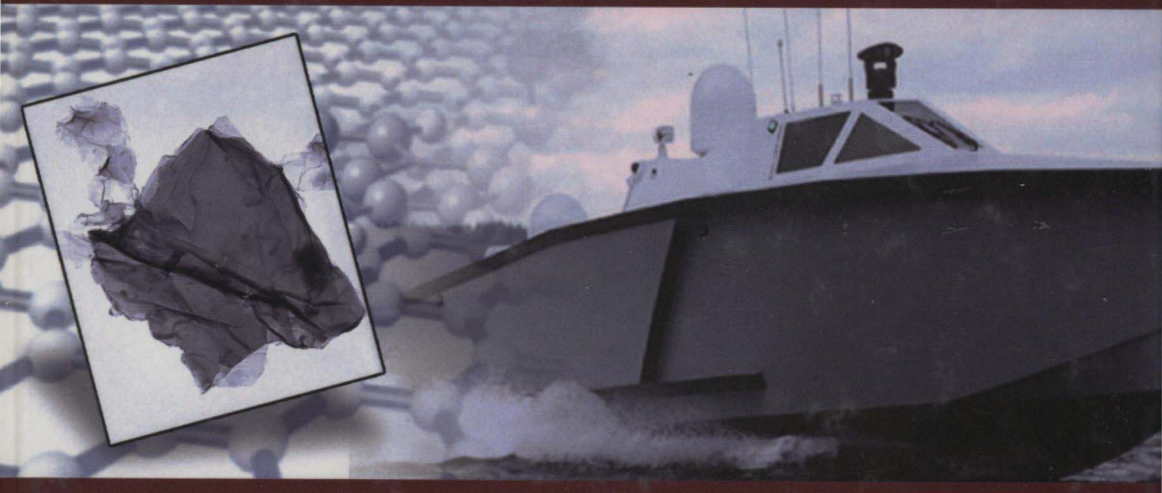
Advance Materials Series

ADVANCED CARBON MATERIALS AND TECHNOLOGY



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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 tne 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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Part 1

GRAPHENE, CARBON NANOTUBES AND FULLERENES