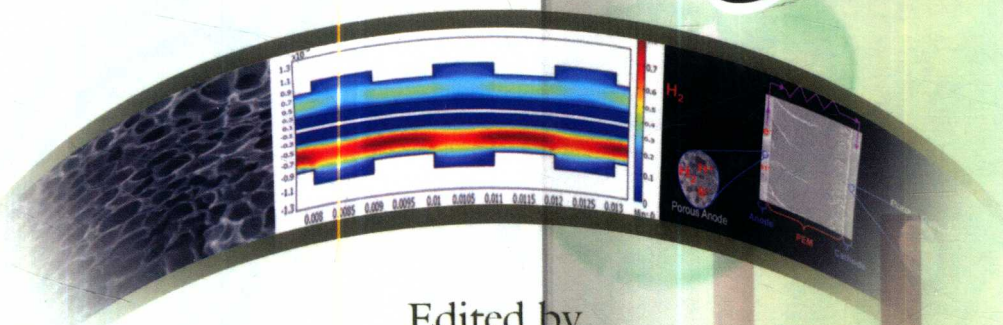
Advances in Hydrogen Production and Storage

Hydrogen Production Technologies



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Advances in Hydrogen Production and Storage

Series Editors: Mehmet Sankir and Nurdan Demirci Sankir

Scope: Energy is one of the most important issues for humankind. Increasing energy demand, regional limitations, and serious environmental effects of the conventional energy sources provide the urgent need for new, clean, and sustainable energy. **Advances in Hydrogen Production and Storage** emphasizes the basics of renewable energy and storage as well as the cutting edge technologies employed for these applications. The series focuses mainly on hydrogen generation, photoelectrochemical solar cells, fuel cells and flow batteries.

Submission to the series:
Please send book proposals to Mehmet Sankir at
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Preface

Energy is one of the most important issues for humankind. Increasing energy demand, regional limitations and serious environmental effects of conventional energy sources have brought about the need for new, clean and sustainable energy. This book series has been planned as a presentation of the basics in the areas of renewable energy and storage as well as the cutting-edge new technologies for these applications. *Hydrogen Production Technologies* is the first volume of the series due to the undeniable importance of hydrogen as a clean energy carrier. Hydrogen has been gaining more attention in both transportation and stationary power applications. Fuel cell-powered cars are on the roads and the automotive industry is demanding feasible and efficient technologies to produce hydrogen. There are various ways to produce hydrogen in a safe and cost-effective manner. This volume covers the new technologies used to obtain hydrogen more efficiently via catalytic, electrochemical, bio- and photohydrogen production and as such is a valuable component in the research area of hydrogen production. The principles and methods described herein lead to reasonable mitigation of the great majority of problems associated with hydrogen production technologies. The book is edited to be useful as a text for university students at both introductory and advanced graduate levels and as a reference text for researchers in universities and industry. The chapters are written by distinguished authors who have extensive experience in their fields. Besides researchers in the engineering area, those in the energy, materials science and chemical engineering fields have been focusing on new materials and production technologies in order to generate hydrogen in an efficient and cost-effective way. Hence a multidisciplinary approach is taken to covering the topics of this book. Readers will absolutely have a chance to compare the fundamental production techniques and learn about the pros and cons of these technologies.

The book is organized into three parts. Part I shows the catalytic and electrochemical principles involved in hydrogen production technologies. It should be clear from this part that the fundamentals and modern status

of water electrolysis, ammonia decomposition, methane reforming, steam reforming of hydrocarbons and biethanol, hydrolysis of ammonia borane and also SO_2 electrolyzer are of great importance. Therefore, their various aspects are discussed such as catalyst development, thermodynamics and kinetics of reaction mechanisms, reactor and mathematical modeling, novel membrane structures, and advanced nanoparticles. Part II is devoted to biohydrogen production. This part is designed to be a good introduction to gasification and fast pyrolysis of biomass, dark fermentation, microbial electrolysis and power production from algae. It specifically presents various catalytic formulations as well as reactor designs to overcome catalytic deactivation due to coking. In addition to gasification of wood, dried sewage sludge, and plastic waste, newly developed staged gasifiers with fewer impurities are discussed. Moreover, there is a discussion of dark fermentation using sulphate-reducing bacteria from the genus *Desulfovibrio* utilized in hydrogen production. Part II also addresses hydrogen production from electrochemically active bacteria (EAB) by decomposing organic compound into hydrogen in microbial electrolysis cells (MECs). Lastly, highly efficient harvesting of energy from algae in the forms of hydrogen and enhanced process integration reducing exergy destruction are demonstrated. The last part of the book is concerned with photohydrogen generation. Recent developments in the area of semiconductor-based nanomaterials, specifically semiconductor oxides, nitrides and metal-free semiconductor-based nanomaterials for photocatalytic hydrogen production are extensively discussed. Moreover, Part III also includes pristine and doped TiO_2 nanostructures for fast hydrogen production during photocatalytic water splitting. Finally, an earth abundant catalyst for water splitting is presented as a very promising narrow band gap visible-light photocatalyst.

Since the findings range over many useful topics specifically discussed in the book, readers from diverse fields such as chemistry, physics, materials science and engineering, mechanical and chemical engineering and also energy-focused engineering programs can benefit from this comprehensive review of the hydrogen production technologies.

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