Green Chemistry and Sustainable Technology

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Gerrit Boschloo
Anders Hagfeldt *Editors*

Molecular Devices for Solar Energy Conversion and Storage

Springer

Green Chemistry and Sustainable Technology

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The series *Green Chemistry and Sustainable Technology* aims to present cutting-edge research and important advances in green chemistry, green chemical engineering and sustainable industrial technology. The scope of coverage includes (but is not limited to):

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The series *Green Chemistry and Sustainable Technology* is intended to provide an accessible reference resource for postgraduate students, academic researchers and industrial professionals who are interested in green chemistry and technologies for sustainable development.

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Foreword

This outstanding and timely book on solar energy acquisition, conversion, and storage covers a broad range of actual hot topics, starting from organic solar cells, polymer cells, dye sensitized solar cells, via light-driven water splitting devices, and carbon dioxide reduction devices up to perovskite solar cells.

In the spirit of lifelong learning, some perceptive or thinking why and how important it is that we should learn or develop molecule-based solar conversion devices will become perfectly clear after having studied this most inspiring book.

Modern versions of spectroscopic techniques in molecular devices are also presented by world renowned scientists in the fields of:

- X-Ray-photoelectron spectroscopy
- Transient absorption spectroscopy
- Electrochemical impedance spectroscopy

The editors Haining Tian (Uppsala), Gerrit Boschloo (Uppsala), and Anders Hagfeldt (Lausanne) have thoughtfully arranged a collection of altogether thirteen contributions, prepared by leading experts.

The perspectives of this book are far-reaching visions contributing to the scientific debate on planetary boundaries and responsible care for environmental changes. The discussion, in terms of global crisis, encompasses our limited energy resources, global water pollution, and climate change to mention but a few. Therefore, it will be fruitful and rewarding for students, researchers, officials, politicians, and engineers to have this book at their shelf.

Berlin K. Rademann

Preface

With increasing demand of energy in our society, exploring and developing renewable energy is therefore becoming more and more desirable. "Affordable and Clean Energy" is listed as the 7th of 17 goals proposed from the United Nations to transform our world with sustainable development. With the background, the motivation to edit this book is further triggered from recently rapid development and broad application of functional molecules in renewable energy conversion fields. The chemical, physical, electrochemical, and photochemical properties of molecules can be well tuned by reasonable structural modification, making them show broad applications in different solar energy conversion and storage devices, such as solar cells, solar fuels, solar batteries/capacitors, and solar-to-thermal conversion devices. This book "Molecular Devices in Solar Energy Conversion and Storage" aims to give pedagogical overview of how different functional molecules are designed for various devices, what the working principles of these devices are, and how to characterize them and further improve the performance of the devices. The book consists of 13 chapters written by scientists who are experts in their own field. I give my great thanks to these authors and colleagues who kindly accepted to contribute the chapters. The contents of this book are briefly introduced as below:

Chapters 1 and 2 give an introduction of organic solar cells and the application of polymers and small molecules in this type of solar cells.

Chapters 3 and 4 serve as reviews of molecular components used in both liquid and solid state dye sensitized solar cells.

Chapter 5 discusses the organic/inorganic hybrid solar cells with a focus on perovskite solar cells.

Chapters 6 and 7 focus on light-driven water splitting and CO_2 reduction devices using molecular photosensitizer and catalysts to convert and store solar energy into fuels.

Chapter 8 introduces working principles of both photobatteries and photocapacitors systems with the various processes at and between the electrodes reactions presented in detail.

Chapter 9 presents the molecular design and functional devices for molecular solar thermal conversion and storage.

Chapters 10–12 are devoted to the application of X-ray Photoelectron Spectroscopy, Transient Absorption Spectroscopy, and Electrochemical Impedance Spectroscopy in the characterization of molecular devices.

Chapter 13 discusses perovskite solar cells concerning stability issue.

The invaluable insights and knowledge provided in this book are relevant for a wide readership, and are particularly useful for students, researchers, and industrial professionals who are working on molecular devices for solar energy utilization.

I am honored to have Prof. Gerrit Boschloo from Uppsala University and Prof. Anders Hagfeldt from EPFL as co-editors. This book will never be finished without their works and supports. I am also grateful to Prof. Klaus Rademann from Humboldt University of Berlin for writing the foreword of this book. At the end, I will give my gratitude to June Tang and Heather Feng from Springer Beijing for their kind invitation to edit this book and helpful assistance during the edition.

Uppsala, Sweden Haining Tian
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