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Book review

Carbon Nanotube Science: Synthesis, Properties and Applications, Peter J.F. Harris. Cambridge University Press (2009). Hardback, Price 45 GBP (US$81), ISBN: 978-0-521-82895-6

Carbon nanomaterials have gained a momentum with the development of nanotechnology as the driving force of the modern science and engineering. Among those materials, carbon nanotubes (CNTs) play a very special role. The publication of transmission electron microscope images of CNTs by Iijima (the issue of priority in the nanotube discovery is discussed in the first chapter of this book), a few years after fullerenes were reported, was a critical factor in convincing a broad community that "there is plenty of room at the bottom" and many new structures can exist at the nanoscale. Carbon nanotubes have become a symbol of the nanotechnology era – you'll find their pictures on book covers, in newspaper articles and magazine centerfolds. However, few people realize that CNTs constitute a large family of materials (or should we call them nanostructures?) with a wide variety of sizes and properties, which are determined by their structure and composition, including chirality, number of walls, ordering of the wall, defects, surface functionalization and other features. A search in the Science Citation Index (ISI, published by Web of Science®) suggests that close to 30,000 papers have been published on carbon nanotubes, nanofibers and related structures (the number would further increase if proceedings papers, book chapters and articles in national and other journals not covered by ISI were included). This volume of work cannot be reviewed in a journal article format. Of course, a book serving as a good summary and an informative guide is required to help both newcomers to the field and experienced researchers navigate in this huge volume of information.

The first edition of the book, which was published in 1999 and titled "Carbon Nanotubes and Related Structures", needed an update because the nanotube field changed dramatically over the past decade. The paperback edition printed in 2001 only included corrections of some errors and typos, but did not provide an update on the latest developments in the field. Many more specialized books have appeared since then, most of which are collections of review articles written by various authors, but none provides a simple, yet very broad coverage of such a variety of nanotube-related topics. As Peter Harris writes in preface of the book, the material concerned with "related structures" has been omitted and the book now focuses almost entirely on nanotubes themselves. I personally miss that part, because a brief description of other structures would help to place the nanotubes into perspective and allow a better comparison of their properties and applications with graphene, vapor grown carbon nanofibers, cones, nanohorns, carbon onions, etc. Still, I thoroughly enjoyed reading the new book.

The book is divided into 12 chapters. After the introductory chapter, the two following chapters are dedicated to a detailed description of nanotube synthesis by arc- and laser vaporization, heat treatment and chemical vapor deposition methods. Naturally, Chapter 4 describes the purification and processing of nanotubes, as these hold the key to the successful applications of nanotubes. Chapter 5 is dedicated to the structure of single- and multi-walled nanotubes. Separate chapters are dedicated to electronic (Chapter 6) and other physical (mechanical, thermal and optical) properties (Chapter 7). The chemistry and biology of nanotubes are covered together in Chapter 8. This chapter also includes a discussion of the possible toxicity of nanotubes. Chapter 9 is dedicated to carbon nanotube composites with polymer, metal, ceramic and carbon matrices. Filled nanotubes are described in the next chapter: solids, gases and liquids can be placed inside nanotubes. The last chapter before Conclusions covers selected applications of nanotubes in probes and sensors. It is necessary to mention that some potential applications of nanotubes were also briefly illustrated in previous chapters as well. However, as the book title says, it's about "carbon nanotube science", so don't expect to find a detailed analysis of current and potential applications or market analysis for CNTs in this book. The book is well illustrated, with illustrations mainly borrowed from "classical" nanotube papers. Each chapter also contains a list of 50–100 references that will help the reader to make further steps towards understanding the subject.

With its extensive coverage of nanotube synthesis, structure, properties and applications, this book will appeal to students and researchers in engineering and sciences. The book may look somewhat superficial to experts in the field, because it is difficult to provide in-depth coverage of each topic on less than 300 pages. Thus, it rather offers an introduction to the topics in carbon nanotubes rather than exhaustive review. The reader will need to take review papers to learn more and find a larger number of relevant articles. On the other hand, this brevity and simplicity makes the book accessible to non-specialists and useful for classroom teaching. I used it when teaching a short course on carbon nanotubes during a recent summer school in China and I used the previous version of Peter Harris' book in my graduate course on Carbon Nanomaterials, which I have been teaching at Drexel University for several years and which includes 6 h of lectures on nanotubes.

As any publication, this book could be further improved. In my opinion, growth of CNTs by decomposition of SiC, which was discovered by Kusunoki in the late 90s, certainly deserves attention as the unique method for producing dense brushes of non-catalytic nanotubes which are close to nanotube crystals. Observation of nanotubes and related structures, such as carbon cones, in nature could also be mentioned. On the other hand, erroneous reports on enormous hydrogen uptake by carbon nanotubes do not deserve the attention given to them by the author. While in most cases the credit is given correctly, there are some omissions as well. For example, Ko and Zussman were first to independently report incorporation of nanotubes into electrospun polymer nanofibers, but a follow-up work from other research groups has been cited in the book. Still, the strengths of this book certainly overweigh its weaknesses and minor omissions.

The previous edition of the book has been cited more than 500 times, according to ISI, and there is no doubt that the new edition will also be widely used and frequently cited.

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