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EDITORIAL

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Chemistry of Renewables

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Sustainable economical growth requires safe resources of raw materials for industrial production. Today's most frequently used industrial raw material (i.e., petroleum) is neither sustainable, because limited, nor environmentally friendly. Whereas the economy of energy can be based on various alternative raw materials (wind, sun, water, biomass, and nuclear fission and fusion), the economy of substances is fundamentally dependent on biomass, in particular plant biomass. Special requirements regarding the efficiency of raw material and product line as well as sustainability need to be met by both, the substance-converting industry as well as research and development.

Today, it appears clear that much, but maybe not all, transportation will still be possible without carbon-containing energy carriers (e.g., by use of electricity, hydrogen, or ammonia in electrical or fuel-cell-driven vehicles). However, it is entirely impossible to envisage a chemical industry that is not based predominantly on carbon. Without available fossil resources, this carbon must come from either biomass or from CO_2, with no alternative. In such a scenario, it is interesting that the amount of biomass available for mankind appears to be able to cover the needs of the chemical industry, whereas it is much more uncertain if the total biomass potential is sufficient to cover our future needs for transportation fuels and energy production. It seems very probable that over the coming years, biomass will find more and more widespread use as a renewable raw material in the chemical industry where it can be used to

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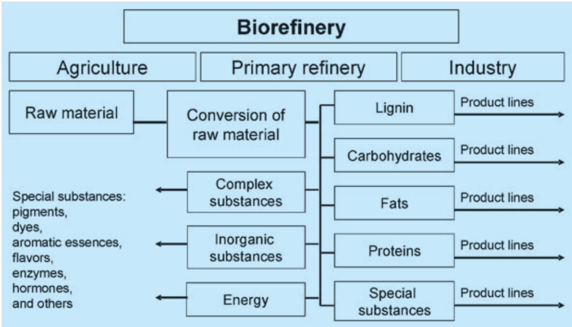

Figure 1. Providing code-defined basic substances via fractionation for the development of relevant industrial product family trees.[1]

produce chemicals with higher value than transportation fuels and energy.[2]

Thus, there are many good reasons to pursue the development of energy-efficient and environmentally friendly technologies that produce chemicals from renewables, and this issue of *ChemSusChem* features a collection of such efforts. Hopefully, this will inspire many others to further develop this field, which will ultimately form the basis for a truly renewable chemical industry.

Nature is a continually renewing production chain for chemicals, materials, fuels, cosmetics, and pharmaceuticals. Many of the bio-based industrial products that are currently used result from the direct physical or chemical treatment and processing of biomass products, such as cellulose, starch, oil, protein, lignin, and terpene.

The majority of biological raw materials are produced from agriculture and forestry and by microbial systems. Thus, biomass can already be modified within the initial process to make it suitable for subsequent processing and to form particular target products, known as "precursors". Plant biomass always consists of the basic products: carbohydrates, lignin, proteins, and fats, beside various substances, such as vitamins, dyes, flavors, and aromatic essences of widely different chemical structures. Biorefineries combine the essential technologies for processing the biological raw materials, industrial intermediates, and final products (Figure 1).

This issue of *ChemSusChem* is dedicated to the presentation of some examples of chemistry of renewables with focus on the development of biorefinery systems. The contributions cover various modern chemical methods for conversion of renewable resources into well-defined structures.

The acid hydrolysis of cellulose as the entry point into biorefinery schemes is discussed in a Review by Robert Rinaldi and Ferdi Schüth. The second Review is focused on myrcene, an acyclic terpene suitable as a platform chemical for preparing terpene alcohols for versatile applications (Arno Behr and Leif Johnen).

Full papers are given on carbohydrate degradation products 5-hydroxymethylfurfural and furfural. Onofre Casanova, Sara Iborra, and Avelino Corma describe the use of gold nanoparticle catalysts for the aerobic oxidation of 5-hydroxymethylfurfural into 2,5-furan dicarboxylic acid. Photochemical key steps in the synthesis of amphoteric surfactants from furfural-derived intermediates are discussed by Abdoula Gassama, Cédric Ernenwein, and Norbert Hoffmann.

Today, the plant oil chemistry is already established, but more efficient conversion methods are necessary, in particular, for fuels production and valorization of transesterification side products. In their Minireview, Dmitry Murzin and co-workers discuss the current technologies and technological developments for commercially more viable biofuels. Graham Hutchings and co-workers investigate the possibility of producing glycolate from glycerol by the use of gold and palladium nanoparticle-coated substrates.

Bio-oils from liquefaction are undefined mixtures. Therefore, the catalytic upgrading of bio-oils by ketonization is discussed in the Communication by James Dumesic and co-workers.

These selected examples are only a small fraction of the many contributions on the chemistry of renewables to the development of biorefinery systems. Further articles will be published in the coming issues, and we invite all researchers in this field to send their papers to *ChemSusChem*.

On behalf of the editorial team, we hope you enjoy this special issue. Furthermore, we look forward to reading about your new and exciting findings in *ChemSusChem* in the future.

Birgit Kamm and Claus H. Christensen

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[1] B. Kamm, P. R. Gruber, M. Kamm, *Biorefineries—Industrial Processes and Products*, in *Ullmann's Encyclopedia of Industrial Chemistry*, 7th Ed., Wiley-VCH, Weinheim, **2007**.
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