Catal Lett (2012) 142:655–656
DOI 10.1007/s10562-012-0835-z

BOOK REVIEW

Blake A. Simmons (ed.): Chemical and Biochemical Catalysis for Next Generation Biofuels

Copyright 2011, 206 pp, hardback, ISBN 978-1-84973-030-3

Jason C. Hicks

Received: 9 April 2012 / Accepted: 20 April 2012 / Published online: 3 May 2012

This book presents a thorough, yet concise, overview of advances and challenges remaining in generating next generation biofuels from lignocellulosic biomass. From catalysis to land availability, the contents of the book span broad areas of science and would be interesting to a wide audience. Although not structured as a textbook, it could be an excellent supplementary resource for graduate courses covering energy or sustainability related topics.

The topics in the book include land availability, catalyst design and surface science, pretreatment, bioconversion, and gasification. Biomass pretreatment was given particular attention. The book begins with a brief introduction to the challenges faced when generating biofuels from lignocellulosic biomass, setting the stage for the remainder of the book. In **Chapter 2**, the authors provide a detailed overview of land types, land availability, and biomass types. This chapter is one of the best resources available for a detailed description of land types. Furthermore, the effects of soil contaminants on the resulting biomass composition were discussed. The relationship between inorganic contaminants in biomass and conversion to fuels is an important research area. For instance, inorganic contaminants may act as catalysts during thermochemical conversions or act as catalyst poisons during biomass upgrading to fuels. In either case, understanding the potential contaminants in the soil that are transferred to biomass will enable better catalyst and process design strategies for biofuels production. Although the agricultural, harvest, and fossil fuel inputs of various herbaceous crops and rotational crops were included, the general composition (e.g. lignin, cellulose, hemicellulose, alkali metal content, etc.) of the various types of biomass was absent.

J. C. Hicks (✉)
Department of Chemical and Biomolecular Engineering,
University of Notre Dame, Notre Dame, IN 46556, USA
e-mail: jhicks3@nd.edu

In **Chapter 3**, biomass refining to value-added products was discussed in terms of surface science and heterogeneous catalyst design. Biomass feedstocks contain a wide variety of chemical functionalities that complicate the refining and upgrading processes. The fundamental understanding of the mechanisms associated with specific chemical transformations on the surface of well-defined catalysts provides the basis for structure–property determinations and enhances the ability to design new catalysts. This chapter provided a very nice overview of the key chemical transformations in a biorefinery with particular focus applied to the different oxygenated species present in biomass-based resources and how these species adsorb and react on catalytic surfaces.

Two outstanding chapters on biomass pretreatment were included in this book (**Chapters 4** and **5**). In **Chapter 4**, both dilute acid pretreatment and hydrothermal pretreatment methods were reviewed, including the types of reactors and methods to perform cellulosic pretreatment experiments. As indicated by the authors, the most important goal to accomplish through the pretreatment processes is to increase the accessibility of the cellulose to enzymes by opening up the lignocelluolosic structure. A brief summary of the economics of pretreatment processes was included with discussion of the challenges in maximizing yields and reducing the cost of these processes. In **Chapter 5**, the authors present a mini-review on ammonia-based pretreatment methods with particular emphasis on the ammonia fiber expansion (AFEX) process. This chapter covers in detail the effects of AFEX on all types of lignocellulosic biomass feedstocks (e.g. sorghum, miscanthus, switchgrass, etc.) and compares the advantages and disadvantages of AFEX on the storage, stability, and pelletizing/densification of the various potential feedstocks. These two chapters inform the reader on key benefits and challenges of pretreatment processes for lignocellulosic biomass feedstocks.

Literature reported conversion processes for upgrading low cost, lignocellulosic biomass feedstocks into fuels and chemicals are numerous. This book presents perhaps the most common methods used to transform biomass into fuels: bioconversion (**Chapter 6**) and gasification (**Chapter 7**). The reader will find a very strong introduction to bioconversion using cellulases and hemicellulases and motivating factors for future research on engineering better enzymes to enable the efficient conversion of biomass to fuels. In **Chapter 7**, the reader will find information regarding gasification technologies and operation of gasification reactors. An expansive view of other thermochemical approaches to biofuels production would have been a nice addition to the conversion process chapters.

The development of new and improved catalysts specifically designed to convert lignocellulosic biomass into fuels is of utmost importance. As presented in **Chapter 8**, the design of novel bioinspired catalysts to reach this goal is highlighted. Using enzymes as the model, the creation of multifunctional catalysts that mimic enzymatic catalytic selectivities and activities is a synthetic challenge with immense impact. This chapter is an excellent resource for bioinspired catalysts and a well-chosen chapter to conclude the book. The authors provide detailed comments on the imperative challenges and future directions in this area of research.

This book should be interesting to many readers, particularly those who are new to the area of biofuels or interested in learning more about the challenges and future directions for potential commercialization. The book ties together key challenges in catalysis, pretreatment, and conversion technologies. However, the reader should not expect a cumulative progression between chapters. Rather, each chapter could stand alone as an independent contribution.