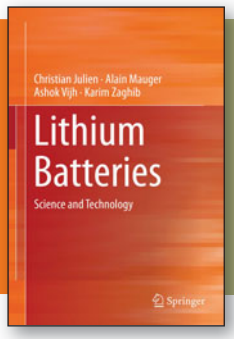


Lithium Batteries: Science and Technology

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

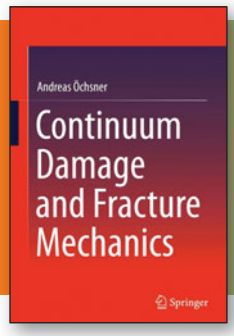
Lithium-ion batteries dominate mobile electronics: laptops, cell phones, e-readers, etc. Their role is expanding as electric propulsion, wearable electronics, and the Internet of things are being developed. However, they fall short of their potential: current technologies achieve only 20% of the theoretical 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.

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