Carbon Nanostructures

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Nianjun Yang · Xin Jiang
Dai-Wen Pang
Editors

Carbon Nanoparticles and Nanostructures

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Editors
Nianjun Yang
Institute of Materials Engineering
University of Siegen
Siegen
Germany

Dai-Wen Pang
Wuhan University
Wuhan
China

Xin Jiang
Institute of Materials Engineering
University of Siegen
Siegen
Germany

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Preface

Carbon is an extraordinary element. Because of its ability to covalently bond with different orbital hybridizations, a uniquely rich array of molecular structures are formed. Carbon is thus the basis of all-known life on earth. For millennia, there were only two known substances of pure carbon atoms: graphite and diamond. In recent decades, a series of new carbon nanostructures have been discovered, including fullerenes in the mid-1980s, carbon nanotubes in the early 1990s, graphene in 2003, onions, nanoparticles, nanohorns, nanobells, nanopeapods, and nanofoams. The properties of these different carbon materials are actually determined by their carbon–carbon covalent bonding and the organization of the carbon atoms into a characteristic nano- and microstructure.

Carbon nanostructures have been thus classified from the hybridizations of the sp atomic orbitals of carbon, different from the approaches using the topological dimension of carbon, or the characteristics of carbon structures. If one takes the topological dimension of carbon as an example, carbon nanostructures cover zero-dimensional fullerenes and carbon nanoparticles, one-dimensional nanotubes and diamond nanorods, two-dimensional graphene and diamond nanoplates, and three-dimensional ultrananocrystalline diamond films. Owing to their characteristic size, shape, and spatial arrangement, carbon nanostructures and nanoparticles have shown different properties. Numerous varied applications using carbon nanostructures and nanoparticles have been realized as well in different fields.

This book contains a collection of the most important progress achieved in the fields of the preparation and applications of carbon nanostructures and nanoparticles. Ten chapters have been collected from international experts, which can be divided into three parts. The first part (Chaps. "Nanodiamonds: From Synthesis and Purification to Deposition Techniques, Hybrids Fabrication and Applications" and "One-Dimensional Carbon Nanostructures: Low-Temperature Chemical Vapor Synthesis and Applications") concerns the synthesis of carbon nanostructures and nanoparticles. Chapter "Nanodiamonds: From Synthesis and Purification to Deposition Techniques, Hybrids Fabrication and Applications" summarizes the recent advances in the production and the purification methods of diamond

nanoparticles. The different strategies for seeding and patterning of surfaces are detailed. The CVD growth of carbon nanostructures at low temperatures (<450 °C) and their growth mechanisms are overviewed in Chap. "One-Dimensional Carbon Nanostructures: Low-Temperature Chemical Vapor Synthesis and Applications". The second part (Chaps. "Carbon Nanohorns and Their High Potential in Biological Applications"–"Polyglycerol-Functionalized Nanoparticles for Biomedical Imaging") is devoted to the biological, medical, imaging, and quantum sensing applications of carbon nanostructures and nanoparticles. In Chap. "Carbon Nanohorns and Their High Potential in Biological Applications", the formation, properties, and and biological applications of carbon nanohorns are introduced. Chapter "Bioimaging and Quantum Sensing Using NV Centers in Diamond Nanoparticles" is about bioimaging and quantum sensing using diamond nanoparticles with NV negatively charged nitrogen vacancy centers. Polyglycerol-functionalized nanoparticles, including detonation nanodiamond, superparamagnetic iron oxide nanoparticle, and fluorescent nanodiamond, for biomedical imaging is presented in Chap. "Polyglycerol-Functionalized Nanoparticles for Biomedical Imaging". The third part (Chaps. "Carbon Based Dots and Their Luminescent Properties and Analytical Applications"–"Catalytic Applications of Carbon Dots") focuses on analytical, electrochemical, and catalytic applications of carbon nanostructures and nanoparticles. Chapters "Carbon Based Dots and Their Luminescent Properties and Analytical Applications" and "Photoluminescent Properties of Carbon Nanodots" cover the synthesis, the luminescent properties, and the analytical applications of carbon dots, while the catalytic applications of carbon dots are highlighted in Chap. "Catalytic Applications of Carbon Dots". Diamond electrochemistry at the nanoscale using diamond nanostructures and nanoparticles is shown in Chap. "Diamond Nanostructures and Nanoparticles: Electrochemical Properties and Applications". Chapter "Carbon-Based Nanostructures for Matrix-Free Mass Spectrometry" presents recent developments in the use of carbon-based materials for matrix-free mass spectrometry.

From our point of view, all the chapters in this book coupled with their citations will be useful to both specialists and early-stage researchers. It is hoped that this book will attract a broad readership ranging from materials scientists, chemists, biologists, physicists, and engineers. We strongly believe this book will simulate more researchers to devote their effort and energy to the progress of the preparation and the applications of carbon nanostructures and nanoparticles in the forthcoming years.

Nianjun Yang
Xin Jiang
Dai-Wen Pang

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