# Biofuels and Biorefineries

Volume 7

## Aims and Scope of the Series

The Biofuels and Biorefineries Series aims at being a comprehensive and integrated reference for biomass, bioenergy, biofuels, and bioproducts. The series provides leading global research advances and critical evaluations of methods for converting biomass to biofuels and chemicals. Scientific and engineering challenges in biomass production and conversion are covered that show technological advances and approaches for creating new bio-economies in a format that is suitable for both industrialists and environmental policy decision-makers.

The Biofuels and Biorefineries Series provides readers with clear and concisely written chapters that are peer-reviewed on significant topics in biomass production, biofuels, bioproducts, chemicals, catalysts, energy policy, economics, and processing technologies. The text covers major fields of plant science, green chemistry, economics and economy, biotechnology, microbiology, chemical engineering, mechanical engineering, and energy.

## Series Description

Annual global biomass production is about 220 billion dry tons or 4,500 EJ, equivalent to 8.3 times the world's energy consumption in 2014 (543 EJ). On the other hand, world-proven oil reserves at the end of 2011 reached 1652.6 billion barrels, which can only meet just over 50 years of global production. Therefore, alternative resources are needed to both supplement and replace fossil oils as the raw material for transportation fuels, chemicals, and materials in petroleum-based industries. Renewable biomass is a likely candidate, because it is prevalent over the Earth and is readily converted to other products. Compared with coal, some of the advantages of biomass are (i) its carbon-neutral and sustainable nature when properly managed, (ii) its reactivity in biological conversion processes, (iii) its potential to produce bio-oil (ca. yields of 75%) by fast pyrolysis because of its high oxygen content, (iv) its low sulfur and lack of undesirable contaminants (e.g., metals, nitrogen content), (v) its wide geographical distribution, and (vi) its potential for creating jobs and industries in energy crop productions and conversion plants. Many researchers, governments, research institutions, and industries are developing projects for converting biomass including forest woody and herbaceous biomass into chemicals, biofuels, and materials, and the race is on for creating new "biorefinery" processes needed for future economies. The development of biorefineries will create remarkable opportunities for the forestry sector and biotechnology, materials, and chemical processing industry and stimulate advances in agriculture. It will help to create a sustainable society and industries that use renewable and carbon-neutral resources.

More information about this series at http://www.springer.com/series/11687

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# Production of Platform Chemicals from Sustainable Resources

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# Preface

With increasing concerns on environmental pollution and global warming that resulted from traditional fossil resource applications, much progress has been made in the past few years in developing catalytic reaction systems and chemistries for the conversion of various biomass resources into platform chemicals. This text provides state-of-the-art reviews, current research, prospects, and challenges of production of platform chemicals such as C6 sugars, 5-hydroxymethylfurfural, furfural, $\gamma$-valerolactone, xylitol, 2,5-furandicarboxylic acid, levulinic acid, ethanol, and others from sustainable biomass resources with processes that include heterogeneous catalysis, ionic liquid, hydrothermal/solvothermal, electrochemical, and fermentation methods. Reaction mechanism, methods for product separation and purification, and process integration are introduced. The application of these chemicals and their derivatives for synthesizing commodity chemicals via various routes is also covered.

This book is the seventh book of the series entitled "Biofuels and Biorefineries," and it contains 14 chapters contributed by leading experts in the field. The text is arranged into five key areas:

**Part I:** Production of Sugars (Chap. 1)
**Part II:** Production of Aldehydes (Chaps. 2, 3, and 4)
**Part III:** Production of Acids (Chaps. 5, 6, 7, and 8)
**Part IV:** Production of Alcohols (Chaps. 9, 10, 11 and 12)
**Part V:** Production of Lactones and Amino Acids (Chaps. 13 and 14)

**Chapter 1** presents a brief introduction into the characterization of lignocellulosic biomass and outlines some developing and promising pretreatment and hydrolysis methods for lignocellulosic biomass. **Chapter 2** provides state-of-the-art developments in the field of catalytic synthesis of furfural from C5 sugars and hemicellulose biomass, taking into consideration green chemistry principles, and gives critical analyses and perspectives of the development of sustainable furfural production processes. **Chapter 3** summarizes the catalytic production of 5-hydroxymethylfurfural from biomass-derived sugars and lignocelluloses and mainly focuses on the characteristics and superiority of different catalysts on the

catalytic transformation of various feedstocks. **Chapter 4** provides an overview of the historical role of 5-(halomethyl)furfurals in the chemical investigation of carbohydrates and describes multiple approaches to their preparation. Commercial markets that can be unlocked by synthetic manipulation of 5-(chloromethyl)furfural and its immediate derivatives are highlighted. **Chapter 5** offers an overview on process technology studies of kinetic models and the status of large-scale production of levulinic acid from biomass. Levulinic acid derivatives and their application are also presented. **Chapter 6** gives a concise overview of up-to-date methods for the synthesis of 2,5-furandicarboxylic acid from 5-hydroxymethylfurfural or directly from carbohydrates, with special attention to catalytic systems, mechanistic insight, reaction pathway, and catalyst stability. **Chapter 7** introduces the chemical processes for the production of gluconic acid and glucaric acid from monosaccharides and polysaccharides with a focus on heterogeneous catalysts. **Chapter 8** reviews microorganism producers, cultivation, separation technologies, alternative substrates of lignocellulosic biomass, and integration strategies to provide analysis of the strategies and economics of 1,4-diacid commercial-scale production. **Chapter 9** analyzes sorbitol's current market and its potential as a platform chemical and describes sorbitol production methods by chemical, electrochemical, and biotechnological routes. Some prospects about the direction of future research for overcoming current bottlenecks for further development are discussed. **Chapter 10** describes biotechnological xylitol production from the selection and preparation of the raw material to fermentative process conditions, downstream strategies, and future perspectives. **Chapter 11** introduces the development of heterogeneous catalysts for the production of C2 to C6 diols by removal of OH groups, hydrogenation of COOH to $CH_2OH$, and/or ring-opening C-O hydrogenolysis. **Chapter 12** compiles recent advances in lignocellulosic ethanol production processes, from novel raw materials or fermenting microorganisms to new processing technologies and their present commercialization. **Chapter 13** surveys the methodology and recent advances in the production of γ-valerolactone (GVL) from different renewable biomass-derived sources, from the pioneering studies to the present state of the art. **Chapter 14** provides an overview of the microbial production of L-glutamic acid and L-lysine and their applications as building block chemicals from biomass for synthesizing commodity chemicals and non-protein amino acids.

The text should be of interest to students, researchers, academicians, and industrialists who are working in the areas of renewable energy, environmental and chemical sciences, engineering, resource development, biomass processing, sustainability, materials, biofuels, and chemical industries.

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Tianjin, China — Xinhua Qi

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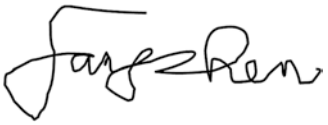

Zhen Fang, January 24, 2017, in Nanjing (Zhen Fang)

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