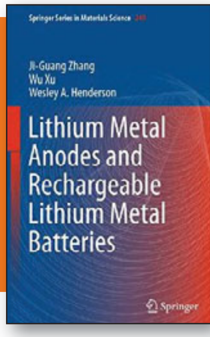


Lithium Metal Anodes and Rechargeable Lithium Metal Batteries

Ji-Guang Zhang, Wu Xu, and Wesley A. Henderson

Springer, 2017
194 pages, $99.99 (e-book $79.99)
ISBN 978-3-319-44053-8

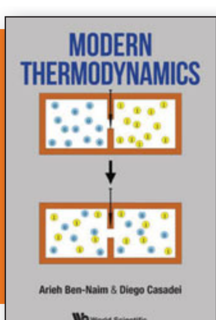
Lithium metal is light (with a density of 0.534 g/cm^3), has a specific capacity of 3860 mAh per gram, and has the highest electroactivity with redox potential of –3.04 against the standard hydrogen electrode. It should be the ideal anode material for rechargeable batteries. So what is stopping it? This book analyzes two barriers to the commercial development of rechargeable batteries with lithium-metal anodes: growth of lithium dendrites and low Coulombic efficiency of lithium cycling in the battery. At one time, the problems were considered insurmountable, and interest shifted to compromise candidates: disordered carbon and then to the present-day ordered graphite anode.

Is there a second coming for lithium-metal anodes? This book provides a structured response to this question. A brief introductory chapter on rechargeable batteries sets the stage for the use of lithium-metal anodes. The chapter introduces tree-like structures—with the generic name of dendrites—growing on the anode during charge/discharge cycles. These form internal short circuits, causing capacity loss. Chapter 2 describes seven techniques used to characterize the surface morphology and chemistry of dendrites. Micrographs and schematics contribute to the lucid description of test methods and failure mechanisms of the lithium anode. The chapter also discusses the important role of the solid-electrolyte interface. Theoretical models, including recent ones emphasizing interfacial elastic strength, are described. Chapter 3 discusses factors affecting Coulombic efficiency and dendrite growth, since most of them are common to both. The chapter also discusses various electrolytes and the influence of solvents, lithium salts, additives, and electrolyte concentration.

Chapter 4 considers the application of lithium-metal anodes mainly in lithium-sulfur and lithium-air batteries. The chapter also covers rechargeable batteries where a lithium-metal anode is formed *in situ*. Application of nanotechnology and progress in modeling and experimental work have led to new electrolytes and additives being used in batteries with lithium-metal anodes. Chapter 5 reviews these advances and offers perspectives on the future development of lithium-metal anodes.

References are extensive and cover the work completed up until 2015, with a few references from 2016. This is a valuable reference for people working in rechargeable batteries in general and lithium-metal anodes in particular. It is timely because the lithium anode has remained the holy grail for four decades, and recent developments discussed in the book may well take us nearer to the goal.

Reviewer: N. Balasubramanian *is an independent research scholar working in Bangalore, India.*



Modern Thermodynamics

Arieh Ben-Naim and Diego Casadei

World Scientific, 2016
372 pages, $95.00 (softcover $48.00)
ISBN 978-981-3200-75-3

This is not the first book entitled *Modern Thermodynamics*, but it is certainly a book from a very uncommon viewpoint for thermodynamics: the information theory proposed by Claude E. Shannon in 1948 (*Bell Syst. Tech. J.* **27** (3), 379). Ben-Naim and Casadei have written this book presenting their systematic research on the link between information theory and thermodynamic entropy.

The book is divided into two sections: Fundamentals and Applications. Eight chapters cover the fundamentals, and four chapters cover specific applications. The first two chapters provide a brief historical development of thermodynamics and information theory. Perhaps the most interesting subsection is The Basic Idea of Information Theory, which is presented using a question game to find an unknown subject, person, or thing. The third chapter introduces the elements of probability theory, which are required to fully understand the concepts of Shannon's Measure of Information (SMI), called "entropy." The authors argue that SMI is definitely different from thermodynamic entropy because it is more general. They use the axiomatic approach to probability and introduce the three major probability distributions (uniform, exponential, and normal) that are required for deducing the ideal gas entropy. Chapters 4 and 5 present the principal theorems behind SMI, which are related to the defined probability distribution functions. They also provide an important discussion on the interpretation of SMI and its maximum value, which is associated with the most probable distribution, the equilibrium distribution density.

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