

Nanoenergy

Flavio L Souza · Edson R Leite
Editors

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Nanotechnology Applied for Energy
Production

Second Edition

 Springer

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Preface

The worldwide energy demand has been currently addressed by hundreds of scientific published articles, books, newspapers, symposiums, scientific and technological conferences in the field. Accordingly, to these sources considerable enhancement on the worldwide energy consumption was projected for reaching the double and triple in 2050 and 2100 compared with 13 TW (Terawatts) needed nowadays. The increased global energy consumption with an uncontrollable CO₂ emission from fossil energy resource that supply the carbon-based technology is the challenge facing the humanity in this century. Free-carbon technology is an alternative way to produce clean and sustainable source of energy to prevent the urban air pollution and provide an environmental friendly. To reach this scenario a scalable and cost-effective methods to design new materials for engineering highly efficiency free-carbon technologies and fuels must be developed. In this sense, the future energy demand and CO₂ emission control has been part of the governmental program worldwide with huge financial support to the academy and industrial to create and developing technologies to store and produce free-carbon fuels. Early of 2012, several books on energy topic addressing the main achievements in Europa, USA, Asia by the leading experts were published. In the year after (2013), the first edition of the Nanoenergy book edited by springer was launched given an overview of the main developments in Brazil by leading experts on the energy field. In this context, motivated by the great interest of the scientific community this second edition of the Nanoenergy book brings new contributions and updated version of the first edition chapters regarding of recent progress in renewable, sustainable and clean energy production and storage. Indeed, the second edition of Nanoenergy book summarizes the latest advances in material, scalable-cost-effective manufacturing methods and technology applications by researcher's experts in major fields of physical, chemistry and material science in Brazil related to the energy production with a special chapter contribution on clean energy storage from a group in France. This second edition consists in 10 chapters, which six from the first edition were revised or completely changed to cover the current state-of-art in the area with three additional new contribution on the hot topic in energy field related to the solar fuel production, hydrogen fuel storage and wastewater conversion into chemical fuel. The fourth

initial chapter is focused on the solar energy conversion into electricity via organic-inorganic or dye sensitizer cells; or hydrogen solar fuel via photo-chemical and electrochemical process. The followed chapters will address achievements in materials and devices application on biofuels, development of electrocatalysts in nanoscale for oxygen reduction and ethanol oxidation reactions, lithium-ion, metal-hydrated and neutralization battery and hydrogen storage using metal-alloys. The books begin with an exciting critical overview of the classical bulk hetero-junction device focused on the replacement of the traditional use of fullerene derivative by inorganic and metal nanoparticles incorporation. The following contribution is focused on the latest achievements on dye-sensitizers which have allowed to modulate their photochemical and photophysical properties to rise the solar devices efficiency. The fundamental characteristics, synthetic process, charge transfer and other aspects are also reviewed. The next two chapter will address the state-of-the-art on direct solar conversion into oxygen and hydrogen gas by using Earth abundant elements in electrode and suspended form. The experimental advances, chemical surface and defects, water oxidation reaction (OER) mechanism, charge transfer models, optical properties, structural effects and morphology design will be highlighted given an overview of the last decades followed by a critical view of remaining material and device drawbacks. To keep the multidisciplinary focus of this book, the next chapter gives an exciting overview of the biocatalytic phenomena when the enzymes are attached onto a solid platform describing the influence of this interface on charger transfer, which is the main drawback in this field that need to be overcome for improve the device efficiency. It will be also reviewed the fundamentals of thermodynamic and kinetics of this bioelectrodes till the most important challenges in miniaturizing this biodevices and developing bio-inspired technological systems. The development of electrocatalysts designed in nanoscale will be discussed in Chap. [Developments in Electrocatalystsfor Oxygen Reduction and Ethanol Oxidation](#) focusing on the main challenges and progress on oxygen reduction reaction (ORR) and ethanol oxidation reaction for low-temperature fuel cell application. The recent achievements on performance, charge capacity, most of the fundamental aspect such as charge transport models, electro-to-chemical reaction and mechanism on lithium-ion, metal-hydride and neutralization battery will also be covered on this second edition by followed chaps. [Nanocomposites from V₂O₅ and Lithium-Ion Batteries to Neutralization Batteries](#). Assuring that most of the aspects on energy field will be addressed, the last chapter brings the latest advances on hydrogen fuel storage by using new ternary intermetallic based magnesium materials introducing the fishing approach, as powerful tool to discover new magnesium-rich phases materials. This ternary class of material crystalizes within a new 2D structure leading an original physical property, which are discussed in this chapter in terms of mechanical, electrical, magnetic and hydrogen sorption.

The editors truly appreciate the efforts and commitment of the current and new authors to provide revised and extended manuscripts to this second edition of Nanoenergy book. We hope that this book provides information and guidance to the students, scientists, engineering, governments and companies interested in developing zero-emission coal technologies. In other words, all the contributions

summarize an exciting overview and understanding on nanoscience and nanotechnology leading an essential comprehension about the urgency to consolidate both knowledges to reach the desired technology.

Santo André, Brazil
May 2017

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*The original version of the book was revised:
Incorrect editor names have been updated.
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