Preface

Short carbon chain molecules (C_2–C_9) obtained either directly from sugars, the hydrolysis of starch, or preferably by the controlled breakup of lignocellulosic biomass into soluble components are the only conceivable sustainable source of carbon on the planet that could ultimately replace the fossil hydrocarbons that currently form the base of the chemical industry and hence our technological civilization at large. In particular, the production of polymer components and polymers that are chemically or at least functionally equivalent to those derived from the refining of crude oil would offer ecologic and environmental as well as economic advantages.

The use of sugars, starch, and ultimately lignocellulosic biomass, i.e., forestry (e.g., wood and bark chips, etc.) and agricultural (e.g., straws, husks, stovers, etc.) residues, as a renewable carbon resource will, however, require careful life-cycle analyses of the processes involved. This in turn is critically dependent on a deep and detailed understanding of the mass and energy flows in these processes and hence their mechanisms at the molecular level. Almost "by definition" these processes will have to be catalytic in nature to be ecologically sustainable and economically viable.

The development of new catalysts and catalytic processes that are specifically designed for and adapted to the unique properties of the biomass-derived carbon substrates poses a unique challenge. Due to the abundance of oxygen-containing functional groups, the pentose and hexose sugars and their furanic condensates obtainable from (hemi-)cellulose as well as the phenol propanoid units of lignin are characterized by a high polarity and reactivity that is very different – one could say almost opposite – to that of the traditionally employed alkane and arene sources available from refined crude oil. The fundamental study of the reaction cascades and mechanisms involved in the transformation of oxygenated biomass to value-added chemicals is the first step to meet this challenge.

Focusing on the use of thermochemical and acid-/base- or metal-catalyzed processes only, the two volumes of this book attempt to give an overview of and insights into the specific aspects of this challenge as perceived and formulated by expert contributors research-active in this field.

Volume I is comprised of chapters that address the nanoscale structure of lignocellulose, the application of acid-base reactions and catalysts to the depolymerization of cellulose, the use of heterogeneous hydrogenation catalysts for its direct conversion to polyols, as well as chapters that explore pathways for the metal-catalyzed dehydration and oxidation of sugars and sugar alcohols to furans and carboxylic acids, respectively.

The chapters of Volume II cover the hydrodeoxygenation of sugar-derived substrates by homogenous catalysts systems; the valorization of carboxylic acids, notably lactic acid and its derivatives; a theoretical approach to the elucidation of the conversion pathways of sugars and sugars condensates and their decomposition to humins as well as mechanistic and practical aspects of the conversion and pyrolysis of lignin to functionalized monocyclic aromatics and the pyrolysis of biomass to synthesis gas.

We hope that the insights provided by the different and varied perspectives offered here will convince the readers that a switch to renewable biomass as a key carbon source for the chemical industry will be feasible and does indeed offer a way forward to a more sustainable future.

Guelph, Canada — Marcel Schlaf
Dalian, China — Z. Conrad Zhang

http://www.springer.com/978-981-287-687-4

Reaction Pathways and Mechanisms in Thermocatalytic Biomass Conversion I
Cellulose Structure, Depolymerization and Conversion by Heterogeneous Catalysts
Schlaf, M.; Zhang, Z. (Eds.)
2016, X, 260 p., Hardcover
ISBN: 978-981-287-687-4