

Preface

With increasing concerns for environmental pollution and energy crisis, production of a variety of chemicals, materials and bioenergy from sustainable biomass resources are attracting more and more interests over the past years. The application of microwave irradiation proved to be a powerful method to enhance the process that is able to reduce reaction time, increase product yield and selectivity, and improve energy efficiency. The present text provides up-to-date fundamentals, state-of-the-art reviews, current assessments and prospects in this area that includes theoretic aspects of microwave reactors design, microwave-assisted pretreatment, transformation and pyrolysis of lignocellulose, microalgae and the other substrates to various chemicals, biodiesel and materials. The techno-economic analysis of the processes and some other auxiliary methods such as catalysis and supercritical fluid techniques used in the pretreatment and transformations are also introduced.

This book is the third book of the series entitled *Biofuels and Biorefineries* and it consists of 12 chapters contributed by leading experts in the field around the world. The chapters are categorized into three parts:

Part I: Microwave Theory and Reactor Design (Chaps. 1–3)

Part II: Microwave-assisted Conversions and Syntheses (Chaps. 4–9)

Part III: Pretreatment Strategies and Techno-Economics (Chaps. 10–12)

Chapter 1 introduces theoretical aspects of microwave irradiation practice, including microwave properties, temperature monitoring and microwave effects. Chapter 2 covers theoretical and practical aspects in the design of microwave reactors for chemical and biofuel synthesis. Chapter 3 introduces synergistic effects that can be used to increase process efficiency for biodiesel production through the combination of different activation techniques such as microwave, ultrasound, hydrodynamic cavitation and high-shear mixing in flow processes. Chapter 4 addresses microwave-assisted conversion of lignin and methods for direct chemical or catalytic conversion of lignin to high value-added products. Chapter 5 shows how microwave can be used in biomass pyrolysis and gasification processes for biofuel production and includes case studies. Chapter 6 demonstrates

how microwave-induced pyrolysis has the potential to produce high-quality syngas from organic wastes for the production of polymers *via* fermentation and considers waste type, moisture content, pyrolysis temperature and the microwave receptor. Chapter 7 provides an overview of the latest advances in the production of platform chemicals such as 5-hydroxymethylfurfural, furfural, lactic acid and sugars from biomass using microwave irradiation. Chapter 8 introduces microwave-enhanced methods for converting algal biomass into biodiesel through both non-catalytic and catalytic approaches and covers reaction mechanisms, experimental protocols, statistical analysis, experimental design and energy consumption of the proposed processes. Chapter 9 focuses on recent developments of the synthesis of cellulose-based (nano)composites and derivatives via microwave. Chapter 10 reviews advances in application of microwave irradiation technology for the pretreatment of lignocellulosic biomass to produce biofuels and chemicals with critical analysis of the methods. Chapter 11 provides green chemistry metrics that is tailored for microwave applications in biodiesel and includes factors for energy consumption and kinetic analyses. Chapter 12 demonstrates an overall techno-economic analysis for a transportable small-scale microwave-assisted ex-situ catalytic pyrolysis facility that converts Douglas fir pellets into aromatic hydrocarbons with emphasis on sensitivity analysis for improving the economics of enriched bio-oil, syngas and biochar.

This book covers a wide range of scientific and technical aspects of microwave that relate to the conversion of various biomass substrates to biofuels, bio-based chemicals and materials. The design of microwave reactor and techno-economic assessment necessary for the process are also covered. The text will be of interest to students, researchers, academicians and industrialists in the areas of microwave technique, chemical engineering, biomass and bioenergy processing.



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