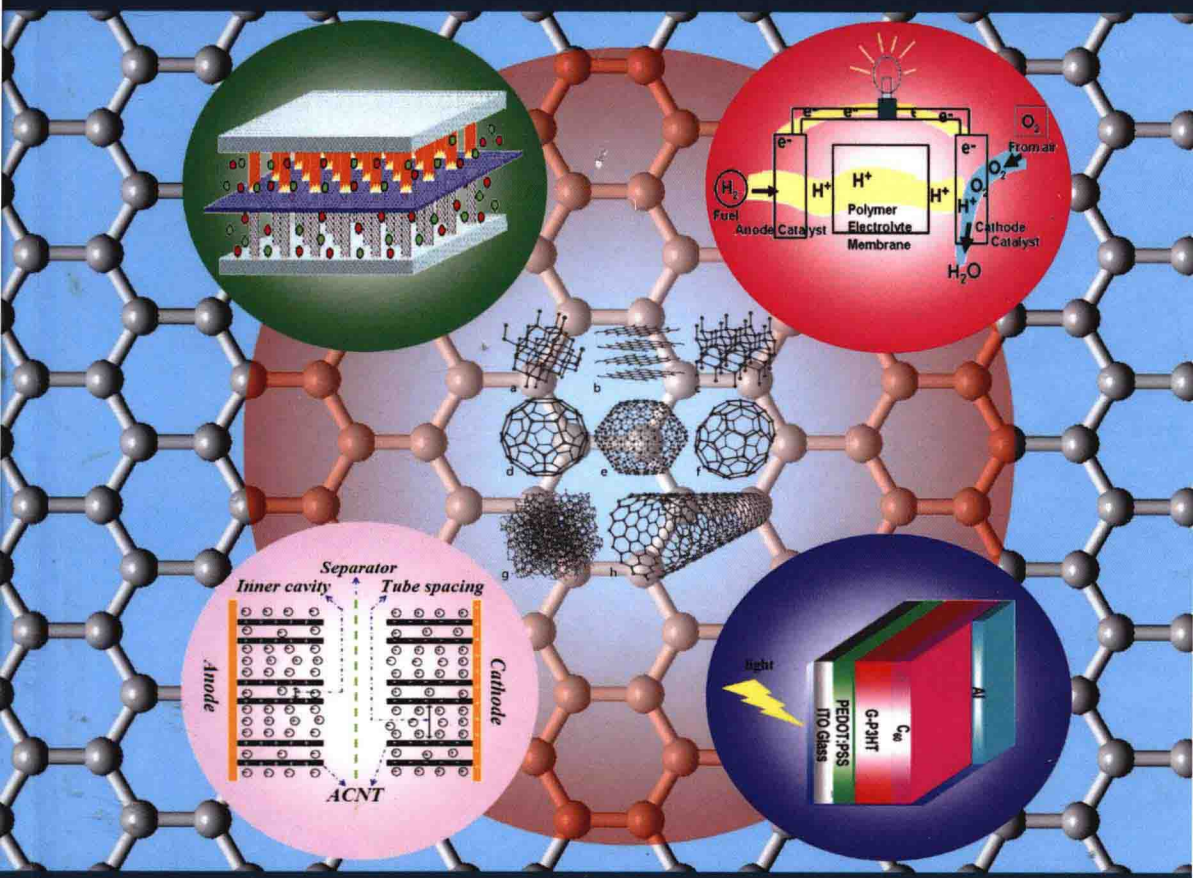
Carbon Nanomaterials for Advanced Energy Systems

Materials Synthesis and Device Applications



Edited By

Wen Lu • Jong-Beom Baek • Liming Dai

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PREFACE

The global energy consumption has been accelerating at an alarming rate due to the rapid economic expansion worldwide, increase in world population, and ever-increasing human reliance on energy-based appliances. It was estimated that the world will need to double its energy supply by 2050. Consequently, the research and development of sustainable energy conversion and storage technologies have become more important than ever. Although the efficiency of energy conversion and storage devices depends on a variety of factors, their overall performance strongly relies on the structure and property of the materials used. The recent development in nanotechnology has opened up new frontiers by creating new nanomaterials and structures for efficient energy conversion and storage. Of particular interest, carbon nanomaterials have been cost-effectively structured into various nanostructures with a high surface area and energy conversion/storage capacities. This book will focus on advances in the research and development of carbon nanomaterials for advanced energy systems.

Carbon has long been known to exist in three forms: amorphous carbon, graphite, and diamond. However, the Nobel Prize-winning discovery of buckminsterfullerene C_{60} in 1985 has created an entirely new branch of carbon chemistry. The subsequent discoveries of carbon nanotubes in 1991 and graphene in 2004 opened up a new era in materials science and nanotechnology. Since then, carbon nanomaterials with unique size-/surface-dependent electrical, thermal, optical, and mechanical properties have been demonstrated to be useful as energy materials, and tremendous progress has been achieved in developing carbon nanomaterials for high-performance energy conversion and storage systems. This is a field in which a huge amount of literature has been rapidly generated with the number of publications continuing to increase each year. Therefore, it is very important to cover the most recent developments in this field in a timely manner.

This book deals with the synthesis, fundamentals, and device applications of a wide range of carbon nanomaterials. In order to cover the multidisciplinary field of such diversity, *Carbon Nanomaterials for Advanced Energy Systems* provides a collection of chapters written by top researchers who have been actively working in the field, and the text has been divided into three major parts. The first part consisting of Chapters 1–4, *Synthesis and Characterization of Carbon Nanomaterials*, deals with the synthesis and basic science of various carbon nanomaterials, including fullerenes, carbon nanotubes, graphene, and their multidimensional/multifunctional derivatives. In the second part, *Carbon Nanomaterials For Energy Conversion*, Chapters 5–8 present an overview of carbon nanomaterials for various energy conversion systems, such as solar cells, fuel cells, and thermoelectric devices. A large variety of carbon-based energy storage devices, ranging from supercapacitors through batteries to energy-related gas storage systems, are then described in the final part (Chapters 9–13), *Carbon nanomaterials for energy storage*, of the book. The above approach will allow the readers to first review the scientific basis of carbon nanomaterials and then extend the basic knowledge to the development, construction, and application of functional devices; many of them are of practical significance.

The readers who are new to the field will be exposed to many self-explanatory illustrations that could provide an overview understanding even before a serious reading. In the meantime, the large number of updated references cited in each of the chapters should enable advanced readers to quickly review the multidisciplinary and challenging field with information on the latest developments. Therefore, *Carbon Nanomaterials for Advanced Energy Systems* is an essential reference on carbon nanomaterials for energy systems to scientists, engineers, teachers, and students who are new to the field. Experienced academic and industrial professionals can use this book to quickly review the latest developments in this challenging multidisciplinary field and broaden their knowledge of carbon nanomaterials for developing novel devices/systems for advanced energy conversion and storage.

Finally, we wish to express our sincere thanks to Dr. Edmund H. Immergut, Ms. Anita Lekhwani, Ms. Cecilia Tsai, and their colleagues at Wiley and Wiley-VCH for their very kind and patient cooperation during the completion of this book project, without which this book would never have been appeared. We would also like to thank all of the chapter contributors, authors whose work was cited, and our colleagues who contributed in one way or the other to the book. Last, but not the least, we thank our families for their love, unceasing patience, and continuous support.

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