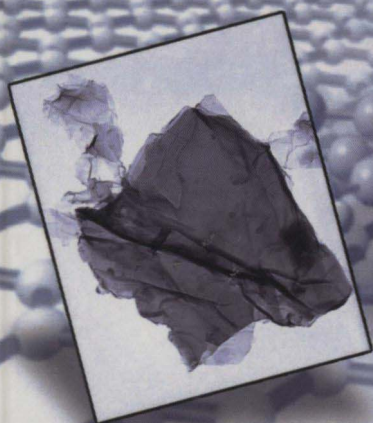


Advance Materials Series

ADVANCED CARBON MATERIALS AND TECHNOLOGY



Edited By

Ashutosh Tiwari and S. K. Shukla

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Preface

The expansion of carbon materials is the focal point of materials research and technology which is mostly related to physics, chemistry, biology, applied sciences and engineering. Research on carbon materials has mainly focused on the aspects of fundamental physics that have unique electrical, thermal and mechanical properties applicable for a range of applications. The electrons in graphene and other derived carbon materials behave as dirac fermions due to their interaction with the ions of the lattice. This direction has led to the discovery of new phenomena such as Klein tunneling in carbon-based solid state systems, and the so-called half-integer quantum Hall effect due to a special type of Berry phase. In pursuit of the same goal, *Advanced Carbon Materials and Technology* offers detailed, up-to-date chapters on the processing, properties and technological developments of graphene, carbon nanotubes, carbon fibers, carbon particles and other carbon-based structures, including multifunctional graphene sheets, graphene quantum dots, bulky balls, carbon balls, and their polymer composites.

Nanoscaled materials have properties which make them useful for enhancing surface-to-volume ratio, reactivity, strength and durability. The chapter entitled, "Synthesis, Characterization and Functionalization of Carbon Nanotubes and Graphene: A Glimpse of Their Application," encompasses the principles of nanotubes and graphene production, new routes of preparation and numerous methods of modification essential for various potential applications. The chapter on, "Surface Modification of Graphene," covers a range of covalent and non-covalent approaches. In the chapter, "Graphene and Carbon Nanotube-Based Electrochemical Biosensors for Environmental Monitoring," the use of carbon nanotubes and numerous graphene-based affinity electrodes for the development of novel tools for monitoring environmental pollution are described. The chapter on, "Catalytic Application of

Carbon-Based Nanostructured Materials on Hydrogen Sorption Behavior of Light Metal Hydrides," describes the state-of-the-art of carbon nanotubes, carbon nanofibers and graphene as a catalyst for the aforesaid hydrogen storage materials. An informal presentation about recent progress in the advances in synthetic techniques for large-scale production of carbon nanotubes, their purification and chemical modification, and the emerging technologies they enable are presented in the chapter, "Carbon Nanotubes and Their Applications." Moreover, a chapter dedicated to the, "Bioimpact of Carbon Nanomaterials," discusses graphene, nanotubes and fullerenes, along with their nanotoxicity, nanoecotoxicity, and various biomedical applications.

Carbon nano-objects including fullerenes, carbon nanotubes, carbon quantum dots, shungites and graphenes, show unique photorefractive characteristics. The chapter on, "Advanced Optical Materials Modified with Carbon Nano-Objects," illustrates the spectral, photoconductive, photorefractive and dynamic properties of the optical carbon objects-based nanomaterials. "Covalent and Non-Covalent Functionalization of Carbon Nanotube: Applications," deals with the photocatalytic nature of carbon nanotube-based composites. Illustrated in, "Metal Matrix Nanocomposites Reinforced with Carbon Nanotubes," are the preparation and properties of nanocomposites based on aluminium, copper, magnesium, nickel and titanium with reinforced matrix of nanofiller carbon materials (e.g., nanoplatelets, nanoparticles, nanofibers and carbon nanotubes) using various processing techniques. The chapter also discusses reinforcement using carbon nanotubes, interfacial bonding, thermal, mechanical, and tribological properties and the challenges related to the synthesis of composites.

Fly ash, a waste by-product of coal thermal power plants, is a carbon-based lightweight material. Fly ash is generally inexpensive and is considered to be an environmental hazard, thus utilization of fly ash in composites proves to be both economically and environmentally beneficial. In this way, use of fly ash in developing advanced composites is very encouraging for the next generation of advanced lightweight composites. The discussion in, "Aluminum/Fly Ash Syntactic Foams: Synthesis, Microstructure and Properties," is focused on the methods of synthesis for fly ash-filled aluminum matrix composites along with their microstructure and mechanical properties, and the tribological properties of Al/fly ash syntactic foams. The chapter entitled, "Engineering Behavior

of Ash Fills,” covers the extensive characterization, hardening, bearing capacity and settlement of ash fill technology. The chapter on, “Carbon-Doped Cryogel Thin Films Derived from Resorcinol Formaldehyde,” presents results of the structural and optical properties of carbon-doped cryogel thin films derived from resorcinol formaldehyde.

This book is written for a large readership, including university students and researchers from diverse backgrounds such as chemistry, materials science, physics, pharmacology, medical science and engineering, with specializations in the civil, environmental and biomedical fields. It can be used not only as a textbook for both undergraduate and graduate students, but also as a review and reference book for researchers in materials science, bioengineering, medicine, pharmacology, biotechnology and nanotechnology. We hope that the chapters of this book will provide the readers with valuable insight into state-of-the-art advanced and functional carbon materials and cutting-edge technologies.

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Contents

Preface	xiii
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Part 1 Graphene, Carbon Nanotubes and Fullerenes 1

1 Synthesis, Characterization and Functionalization of Carbon Nanotubes and Graphene: A Glimpse of Their Application	3
<i>Mahe Talat and O.N. Srivastava</i>	
1.1 Introduction	4
1.2 Synthesis and Characterization of Carbon Nanotubes	5
1.3 Synthesis and Characterization of Graphene	11
1.3.1 Micromechanical Cleavage of Highly Oriented Pyrolytic Graphite	11
1.3.2 Chemical Vapor Deposition Growth of Graphene either as Stand Alone or on Substrate	11
1.3.3 Chemical and Thermal Exfoliation of Graphite Oxide	13
1.3.4 Arc-Discharge Method	14
1.4 Methods Used in Our Lab: CVD, Thermal Exfoliation, Arc Discharge and Chemical Reduction	14
1.4.1 Raman Spectra	16
1.4.2 Electrochemical Exfoliation	18
1.5 Functionalization of Carbon Nanotubes and Graphene	19
1.5.1 Covalent Functionalization	20
1.5.2 Non-Covalent Functionalization	21
1.5.3 FTIR Analysis of CNTs and FCNTs	23
1.6 Applications	24
1.7 Conclusion	29
Acknowledgements	29
References	30

2	Surface Modification of Graphene	35
	<i>Tapas Kuila, Priyabrata Banerjee and Naresh Chandra Murmu</i>	
2.1	Introduction	36
2.2	Surface-Modified Graphene from GO	39
2.2.1	Covalent Surface Modification	39
2.2.2	Non-covalent Surface Modification	60
2.3	Application of Surface-Modified Graphene	70
2.3.1	Polymer Composites	71
2.3.2	Sensors	72
2.3.3	Drug Delivery System	73
2.3.4	Lubricants	73
2.3.5	Nanofluids	74
2.3.6	Supercapacitor	75
2.4	Conclusions and Future Directions of Research	75
	Acknowledgement	77
	References	77
3	Graphene and Carbon Nanotube-based Electrochemical Biosensors for Environmental Monitoring	87
	<i>G. Alarcon-Angeles, G.A. Álvarez-Romero and A. Merkoçi</i>	
3.1	Introduction	88
3.1.1	Carbon Nanotubes (CNTs)	88
3.1.2	Graphene (GR)	91
3.1.3	Electrochemical Sensors	93
3.1.4	Sensors and Biosensors Based on CNT and GR	94
3.2	Applications of Electrochemical Biosensors	97
3.2.1	Heavy Metals	97
3.2.2	Phenols	103
3.2.3	Pesticides	109
3.3	Conclusions and Future Perspectives	121
	References	121
4	Catalytic Application of Carbon-based Nanostructured Materials on Hydrogen Sorption Behavior of Light Metal Hydrides	129
	<i>Rohit R Shahi and O.N. Srivastava</i>	
4.1	Introduction	130
4.2	Different Carbon Allotropes	133

4.3	Carbon Nanomaterials as Catalyst for Different Storage Materials	135
4.4	Key Results with MgH_2 , NaAlH_4 and Li-Mg-N-H Systems	137
4.4.1	Magnesium Hydride	137
4.4.2	Sodium Alanate	148
4.4.3	Amides/Imides	157
4.5	Summary	164
	Acknowledgements	165
	References	165
5	Carbon Nanotubes and Their Applications	173
	<i>Mohan Raja and J. Subha</i>	
5.1	Introduction	173
5.2	Carbon Nanotubes Structure	174
5.3	Carbon Nanotube Physical Properties	176
5.4	Carbon Nanotube Synthesis and Processing	177
5.5	Carbon Nanotube Surface Modification	178
5.6	Applications of Carbon Nanotubes	179
5.6.1	Composite Materials	179
5.6.2	Nano Coatings – Antimicrobials and Microelectronics	182
5.6.3	Biosensors	184
5.6.4	Energy Storages	185
5.7	Conclusion	187
	References	187
6	Bioimpact of Carbon Nanomaterials	193
	<i>A. Djordjevic, R. Injac, D. Jovic, J. Mrdjanovic and M. Seke</i>	
6.1	Biologically Active Fullerene Derivatives	194
6.1.1	Introduction	194
6.1.2	Functionalization/Derivatization of Fullerene C_{60}	196
6.1.3	Biological Activity of Non-Derivatized Fullerene C_{60}	196
6.1.4	Biological Activity of Derivatized Fullerene C_{60}	197
6.1.5	Chemical Synthesis of Fullerenol $\text{C}_{60}(\text{OH})_n$	201
6.1.6	Fullerenol and Biosystems	202

6.2	Biologically Active Graphene Materials	219
6.2.1	Chemical Synthesis and Characterization of Important Biologically Active Graphene Materials	219
6.2.2	Biologically Active Graphene Materials	222
6.3	Bioimpact of Carbon Nanotubes	230
6.3.1	Introduction	230
6.3.2	Properties of CNTs	231
6.3.3	Classification of CNTs	231
6.3.4	Synthesis of CNTs	231
6.3.5	Functionalization of CNTs	232
6.3.6	Drug (Molecule/Gene/Antibody) Delivery, Targeting, Drug Release	232
6.3.7	Toxicity	236
6.3.8	The Fate of CNTs	237
6.4	Genotoxicity of Carbon Nanomaterials	238
6.4.1	Genotoxicity of Graphene in <i>In Vitro</i> and <i>In Vivo</i> Models	239
6.4.2	Genotoxicity of SWNT and MWNT	242
6.4.3	Genotoxicity of Polyhydroxylated Fullerene Derivatives	244
6.4.4	Conclusion	246
6.5	Ecotoxicological Effects of Carbon Nanomaterials	247
	References	251
Part 2	Composite Materials	273
7	Advanced Optical Materials Modified with Carbon Nano-Objects	275
	<i>Natalia V. Kamanina</i>	
7.1	Introduction	275
7.2	Photorefractive Features of the Organic Materials with Carbon Nanoparticles	279
7.3	Homeotropic Alignment of the Nematic Liquid Crystals Using Carbon Nanotubes	297
7.4	Thin Film Polarization Elements and Their Nanostructurization via CNTs	303
7.5	Spectral and Mechanical Properties of the Inorganic Materials via CNTs Application	307

7.6 Conclusion	310
Acknowledgments	311
References	312
8 Covalent and Non-Covalent Functionalization of Carbon Nanotubes	317
<i>Tawfik A. Saleh and Vinod K. Gupta</i>	
8.1 Introduction	317
8.2 Functionalization of Carbon Nanotubes	318
8.3 Covalent Functionalization	318
8.4 Non-Covalent Functionalization	320
8.5 Functionalization of CNT with Nanoparticles	320
8.5.1 Applications of the CNT-Based Nanocomposites	324
8.5.2 Nanocomposites as Photocatalysts	324
8.5.3 Nanocomposites as Adsorbents	325
8.6 Conclusion	326
Acknowledgment	327
References	327
9 Metal Matrix Nanocomposites Reinforced with Carbon Nanotubes	331
<i>Praveennath G. Koppad, Vikas Kumar Singh, C.S. Ramesh, Ravikiran G. Koppad and K.T. Kashyap</i>	
9.1 Introduction	332
9.2 Carbon Nanotubes	333
9.3 Processing and Microstructural Characterization of Metal Matrix Nanocomposites	338
9.3.1 Powder Metallurgy	339
9.3.2 Electroless and Electrodeposition Techniques	343
9.3.3 Spray Forming	346
9.3.4 Liquid Metallurgy	349
9.3.5 Other Techniques	350
9.4 Mechanical Properties of Carbon Nanotube Reinforced Metal Matrix Nanocomposites	353
9.4.1 CNT/Al Nanocomposites	353
9.4.2 CNT/Cu Nanocomposites	356
9.4.3 CNT/Mg Nanocomposites	359
9.4.4 CNT/Ti Nanocomposites	360

9.5	Strengthening Mechanisms	361
9.6	Thermal Properties of Carbon Nanotube Reinforced Metal Matrix Nanocomposites	363
9.7	Tribological Properties of Carbon Nanotube Reinforced Metal Matrix Nanocomposites	366
9.8	Challenges	368
9.9	Concluding Remarks	371
	References	371
Part 3	Fly Ash Engineering and Cryogels	377
10	Aluminum/Fly Ash Syntactic Foams: Synthesis, Microstructure and Properties	379
	<i>Dung D. Luong, Nikhil Gupta and Pradeep K. Rohatgi</i>	
10.1	Introduction	380
10.2	Hollow Particles	382
10.2.1	Fly Ash Cenospheres	382
10.2.2	Engineered Hollow Particles	384
10.3	Synthesis Methods	388
10.3.1	Stir Mixing	388
10.3.2	Infiltration Methods	389
10.3.3	Comparison of Synthesis Methods	391
10.4	Microstructure of Aluminum/Fly Ash Composites	393
10.5	Properties of Aluminum/Fly Ash Syntactic Foams	398
10.6	Applications	409
10.7	Conclusion	411
	Acknowledgments	412
	References	412
11	Engineering Behavior of Ash Fills	419
	<i>Ashutosh Trivedi</i>	
11.1	Background	420
11.1.1	Physico-Chemical Characterization	420
11.1.2	Engineering Characteristics	421
11.2	Engineering Evaluation of Cemented Ash Fill	439
11.2.1	Measurement of Cemented Ash Characteristics: Application of RQD	439
11.2.2	Concept of Strength Ratio and Modulus Ratio	440

11.2.3	Evaluation of Joint Parameters	442
11.2.4	Relationship of RQD and Joint Parameters	443
11.2.5	Steps to Obtain Deformations from the Present Technique	444
11.3	Problems of Uncemented Ash Fill	446
11.3.1	Collapse, Piping and Erosion, Liquefaction	446
11.3.2	Collapse Behavior of Ash Fills	448
11.4	Ash as a Structural Fill	453
11.4.1	Penetration Test	454
11.4.2	Load Test	455
11.4.3	Test Setup for Ash Fills and Testing Technique	457
11.4.4	Bearing Capacity of Ash Fill	460
11.4.5	Settlement of Ash Fills by PLT	463
11.4.6	Settlement on Ash Fills by PLT, CPT and SPT	464
11.4.7	Settlement of Footings on Ash Deposit	466
11.5	Conclusions	470
	Salutations, Acknowledgement and Disclaimer	470
	References	471
12	Carbon-Doped Cryogel Thin Films Derived from Resorcinol Formaldehyde	475
	<i>Z. Marković, D. Kleut, B. Babić, I. Holclajtner-Antunović, V. Pavlović and B. Todorović-Marković</i>	
12.1	Introduction	476
12.2	Experimental Procedure	476
12.3	Results and Discussion	477
12.3.1	FTIR Analysis	477
12.3.2	Raman Analysis	478
12.3.3	Surface Morphology of Carbon-Doped RF Cryogel Thin Films	481
12.4	Conclusion	483
	Acknowledgements	484
	References	484
	Index	487

Part 1

GRAPHENE, CARBON NANOTUBES AND FULLERENES

