Multifunctional catalysis and plant chemistry

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With the predicted disappearance of petroleum oil reserves and while being encouraged by governmental bodies all over the world, research is currently intensively focused on renewable raw materials. Their uses are indeed of great importance for the production of platform and/or value-added chemicals of the near future, some of them being quite different from those accessible by petrochemical routes. However, these products are in most cases polyfunctional and their transformation requires the close control of the chemio-, regio- and/or enantioselectivity of the processes. To overcome these drawbacks, catalysis was expected to play a pivotal role by offering to chemists useful tools for performing selective transformations to high added value chemicals.

Methyl- or ethyl-esters, ethanol, ethers, … are well-known examples of applications in the field of energy. On the other hand, transformations of oils, fats, sugars, cellulose, lignins, … into higher added-value products (chemicals) also represent key targets to be reached by scientists. Such reactions generally require numerous chemical steps including the consecutive separation of the products from the reaction medium, as well as costly purification and waste treatment processes.

Recent studies have clearly shown that multifunctional catalysts based on porous inorganic or organic solid supports can directly and positively impact on the reaction rate and selectivity. The development of such new catalysts with a controlled distribution of various and dedicated active sites is probably one of the most fascinating examples. Moreover the close control of the hydrophilicity of the catalyst surface is also a key parameter to monitor in order to control the selectivity of the process.

In this lecture, it will be clearly shown that a lot of secondary reactions could be limited or even avoided thanks to the design of such new catalytic surfaces, thereby allowing us to transform carbohydrates, glycerol, hydroxylated fatty acids, unsaturated esters,… with selectivities and yields higher than those obtained with homogeneous or conventional solid catalysts. Catalytic reactions are preferentially performed in the absence of solvent. However, for specific reactions and/or when starting from lignocellulosic compounds, new cheap and safe solvents capable of replacing the traditional volatile organic ones need to be addressed.