Preface

Today, the world urgently needs alternative sources of environmentally sustainable energy supply for rapid industrial development and for consumption, such as in China. Indeed, it has become crucial for the future of humanity to find clean and safe methodologies to produce alternative energy for avoiding the growing global warming effect and urban air pollution. As a consequence, to reach this purpose it is necessarily to create new materials to build devices for renewable energy. In the past decade, funding agencies and governmental programs were created worldwide to give the scientific community support to find and develop new materials and devices for alternative energy production. In this context, this book tries to give an overview of the main developments in Brazil and its contribution to produce a clean and alternative source of energy. This book written by leading experts in major fields of physics, chemistry, and material sciences in Brazil covers the fundamental use of semiconductors, organic, and inorganic materials to build devices that directly convert solar irradiation into hydrogen and electricity, the latest development of biofuel cell and low temperature fuel cell devices using nanomaterials, as well as the latest advances on lithium-ion batteries and nickel–metal hydride batteries. This book consists of seven chapters which address in detail the fundamental importance of nanomaterials on the device performance and efficiency. The first three chapters concern an overview of the main contribution of research in development of a photoelectrochemical device which directly converts solar irradiation into electricity and hydrogen. This book begins with a chapter by Nogueira and Freitas summarizing the recent progress on the incorporation of inorganic semiconductor nanoparticles and metal nanoparticles into organic solar cells. The improvement caused by nanoparticles insertion on organic solar cell and its efficiency are discussed. In Chap. 2, Souza and Polo describe the recent advances in the developments on *tris*-heteroleptic ruthenium dye-sensitizers and its impact on dye-sensitized solar cells, efficiency. In addition, this chapter also gives an overview of natural dyes promptly obtained from several fruits or flowers in a very simple way which are also being employed as semiconductor sensitizers to produce these devices at a low cost. Souza and Leite present the recent advances on chemical synthesis to obtain a very promising semiconductor to be used as

photoanode in a photoelectrochemical device. This chapter illustrates a general discussion on solid–liquid interface, photoelectrochemical device performance due to a variety of nanostructured morphologies prepared by chemical methods and the main features of molecular oxygen evolution mechanism (OER) from water oxidation under solar light irradiation.

The next two chapters give readers the recent progress and fundamental discussion on producing an efficient fuel cell working at low temperature based on nanomaterials and interface of biomolecule immobilized on nanostructure surface. Olyveira and Crespilho describe in this chapter recent studies using biological materials immobilized on nanostructured film surface to generate electricity. The main focus of this chapter is how to build biofuel cells with high power density, controlling the enzyme immobilization methodologies and stability. Lima and Cantane present a development of a new class of electrocatalysts for application on low temperature fuel cells. This chapter discusses the main challenges of oxygen reduction reaction (ORR), and of the ethanol oxidation reaction (EOR) for proton and anion exchange membrane electrolytes. Also, the performance and test stability for some ORR electrocatalysts are included.

Finally, the last two chapters are dedicated to contextualize the readers on the advances in development of lithium-ion batteries and nickel–metal hydride batteries with the use of nanomaterials. Huguenin and Torresi describe the main advances resulting from the use of sol–gel route to produce V_2O_5 xerogel, nanocomposites of V_2O_5, and polymer cathodes for lithium-ion batteries. This chapter reviews the importance of structural features for better understanding of lithium-ion insertion/deinsertion, and their influence on electrochemical properties and charge capacity. Also, the use of nanomaterial on lithium-ion batteries is discussed. A chapter focusing on novel hydrogen storage materials and fundamental aspects for using nickel–metal hydride (Ni–MH) as rechargeable batteries is discussed by Santos and Ticianelli. The recent progress on developments of anode materials, with special emphasis on the nanostructured Mg alloys, its challenges, and perspectives are reviewed.

We are thankful to our current authors for their valuable contribution. We hope that this book gives an important contribution for understanding the urgency of the world to develop a new and efficient device for supplying the current necessity of humanity to have a clean and sustainable source of energy. In addition, our expectations to aid a wide scientific community to understand the actual progress was only possible due to consolidation of nanoscience and nanotechnology.

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Prof. Dr. Flavio Leandro de Souza
Prof. Dr. Edson Roberto Leite

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