Preface

Growing scarcity of fossil resources, concerns about the effects of global warming, and the desire for a more independent, stable supply of energy and resources force us to develop more sustainable production routes based on renewable resources. These efforts should culminate in the development of highly integrated biorefineries, which will eventually replace the conventional petrochemical ones. In order to be able to compete economically as well as ecologically, such biorefineries should not only produce our required energy-carriers but also focus on the production of high value chemicals and materials, as needed by our society, to be an integral part of such a facility. As far as the renewable production of carbon-containing chemicals and liquid transportation fuels is concerned, biomass is in principle the only viable and abundantly available alternative resource. This, of course, with the provision that the biomass is produced in such a manner that it does not compete with the food supply.

In addition to the geopolitical imperative for a transition from fossil to renewable resources, using biomass as feedstock holds additional, specific advantages for the chemist. Nature supplies us with an enormous structural diversity in the highly functionalized feed that is biomass. Not only are the various components of biomass often extensively functionalized, they often come to us stereochemically pure. This feedstock thus provides an excellent opportunity for a more facile production of highly valuable polymer building blocks, specialty chemicals and pharmaceuticals. Indeed, achieving such structural complexity in the petrochemical bottom-up approach by selectively introducing functional groups, hetero-atoms, and stereochemical information is currently a rather cumbersome process as one has to start from non-functionalized hydrocarbons. For the production of bulk and commodity chemicals, on the other hand, selective defunctionalization is often required if we want to obtain these high volume products from renewable resources. In any case, i.e., both for selective functionalization as well as defunctionalization, the development of new catalysts and new catalytic conversion routes will be essential. In fact, catalysis has been identified as one of the key enabling technologies ultimately required for the realization of the “ideal biorefinery.” To achieve this, both chemical and enzymatic catalysis will be necessary and in particular a combination of both represents a promising yet challenging approach. Organometallics, or more broadly speaking transition-metal complexes, are ideally suited as catalyst to deal with the complex biomass feedstock in a selective manner. One can easily envisage that the application of the general approach of systematic catalyst optimization by rational ligand design, common in transition metal-complex catalysis, to renewable substrates, such as sugars, terpenes, or fatty acid derivatives, can give rise to many new or improved chemo-, regio-, and enantioselective conversion routes. This volume reviews and highlights some of the recent efforts in this direction. The five chapters are organized along the lines of reaction types rather than class of renewable substrate. Behr and Vorholt, for instance, discuss a classical set of olefin addition reactions, i.e., the hydroformylation and related conversions, when applied to renewables. The exploitation of unsaturations in renewable substrates such as fatty acids and terpenes by the exceptionally versatile ruthenium-metathesis catalysts is reviewed by Montero de Espinosa and Meier. Korstanje and Klein Gebbink review the wealth of information on the selective rhenium-catalyzed oxidation and deoxygenation of renewables. Bruijnincx, Weckhuysen, and co-workers discuss the renaissance of the palladium-catalyzed telomerization reaction in light of the recent use of renewables as multifunctional substrates. Finally, Williams and co-workers show the recent advances in using transition-metal catalysts and initiators for the production of renewable polymers. Together, these contributions show the potential and power of using transition-metal catalysts for the production of renewable chemicals. One also has to note, however, that the area of "Organometallics and Renewables" is a terrain that largely still remains to be explored. Many other exciting contributions of research on catalysis with organometallics to the blooming field of catalytic biomass conversion can therefore be expected in the near future. We hope that this volume not only highlights the potential of the field but also serves as a source of inspiration for the organometallic chemist to further investigate this field rich in opportunities.

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