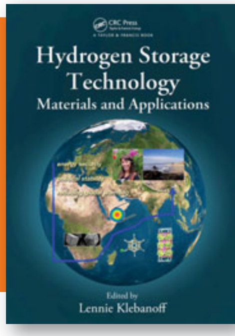


Hydrogen Storage Technology: Materials and Applications

Editor: Lennie Klebanoff

CRC Press, 2013
455 pages, $169.95
ISBN: 978-1-4398-4107-5

It is an often heard statement that hydrogen is the fuel of the future; some people add, "and will always be." Why is the first element in the periodic table so important to our future? Its combustion produces energy with no release of CO_2, since it does not contain carbon. Its use in fuel cells does not emit NO_x. It can be produced from water, which is available widely and more abundantly than fossil fuels. How do we make its generation, storage, and distribution affordable? These precisely are the issues discussed comprehensively in the 12 chapters of this book.

In Section I, Klebanoff and co-authors provide two introductory articles for a general audience. They discuss the need for hydrogen-based energy technologies, hydrogen conversion devices, and automotive applications, including a very readable introduction to fuel cells. Section II offers six articles devoted to hydrogen storage materials with an emphasis on solid-state storage. Materials science, physics, and engineering aspects are dealt with fully. Section III, containing four articles, takes the engineering approach in discussing storage materials, refueling, codes, and standards.

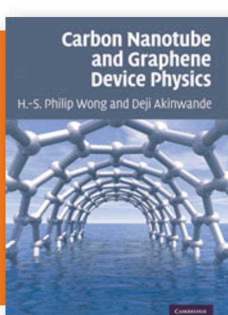
Many of the contributors in this multi-author volume participated in three hydrogen storage centers of excellence set up by the US Department of Energy, which accounts for the uniformity of style and quality in this book. Contributions come from four countries: the United States, Canada, China, and the United Kingdom, reflecting international concerns. The book as a whole will be a good reference in a graduate level course on energy systems and will also be useful to scientists and engineers in fundamental and industrial research. Policymakers will especially be interested in Section I.

The publication of this book is timely. Materials tend to be closer to commercialization when they have more than one application. Metal hydrides, for example, originally developed for hydrogen storage, and discussed in depth in Chapters 5 and 6, are now used in concentrating solar power plants to store power produced from intermittent solar radiation. New catalysts are being discovered for generating hydrogen from water using sunlight: porous silicon with pore size 8–15 nm; nontoxic, cheap, and abundant materials like tin oxides for water-splitting reactions using visible light; and cobalt-containing molecules grafted to semiconductors and subnanometer gold clusters, to name a few.

Recently, it was found that a combination of aluminum oxide, water, and olivine subjected to 2 kbar pressure at 200–300°C liberates hydrogen from water while the remaining oxygen converts olivine to serpentine. Automobile companies are turning to hydrogen in order to meet the exacting standards for emissions and fuel economy.

The future is closer than we think.

***Reviewer: N. Balasubramanian** is a consultant in Bangalore, India, working on materials for energy generation and for storage and materials genomics.*



Carbon Nanotube and Graphene Device Physics

H.-S. Philip Wong and Deji Akinwande

Cambridge University Press, 2011
251 pages, $ 92.00
ISBN 978-0-521-51905-2

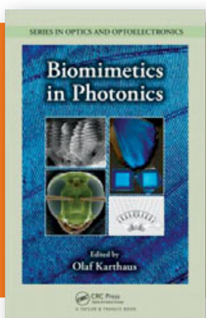
This book is based on a graduate level course at Stanford University, which characterizes the whole book. Each chapter begins with a very short elementary introduction to the topic, although the level of abstraction increases immediately. The interested reader requires some knowledge of modern solid-state physics; a reader without an appropriate background in science would be thankful for a more extended introduction. However, it is an important advantage of this book that the authors use mathematical notation commonly used among engineers. Furthermore, each chapter ends with a set of problems. This is important for readers to check their progress in understanding the topics. However, it would have been helpful if the answers were also provided.

The coverage of the topics is comprehensive. The book starts with an overview of carbon nanotubes and graphene with respect to their structure. Importantly, the concept of chirality for nanotubes is explained in detail. This is often neglected because it does not generally exist in crystallography. After an excellent introduction to electrons in a solid, the electronic states of graphene and carbon nanotubes are described. On the basis of this knowledge, electrical conductivity of these materials is discussed and the fundamental differences between ohmic and quantum conductance are clearly presented. Problems related to carbon nanotube interconnects are explained in order to design devices based on carbon nanotubes and graphene. This chapter gives hints to the reader on how to design electronic devices based on these materials and the problems observed in connecting to the macroscopic world, where the wires are made, in most cases, of copper.

At the end, the important development of a carbon nanotube-based field-effect transistor and its properties are explained. In the last section devoted to applications, nearly all possibilities for technical use in current discussion are explained. Also, the use of carbon nanotubes as a mass sensor with atomic resolution is covered. Fascinating!

In summary, this is an excellent and very complete book on carbon-based nanomaterials and their applications. This book is strongly recommended to everyone interested in the science and applications of carbon nanotubes and graphene, provided the reader has some basic knowledge of solid-state physics. The reader will certainly develop many new ideas for applications.

***Reviewer: Dieter Vollath** is CEO of NanoConsulting, Stutensee, Germany.*



Biomimetics in Photonics
Editor: Olaf Karthaus

CRC Press; Taylor and Francis Group, 2012
289 pages, $125.95
ISBN 978-1-4398-7746-3

Biological systems display an uncanny inventiveness in adapting to diverse environments available on earth. Given the complexity of living organisms, their adaptations cover a range of topics in engineering, physics, and chemistry, such as mechanics, heat transfer, optics, and electrochemistry. This interesting and illuminating edited volume deals with photonic structures found in plants and animals. It provides an overview of the underlying physical principles which result in the observed photonic structures. The book outlines avenues through which such structures can be adapted for practical engineering applications, such as antireflective coatings, displays, structural colors for textiles, infrared sensors, and night vision enhancement. Numerical approaches for simulating complex structural colors found in nature are also discussed.

This volume is organized into seven chapters contributed by authors with expertise in different areas. Chapter 1 introduces the basic physical principles that enable plant structures such as flowers or leaves to produce or enhance colors by structural adaptations, such as multilayer films and geometrical effects. In Chapter 2, the main biominerals found in nature are discussed along with their optical properties. Optical effects in naturally occurring biominerals such as mother-of-pearl, the cell walls of diatoms, and the spicules of sponges are presented. This chapter also outlines possible approaches for replicating naturally occurring structures for photonic engineering applications. Chapter 3 contains a fascinating discussion of several aspects of photonic structures found in nature—the antireflective properties of moth eyes, metallic reflection in beetles and fish, and narrow-band and wide-angle color reflection in the *Morpho* butterfly wings. The roles of nanostructure and randomness in narrow-band reflection from the *Morpho* butterfly wings are given particular attention and makes for very interesting reading.

Chapter 4 introduces the extraordinary infrared (IR) detection capability of the *Melanophila* beetle, which can detect IR heat fluxes in the range of 4×10^{-5} W/m^2 to 3×10^{-4} W/m^2, and models the mechanism with a Golay cell detector. Chapter 5 outlines possible approaches for industrial scale production of one- and three-dimensional photonic structures with tunable colors as well as moth-eye–based anti-reflection films. Chapter 6 covers the basic principles underlying enhanced night vision in nocturnal animals such as the *Megalopta genalis* (nocturnal bee). The principles are then extended to develop algorithms to enhance image processing for monochromatic and color video images. Chapter 7 discusses and applies the underlying theory of Finite-Difference Time-Domain numerical approaches to simulate the structural colors found in the *Morpho* butterfly wings.

In summary, this volume is written in an accessible fashion and is a useful introduction to the field of biomimetics for photonic applications.

***Reviewer: Nirmal Govindaraju** is a Research Assistant Professor in the School of Materials Science and Engineering at Oklahoma State University, USA.*

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