Diamondoid Molecules: With Applications in Biomedicine, Materials Science, Nanotechnology and Petroleum Science

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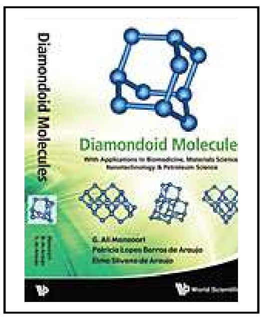
  Book review

Diamondoid Molecules: With Applications in Biomedicine, Materials Science, Nanotechnology and Petroleum Science, G. Ali Mansoori, Patricia Lopes Barros de Araujo, and Elmo Silvano de Araujo, World Scientific, Hackensack, NJ, 2012. $128.00 (400 pp.). ISBN 978-981-4291-60-6

Of the many biologically interesting molecules in existence, few have attracted such broad interest as diamondoids, cage-like organic hydrocarbon molecules whose structures are similar to diamonds'. One can think of diamondoids as truncated diamonds whose dangling bonds are terminated with hydrogen atoms. Similar to diamonds, diamondoids can be stiff, comparable to graphite and carbon nanotubes. Besides serving in applications that exploit their physical properties, including their strength, they are the building blocks for important drugs. Furthermore, because they have a negative electron affinity, they are potentially useful in electron-emitting devices. In nature, diamondoids have been discovered in petroleum, but many research groups are working to synthesize them.



Few books have discussed diamondoids. *Science of Fullerenes and Carbon Nanotubes: Their Properties and Applications* (Academic Press, 1996) by Mildred Dresselhaus, Gene Dresselhaus, and Peter Eklund does discuss them, but in a short and not very detailed section. Now 17 years old, that book also does not cover the latest developments; and neither does the topical but otherwise dated *Adamantane: The Chemistry of Diamond Molecules* (Marcel Dekker, 1976) by Raymond Fort. *Optical and Electronic Properties of Diamondoids: Experiments on the Size and Shape Dependence of the Finite Size Effects in Ideal Nanodiamond Crystals* (Südwestdeutscher Verlag für Hochschulschriften, 2011) by Lasse Landt is more up-to-date, but as the title indicates, it restricts its focus to optical and electronic properties. Now comes *Diamondoid Molecules: With Applications in Biomedicine, Materials Science, Nanotechnology and Petroleum Science*, which aims to bridge the gap between the various disciplines named in the subtitle. Writing such a book is a monumental task and requires broad, cross-disciplinary knowledge. The authors, G. Ali Mansoori, Patricia Lopes Barros de Araujo, and Elmo Silvano de Araujo, have each been diamondoid experts for many years, and their clear, detailed, and broadly accessible presentation reflects that expertise. Extensive references for further reading are also provided at the end of each chapter.

The first three of the book's seven chapters prepare the reader with some basic chemical and physical properties of synthetic and naturally occurring diamondoids; that background material will be helpful to someone with a pure physics background. In those introductory chapters, the authors artfully interweave history and the latest developments and synthesis methods, along with numerous relevant figures and tables. They also discuss how diamondoids are extracted from petroleum, and they show soft-x-ray spectroscopy results that reveal how diamondoids come by their electronic and optical properties. Those who are curious about the thermodynamics will find the phase diagram of adamantane, the simplest diamondoid, and learn about the importance of temperature dependence for adamantane's biomedical applications.

Chapter 4, "Diamondoids as Nanoscale Building Blocks," explains how diamondoids can be used in nanotechnology. Those who are interested in building a nanorotor or nanogears should turn to sections 4.2 and 4.3. In chapter 5, "Properties of Diamondoids Through Quantum Calculations," theoreticians finally get a reprieve from the experimental discussions that are typical of monographs on diamondoids. The authors show how the energy gap, ionization potential, and electron affinity change as a function of the number of adamantane cages, and their theoretical calculations are carried out with well-established software packages. They also discuss the quantum transport properties in various smaller diamondoids and extensively document conductance values. Chapter 6, which covers biomedicine, is strength of this book, and will be especially welcome to readers unfamiliar with diamondoids' medical applications. Chapter 7 offers an equally welcome discussion of materials-science applications. The emphasis on comparing theory and experiment is a great strength throughout the book.

The authors state up front that *Diamondoid Molecules* is intended as a reference book, but I find that some parts could supplement graduate or even undergraduate texts on such topics as modern physics, introductory nanoscience, physical chemistry, and biomedical engineering. Its principal shortcoming as a supplemental text is that it has no exercises or problems. However, that vacuum could be easily filled. For instance, in chapter 4, a problem could ask students to build nanodevices. In chapter 5, students could be asked to synthesize a group of new diamondoids, use the Gaussian 09 electronic structure modeling software to investigate how the ionization potential changes with the number of adamantane units, and, finally, compare those potentials with experimental measurements.

As someone who has worked in nanoscience for many years, I was gratified to see a book that links the dots in the different areas of science and technology. *Diamondoid Molecules* opens a door for newcomers, even in industry and government, and for seasoned researchers who want to explore new opportunities in other areas of the research. I strongly recommend the book to researchers and students in all the relevant fields.

This article does not have any references.