Preface

Each generation of human civilization on our planet has confronted with new challenges and opportunities for survival and prosperity. Availability of consumable energy in different forms has greatly influenced the living standards of humankind on earth. The quality of life and prosperity of our future generations will primarily be defined by how we live up to the current and future energy demand challenges. Energy has apparently been the cornerstone of sustainable development of our economy and society. Some of the basic needs of the modern society such as food production and processing, water, health, clean environment, and education are critically dependent on energy supply and sufficiency. Developing materials and systems toward sustainable energy is a crucial challenge for the twenty-first century. Most of the energy needs of the current world are met through fossil fuels. As the energy demands are substantially increasing, the limited reserves of fossil fuels are progressively depleting and their continuous use is adversely affecting both the human health and environment. Therefore, research and development worldwide focus on diminishing the negative health and environmental consequences of fossil fuel energy consumption and to explore new materials paradigm for sustainable energy production and applications.

Nanomaterials and nanostructures provide unique electrical, optical, and mechanical properties and have played an important role in the recent advances of energy-related applications. Different nanomaterials have been employed in energy harvest, generation, saving, storage, transport, and conversion processes very effectively and efficiently. This book covers recent progresses on the preparation, characterization, and usage of semiconducting, dielectric, 1D and 2D nanomaterials and hybrid architectures for energy-related applications, technologies and devices, such as solar cells, piezoelectronics, fuel cells, supercapacitors, thermoelectronics, solar water-splitting for hydrogen production, batteries, and biofuels. Moreover, the topics in the book also highlights novel approaches in nanomaterials design and synthesis and evaluate materials characteristics with regard to sustainability issues. Contributions from active and leading experts regarding important aspects like the synthesis, assembly, and properties of nanomaterials for energy-related applications

are compiled into a reference book. As evident from the diverse topics, the book is expected to be useful to researchers working in the interface of physics, chemistry, biology, materials science, and engineering. It is anticipated that the work would stimulate meaningful future developments in this rapidly emerging and critical frontier of nanomaterials for sustainable energy.

This book is not an attempt to exhaustively cover all the interesting and relevant topics on nanomaterials for sustainable energy; apparently it is simply not possible to do so within a single book in concise manner. Instead, the book focuses on the recent developments of fascinating themes for sustainable energy. The various chapters cover the following trendy topics: nanostructured materials for high-efficiency perovskite solar cells (Chap. 1), dielectric nanomaterials for silicon solar cells (Chap. 2), nanostructured cathode buffer layers for inverted polymer solar cells (Chap. 3), nanomaterials for stretchable energy storage and conversion devices (Chap. 4), piezoelectric nanomaterials for mechanical energy harvesting (Chap. 5), liquid crystals for self-organizing photovoltaics (Chap. 6), aligned carbon nanotubes for energy conversion and storage (Chap. 7), graphene-based electrochemical microsupercapacitors for miniaturized energy storage applications (Chap. 8), graphene in fuel cells (Chap. 9), mesoporous materials for fuel cells (Chap. 10), thermoelectric nanocomposites for thermal energy conversion (Chap. 11), nanomaterials for hydrogen generation from solar water-splitting (Chap. 12), nanomaterials for rechargeable lithium batteries (Chap. 13), self-organized chiral liquid crystalline nanostructures for energy-saving devices (Chap. 14), and nanomaterials for the production of biofuels (Chap. 15). In each chapter, the state of the art, along with future prospects in the respective fields, is discussed and highlighted by the experts.

Finally, I would like to express my gratitude to Claus Ascheron at Springer for inviting us to bring this exciting and essential field of research to a wide audience, and to all our distinguished contributors for their dedicated efforts. Also, I am indebted to my wife Changshu, my sons Daniel and Songqiao for their great support and encouragement.

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http://www.springer.com/978-3-319-32021-2

Nanomaterials for Sustainable Energy
Li, Q. (Ed.)
2016, XVII, 590 p. 292 illus., 36 illus. in color.,
Hardcover
ISBN: 978-3-319-32021-2