

DEVELOPMENTS IN FULLERENE SCIENCE

# Endofullerenes

A New Family of Carbon Clusters

*Edited by*

Takeshi Akasaka and Shigeru Nagase

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# Endofullerenes A New Family Of Carbon Clusters

**Pratim Kumar Chattaraj, Ambrish  
Kumar Srivastava**



## **Endofullerenes A New Family Of Carbon Clusters:**

*Endofullerenes* T. Akasaka, Sh. Nagase, 2012-12-06 To the eyes of a chemist carbon is certainly one of the most fascinating elements of the periodic table Basically the electronic structure and atomic size of carbon enables this element to form a variety of bonds with other elements and most importantly with other carbon atoms as well These unique features lead to the amazingly complicated molecular structures we encounter e g in life sciences and organic chemistry Of course the technical importance of carbon is enormous but I don't want to carry too many coals to Newcastle From the viewpoint of an astrophysicist or chemist the significance of carbon lies in the fact that it is the most abundant condensable element in space Born in the interior of stars and from there expelled into the interstellar medium it initiates the formation of simple and complex molecules and of nanoscopic grains These in turn form huge clouds in space the birthplace of new stars and planetary systems The decisive role of carbon in interstellar chemistry is widely accepted and the search for more and more families of interstellar carbon bearing molecules is a topic of ongoing research The interdisciplinary aspect of carbon also concerns its various solid forms in which C and the other closed cage fullerenes are certainly some of the most popular 60 newcomers

**Structure and Properties of Clusters: from a few Atoms to Nanoparticles** George Maroulis, 2006-10-27 This volume on Clusters brings together contributions from a large number of specialists A central element for all contributions is the use of advanced computational methodologies and their application to various aspects of structure reactivity and properties of clusters The size of clusters varies from a few atoms to nanoparticles Special emphasis is given to bringing forth new insights on the structure and properties of these systems with an eye towards potential applications in Materials Science Overall the volume presents to the readers an amazing wealth of new results Particular subjects include water clusters Silicon Iron Nickel and Gold clusters carbon titanium microclusters and nanoparticles fullerenes carbon nanotubes chiral carbon nanotubes boron nanoclusters and more

**Low-Dimensional Solids** Duncan W. Bruce, Dermot O'Hare, Richard I. Walton, 2011-03-29 With physical properties that often may not be described by the transposition of physical laws from 3D space across to 2D or even 1D space low dimensional solids exhibit a high degree of anisotropy in the spatial distribution of their chemical bonds This means that they can demonstrate new phenomena such as charge density waves and can display nanoparticulate 0D fibrous 1D and lamellar 2D morphologies This text presents some of the most recent research into the synthesis and properties of these solids and covers Metal Oxide Nanoparticles Inorganic Nanotubes and Nanowires Biomedical Applications of Layered Double Hydroxides Carbon Nanotubes and Related Structures Superconducting Borides Introducing topics such as novel layered superconductors inorganic DNA delivery systems and the chemistry and physics of inorganic nanotubes and nanosheets this book discusses some of the most exciting concepts in this developing field Additional volumes in the Inorganic Materials Book Series Molecular Materials Functional Oxides Porous Materials Energy Materials All volumes are sold individually or as comprehensive 5 Volume Set

*Carbon Nanotubes and*

*Related Structures* Dirk M. Guldi, Nazario Martín, 2010-01-26 Written by the most prominent experts and pioneers in the field this ready reference combines fundamental research recent breakthroughs and real life applications in one well organized treatise As such both newcomers and established researchers will find here a wide range of current methods for producing and characterizing carbon nanotubes using imaging as well as spectroscopic techniques One major part of this thorough overview is devoted to the controlled chemical functionalization of carbon nanotubes covering intriguing applications in photovoltaics organic electronics and materials design The latest research on novel carbon derived structures such as graphene nanooxions and carbon pea pods round off the book

**Handbook of Fullerene Science and Technology** Xing Lu, Takeshi Akasaka, Zdeněk Slanina, 2022-09-24 Nanocarbon chemistry and physics is a fast developing broad research area the Nobel prizes in 1996 and 2010 awarded to two key discoveries in the field and several other nanocarbon achievements of comparable importance Owing to this rapid growth the nanocarbon landscape fundamentally changes every few years creating a need to survey the field on a regular basis to update the books that have become incomplete or even obsolete As such this book focuses on fullerenes and metallofullerenes and also on the related areas of nanotubes and graphenes All the covered research topics provide important fundamental knowledge for the natural sciences but also for applications in molecular electronics superconductivity catalysis photovoltaics and medical diagnostics The current nanocarbon research activities have particularly high application potential in the conversion of solar energy future molecular memories non conventional materials for optoelectronics and new treatments for civilization diseases Offering a truly up to date critical survey of nanocarbon science its concepts and highlights it follows the concept of a handbook it addresses key topics systematically from historical background methodological aspects current important issues and application potential all supplied with extensive referencing With individual chapters written by leading experts with extensive research experience it is a comprehensive reference resource for graduate students and active researchers alike

**Fullerenes**, 2005 **Organic Nanomaterials** Tomas Torres, Giovanni Bottari, 2013-10-14 Discover a new generation of organic nanomaterials and their applications Recent developments in nanoscience and nanotechnology have given rise to a new generation of functional organic nanomaterials with controlled morphology and well defined properties which enable a broad range of useful applications This book explores some of the most important of these organic nanomaterials describing how they are synthesized and characterized Moreover the book explains how researchers have incorporated organic nanomaterials into devices for real world applications Featuring contributions from an international team of leading nanoscientists Organic Nanomaterials is divided into five parts Part One introduces the fundamentals of nanomaterials and self assembled nanostructures Part Two examines carbon nanostructures from fullerenes to carbon nanotubes to graphene reporting on properties theoretical studies and applications Part Three investigates key aspects of some inorganic materials self assembled monolayers organic field effect transistors and molecular self assembly at solid surfaces Part Four explores topics

that involve both biological aspects and nanomaterials such as biofunctionalized surfaces Part Five offers detailed examples of how organic nanomaterials enhance sensors and molecular photovoltaics Most of the chapters end with a summary highlighting the key points References at the end of each chapter guide readers to the growing body of original research reports and reviews in the field Reflecting the interdisciplinary nature of organic nanomaterials this book is recommended for researchers in chemistry physics materials science polymer science and chemical and materials engineering All readers will learn the principles of synthesizing and characterizing new organic nanomaterials in order to support a broad range of exciting new applications

**Endohedral Fullerenes: From Fundamentals To Applications** Shangfeng Yang, Chun-ru Wang, 2014-04-01 Endohedral fullerenes represent a novel family of carbon nanostructures which are characterized by a robust fullerene cage with atoms ions or clusters trapped in its interior Since the first separation of the endohedral metallofullerene La C<sub>82</sub> in 1991 a large variety of endohedral structures have been isolated and their endohedral nature has been proved by experimental studies Within the past two decades the world of endohedral fullerenes was significantly enlarged by the clusterfullerenes and the new carbon cages including non IPR IPR isolated pentagon rule structures Resulting from the charge transfer from the encaged species to the fullerene cage endohedral fullerenes hold a lot of fascinating properties inaccessible by the empty fullerenes and consequently promise potential applications in biomedicine molecular electronics and photonics etc The book provides a comprehensive overview of endohedral fullerenes focused on the new advances in the past decade including its fundamentals structures synthesis isolation characterization properties functionalization as well as the applications thus representing the most updated and broad review of this exciting field

*21st Century Nanoscience* Klaus D. Sattler, 2022-01-18 This 21st Century Nanoscience Handbook will be the most comprehensive up to date large reference work for the field of nanoscience Handbook of Nanophysics by the same editor published in the fall of 2010 was embraced as the first comprehensive reference to consider both fundamental and applied aspects of nanophysics This follow up project has been conceived as a necessary expansion and full update that considers the significant advances made in the field since 2010 It goes well beyond the physics as warranted by recent developments in the field Key Features Provides the most comprehensive up to date large reference work for the field Chapters written by international experts in the field Emphasises presentation and real results and applications This handbook distinguishes itself from other works by its breadth of coverage readability and timely topics The intended readership is very broad from students and instructors to engineers physicists chemists biologists biomedical researchers industry professionals governmental scientists and others whose work is impacted by nanotechnology It will be an indispensable resource in academic government and industry libraries worldwide The fields impacted by nanoscience extend from materials science and engineering to biotechnology biomedical engineering medicine electrical engineering pharmaceutical science computer technology aerospace engineering mechanical engineering food science and beyond

**Comprehensive Nanoscience and**

**Nanotechnology**, 2019-01-02 Comprehensive Nanoscience and Technology Second Edition Five Volume Set allows researchers to navigate a very diverse interdisciplinary and rapidly changing field with up to date comprehensive and authoritative coverage of every aspect of modern nanoscience and nanotechnology Presents new chapters on the latest developments in the field Covers topics not discussed to this degree of detail in other works such as biological devices and applications of nanotechnology Compiled and written by top international authorities in the field Rare Earth Coordination Chemistry Chun-Hui Huang, 2011-09-23 Edited by a highly regarded scientist and with contributions from sixteen international research groups spanning Asia and North America Rare Earth Coordination Chemistry Fundamentals and Applications provides the first one stop reference resource for important accomplishments in the area of rare earth Consisting of two parts Fundamentals and Applications readers are armed with the systematic basic aspects of rare earth coordination chemistry and presented with the latest developments in the applications of rare earths The systematic introduction of basic knowledge application technology and the latest developments in the field makes this ideal for readers across both introductory and specialist levels *Endohedral Fullerenes: Electron Transfer and Spin* Alexey A. Popov, 2017-05-23 This book discusses recent progress in endohedral fullerenes their production and separation techniques as well as their characterization and properties Furthermore the book delves into the all important issue of stability by investigating electron transfer between the encapsulated metal species and the carbon cage It also reviews spin based phenomena caused by the shielding of endohedral spin by the fullerene and analyzes formation of the spin states by charge transfer as studied by electron spin resonance Tuning of charge states of endohedral species and of spin states of both the cage and the cluster are explained Finally the book considers the recent discovery of magnetism in some endohedral fullerenes and the potential for quantum computing *Handbook of Nanophysics* Klaus D. Sattler, 2010-09-17 Providing the framework for breakthroughs in nanotechnology this landmark publication is the first comprehensive reference to cover both fundamental and applied physics at the nanoscale After discussing the theoretical principles and measurements of nanoscale systems the organization of the set follows the historical development of nanoscience Each peer reviewed chapter presents a didactic treatment of the physics underlying the nanoscale materials applications and detailed experimental results State of the art scientific content is enriched with fundamental equations and illustrations many in color Electrochemistry of Functional Supramolecular Systems Paola Ceroni, Alberto Credi, Margherita Venturi, 2010-01-19 With contributions from the most prominent experts around the world this resource provides an accessible summary of electrochemical techniques and the applications of electrochemical concepts to molecular level systems It describes the most important electro active functional supramolecular systems developed so far including rotaxanes and catenanes as molecular machines and as elements for information processing dendrimers as molecular batteries sensors light harvesting antennae and drug delivery systems and bio hybrid devices **Superhalogens and Superalkalis** Pratim Kumar Chattaraj, Ambrish Kumar

Srivastava,2024-04-15 Superhalogens and Superalkalis is a comprehensive volume designed as the go to resource on the exciting and evolving topics of these special classes of atomic clusters and the acid salt that results from their interactions The book details how these substances possess not only unusual structures but also unique properties which can be exploited for various applications Superhalogens strong oxidizing capacity resulting from their high electron affinity leads to their applications in the design of superacids organic superconductors and ionic liquids The low ionization energy of superalkalis enables them to act as strong reducing agents making them useful in the design of superbases and alkalides Illustrated throughout this timely book provides an overview of the research and development on these and other aspects of superhalogen and superalkalis Key features Offers a basic introduction of superatoms that is accessible for readers to understand Includes extensive study questions after each chapter Provides a systematic presentation of the existing literature on this increasingly trending topic Presents the latest developments in the field offering readers state of art knowledge This book is a key reference guide for graduate students postdocs upper level undergraduate students academic professionals and researchers who are interested in this fascinating topic     Organic Electrochemistry Ole

Hammerich,Bernd Speiser,2015-09-22 Praise for the Fourth Edition Outstanding praise for previous editions the single best general reference for the organic chemist Journal of the Electrochemical Society The cast of editors and authors is excellent the text is in general easily readable and understandable well documented and well indexed those who purchase the book will be satisfied with their acquisition Journal of Polymer Science an excellent starting point for anyone wishing to explore the application of electrochemical technique to organic chemistry and a comprehensive up to date review for researchers in the field Journal of the American Chemical Society Highlights from the Fifth Edition Coverage of the electrochemistry of buckminsterfullerene and related compounds electroenzymatic synthesis conducting polymers and electrochemical fluorination Systematic examination of electrochemical transformations of organic compounds organized according to the type of starting materials In depth discussions of carbonyl compounds anodic oxidation of oxygen containing compounds electrosynthesis of bioactive materials and electrolyte reductive coupling Features 16 entirely new chapters with contributions from several new authors who also contribute to extensive revisions throughout the rest of the chapters Completely revised and updated Organic Electrochemistry Fifth Edition explains distinguishing fundamental characteristics that separate organic electrochemistry from classical organic chemistry It includes descriptions of the most important variants of electron transfers and emphasizes the importance of electron transfers in initiating various electrochemical reactions The sweeping changes and lengthy additions in the fifth edition testify to the field s continued and rapid growth in research practice and application and make it a valuable addition to your collection     **Nanomaterials** Charles M.

Lukehart,Robert A. Scott,2013-02-19 Connecting inorganic chemistry to the hottest topic in materials science this timely resource collects the contributions made by leading inorganic chemists towards nanomaterials research The second volume

in the Wiley Encyclopedia of Inorganic Chemistry Methods and Applications Series this signature title concentrates on recent developments in the field and includes all key topics such as nanowires nanotubes biomineralization supramolecular materials and much more This volume is also available as part of Encyclopedia of Inorganic Chemistry 5 Volume Set This set combines all volumes published as EIC Books from 2007 to 2010 representing areas of key developments in the field of inorganic chemistry published in the Encyclopedia of Inorganic Chemistry Find out more

**Emerging Sustainable Nanomaterials for Biomedical Applications** Seema Garg,Amrish Chandra,Suresh Sagadevan,2024-08-24 This book comprises a detailed overview of nanomaterials for biomedical applications and public health Nanomaterials show various functions in medicine sunscreens electronic device diagnostics military applications photovoltaic cells paints imaging catalysts and drug delivery In this book carbon Nanotubes nanowires nanofibers are explored for tissue engineering applications Functionalized carbon nanotubes silica Nanoparticle silicon quantum dots metal Decorated Nanomaterials biogenic metal nanoparticles magnetic functionalized nanomaterials and nanozymes have been covered for the treatment of bacterial Infections as carriers of gene delivery and for their biological applications This book also explores nano biotechnology and its approach for a sustainable future

Raman Spectroscopy, Fullerenes and Nanotechnology Maher S. Amer,2010 This unique book is the first treatment of nanotechnology as the science controlled by the behaviour of thermodynamic small systems It provides comprehensive discussions on fullerenes as building blocks Raman spectroscopy as a powerful diagnostic tool and nanotechnology as the technology bridging the gap between human made and biological materials systems Aimed at graduate students scientists researchers and educators interested in academia government and industry the text is divided into four chapters The first covers the potential of nanotechnology to develop a better deeper understanding of the physical and chemical phenomena observed in natural systems It also contains a section introducing nanotechnology to the public in simple non scientific terms The second chapter is devoted to Raman spectroscopy and could in itself serve as a basis for a short course on its applications in materials science The third section covers fullerenes and presents their history and development as well as discussing the structure and production of zero dimensional one dimensional and two dimensional fullerenes The fourth and final chapter serves as a correlation discussion and over view It emphasizes the unique nano phenomena exhibited by the fullerene systems as carbon based nanostructured systems This chapter and therefore the book concludes with a discussion on the potential of nano science and technology to shape the future of human society

*Fullerenes and Nanotubes* Prashant V. Kamat,Dirk M. Guldi,Francis D'Souza,2003



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