



**Essential Biomaterials Science**  
David Williams

Cambridge University Press, 2014  
672 pages, \$99.00 (e-book \$79.00)  
ISBN 9780521899086

This textbook, written at an introductory level, covers a broad range of topics related to biomaterials from general materials science, biocompatibility, medical devices including drug-device combination devices to industrial infrastructure. The book also presents an introduction to the ongoing research on regenerative medicine, nanomaterials, etc. The writing style, depth, and balance between pure science and applications are consistent throughout the book. There are study problems at the end of each chapter—many of them are open-ended and suitable for students to use as homework projects.

One of the highlights is the discussion of biocompatibility. It starts from products and their interactions

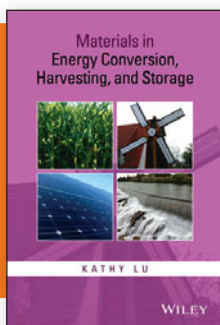
with tissues. Biocompatibility is not a simple reaction of the tissues to materials, components, or similar products. It deals with specific reactions of biological systems to the products that are made of the specific materials, in specific processes, and used in specific ways. In this book, the author uses examples of devices to describe physical, chemical, mechanical, and other possible interactions between medical devices and tissues. The causes and consequences of toxicity, inflammation, infection, immune response, and long-term reactions are discussed.

Introduction to medical devices is another highlight, which makes the discussion of biomaterials more relevant to their end use. The coverage is extensive,

including orthopedic, cardiovascular, central nervous systems, eyes, ears, and other main organs and systems. Each section starts with a brief introduction to the diseases, followed by a description of the devices, their working principles, and device-biological interactions. Most of the devices discussed in the chapter have been approved by the regulatory agencies for treating the diseases of patients. History of the development is presented. Major failure mechanisms are discussed. This not only serves as examples to illustrate how materials are used in medical devices, but also describes how materials and devices, interact with biological systems in real applications.

The references are key publications in the field and up to date. The tables, figures, and in-box descriptions are valuable for readers to understand the content. This is one of the few books that I can highly recommend to college students, researchers, and engineers in the field as a desktop reference.

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



**Materials in Energy Conversion, Harvesting, and Storage**  
Kathy Lu

Wiley, 2014  
448 pages, \$159.95 (e-book \$127.99)  
ISBN 978-1-118-88910-7

This book has both the advantages and disadvantages of a single-author volume. It flows much more smoothly than an edited text. However, the author seems to have taken much of the material from the literature without a sufficiently critical eye, leading to errors of emphasis that are exemplified by the chapter on energy storage discussed later. Also, it is not clear who the target audience is. It is not a textbook, as there are no questions or problem sets, and no introductory material for each area, such as a chapter

on thermodynamics or electrochemistry. A student needs the latter to really understand the role of materials in energy production, harvesting, use, and storage.

The book starts with an introductory chapter 1, which is a bit too short. Figure 1.2 shows where the sources of energy are in the United States. It would have been useful for the reader to know also how this energy is used, for example, directly or indirectly by the user. How much is used to generate electricity? What proportion is used in the following

sectors: manufacturing, residential, and transportation? How much energy is used per capita in North America compared to the rest of the world, and what are the implications of this to the global energy “pollution” if every other country were to wish for the same usage? It would also have been useful to have descriptions of where materials advances could have their largest impact. An area not discussed here or in similar books is where materials could be used to reduce the use of energy.

After the introduction, the remainder of the book is split into 11 chapters. Chapters 2–5 cover fossil energy, nuclear energy, solar energy, and bioenergy. The next two chapters on wind energy conversion, and hydro, geothermal, and ocean energy are much too short to educate the reader on the critical materials issues. For example, there is no mention of pumped hydro storage, despite the commonality of the turbine materials issues and the huge

storage capability of many GWh in the United States.

The eighth chapter is by far the longest and gives a comprehensive discussion of the history and types of fuel cells. It would have been nice to have a conclusion section of the pros and cons of each type of fuel cell, and the major materials challenges that a student or researcher might tackle. Chapters 9 and 10 cover mechanochemical energy harvesting and thermoelectric energy conversion, respectively. The matrix algebra equations seem distinctly out of place for this book.

Chapters 11 and 12 cover energy storage and materials, and hydrogen storage. The former would have been better described as “Electrochemical Energy Storage and Materials,” as it is limited to batteries and capacitors with no mention of flywheels, which are commercial, or of pumped hydro, which is by far the largest means of storing energy. Both of these have severe materials challenges. As noted at the beginning of this review, the author appears to have gained information for this chapter from the literature without giving it a critical analysis. Thus the reader is going to get much misinformation and will be confused by errors. For example, in one paragraph, the author states that lithium batteries have “an easy state-of-the-charge detection due to gradual voltage change upon

discharge,” and in the next paragraph is the statement, “There is no end-of-charge indicator in the voltage profile.” This has to be confusing for any reader. All rechargeable lithium batteries use the voltage to determine and control the end of charge and end of discharge.

In the discussion of cathode materials, the reader comes away with the impression that  $\text{LiFeO}_2$  is the best oxide cathode, whereas in reality, it does not compare favorably with the other oxides discussed. The statement that “Solid electrolytes are currently the most popular electrolyte for Li-ion batteries” is obviously not correct. Similarly, “Na-S batteries are considered one of the most promising candidates for stationary electric energy storage.” “An expansion/contraction of 500%” for Si-based anodes is an exaggeration of the actual 300%. There are also concerns with the units; the author describes storage of power for batteries rather than energy for the grid. Similarly, the units of electrical resistance are given as V/cm.

The reader would believe from Figure 11.4 that thin-film Li-ion batteries can have double the gravimetric energy density of Li-ion batteries and triple the volumetric energy density. It would be interesting to see how these numbers were calculated, as the general understanding in the field is that the energy

density is best improved by eliminating as much of the dead weight as possible, such as the current collector, the separator, etc., which might be achieved by having thicker electrodes rather than thinner. Moreover, today’s Li-ion batteries achieve over 600 Wh/liter, double the value given in the figure.

The details in this chapter deter me from recommending that a student or newcomer to the field use the book as a learning tool. It might be useful to have this book in your laboratory library, but I cannot recommend that the individual purchase it without first checking out one or two chapters. The textbook *Fundamentals of Materials for Energy and Environmental Sustainability*,\* although an edited volume, is much clearer in its presentation, and it is generally error-free. It also contains in each chapter a very useful list of references for further reading and a list of questions for discussion.

**Reviewer: M. Stanley Whittingham** is Distinguished Professor, Chemistry and Materials Science & Engineering, Binghamton University, The State University of New York, USA.

\*The book *Fundamentals of Materials for Energy and Environmental Sustainability* is published by the Materials Research Society, and this reviewer wrote one of the chapters.

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MRS Congressional Fellow 1998–1999  
Office of Senator Lieberman

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