacements, which are cheaper and less toxic, are discussed in chapter 5. The next four chapters discuss three-dimensional networks, polyanionic compounds, fluoro-polyionic compounds, and disordered compounds.

Chapter 10 is devoted to anodes based on carbon, silicon, lithium titanate, and several other materials. Electrolytes and separators are discussed together in chapter 11 since the choice of one depends on the other materials. The important role of solid-electrolyte interphase comes up for a detailed and authoritative discussion here. A special feature of the book is the discussion in chapter 12 on synthesis of nanomaterials and their electrochemical and physical properties. A lot of ongoing research on batteries involves nanotechnology. It is convenient to have a summary of experimental techniques in chapter 13. The next chapter on safety aspects is timely. The concluding chapter presents a brief introduction to technological issues of capacity, electrode loading, degradation, manufacturing, and packaging.

With the fast pace of research in this field, many topics, such as stretchable batteries that can be attached to the skin like an adhesive bandage, material recycling technologies, and lithium-air batteries, will have to wait for future volumes. This book covers the chosen topics comprehensively with good illustrations and a large number of references, including recent ones. Cathodes get more than 800 references and anodes get 650! This book will be useful to students (although homework exercises would have added value), researchers in academia, laboratories, and energy-related industries. With its focus on fundamental materials science, the book not only informs you of the state of the art, but also prepares you for the advances that are likely to come.

***Reviewer: N. Balasubramanian** is an independent research scholar working on energy-related materials and ultrafine-grain materials in Bangalore, India.*



Continuum Damage and Fracture Mechanics

Andreas Öchsner
Springer, 2016
163 pages, $89.99 (e-book $69.99)
ISBN 978-981-287-863-2

This book is a well-condensed, useful textbook that introduces damage mechanics and fracture mechanics. It does not dive deeply into all of the failure modes or mathematical models of all the related theories in applied mechanics, but is a sufficient level of introduction that is necessary to understand the content. The book is comprised of five chapters.

Chapter 1 starts from a classical uniaxial tensile test with round and flat shapes to introduce the stress–strain behavior of a ductile aluminum alloy with corresponding microstructure changes at different stages. This chapter provides the outline and focus of the book, where three theories—classical continuum mechanics, continuum damage mechanics, and fracture mechanics—are described based on material behavior at the microscale.

Chapter 2 introduces elastic materials behavior under simple load conditions. The introduction to the three-dimensional Hooke's Law for isotropic and linear-elastic materials behavior is very useful and essential for finite elements and other numerical analytical methods for engineering design and failure analysis.

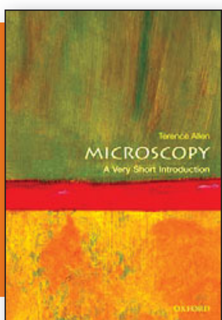
Chapter 3 covers the equations for plasticity of materials through yield condition, flow rule, and hardening mechanisms. The classical failure criteria and several fracture hypotheses are also introduced with well-illustrated graphs and equations.

Chapter 4 introduces straightforward ductile damage mechanics by relating the behavior with the microstructure evolutions to the elastoplastic deformation stage followed by the introduction of Lemaitre and Gurson damage models in one- and three-dimensional circumstances.

Chapter 5 introduces the concepts of failure criteria in the presence of cracks under different stress conditions. The concept of stress concentration based on stress intensity factor, energy release rate, and J-integral is also introduced based on different geometry and defect configurations.

As noted by the author, the purpose of this book is to provide an introduction to damage and fracture mechanics suitable for undergraduates. The author has succeeded in accomplishing the scope and organizing the content in a very readable structure without losing any important information on this topic. Each chapter has sufficient figures/illustrations to help understand the information. There are worked examples in some chapters. The supplementary problems are taken from tutorials in the class, but there are no solutions provided, which encourages students to find the solution on their own with some hints. This book will be useful not only to students, but also junior engineers who frequently utilize these principles. I recommend this book without reservation to anyone who needs to learn fracture mechanics.

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



Microscopy: A Very Short Introduction

Terence Allen

Oxford University Press, 2015
144 pages, $11.95
ISBN 9780198701262

This book is indeed a short introduction; nevertheless, it is surprisingly complete. It is perfect reading for anyone who wants to extend their knowledge of microscopy but has little time. Because of its length, do not expect to learn in-depth details about microscopy techniques.

In general, this book is mostly about optical (light) and electron microscopy. Both optical and electron microscopy are described very well. Beginners who plan to use these techniques can benefit from this book. It has a good blend and description of almost all modes of operation of these two microscopies. The book slightly touches on other advanced techniques, such as scanning probe and x-ray microscopy. The descriptions of these techniques could be improved by polishing facts and updating the information with recent advancements in those areas. It is unlikely that first-time learners can effectively use this book for the latter techniques.

After a brief historical introduction to the world of optical and electron microscopies (chapter 1), the book starts with a more detailed description of techniques behind optical and electron microscopy (chapter 2). Chapter 3 is an excellent description of the details of light microscopy, parts of an optical microscope, and advanced optical imaging modes, such as dark field and phase contrast, polarized light microscopy, and Nomarski mode. This chapter also touches upon ultraviolet and infrared microscopy, describing fluorescent microscopy and confocal and laser scanning confocal microscopies. It further describes ways to increase resolution by either some image post-processing (deconvolution) or by using several advanced methods commonly referred to as "super-resolution," a recent development of light microscopy.

Chapter 4 is entirely devoted to fluorescent microscopy and its use in biological and medical applications. Chapters 5 and 6 nicely describe transmission and scanning electron microscopies, respectively. Both chapters contain useful information about ways to increase the resolution of the samples, specimen preparation, and ways of labeling samples. Chapter 7 describes "magnification by other routes." This includes scanning, tunneling, and atomic force microscopies, both developed in the last 30 years. This chapter also includes information about near-field optical scanning microscopy using exotic "super lenses" created from metamaterials and lensless microscopy (both optical and x-ray).

Finally, chapter 8 describes the impact of microscopy in forensic science, art, environmental science manufacturing, and the development of food and drugs. It finishes with a description of an elegant version of a super cheap "origami" optical microscope. The last two pages are devoted to a description of further readings, which include only one book for each microscopy. The book's figures are black and white; while they are not extraordinary, they are still useful.

This book is worth reading by anyone who wants to learn (or verify existing knowledge) about optical and electron microscopies. It is an excellent, concise description of these techniques. The book can be improved upon by further expanding the material on scanning probe microscopy. Otherwise, it is a small gem definitely worth having.

Reviewer: Igor Sokolov *is a professor at Tufts University, Medford, Mass., USA.*