



Developing catalysts using
non-critical elements designed
to unlock the potential of biomass

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19th November 2014 @ 9am

(10am CET and 5pm Japanese time)

Overview: This free webinar will take about 1 hour with a short introduction by the Novacam Project Leader (Professor Emiel Hensen, Technische Universiteit Eindhoven), 40 minutes lecture (Dr. Evgeny Pidko, Technische Universiteit Eindhoven) and 20 minutes for discussion of the questions collected from delegates during the lecture.

Mechanisms of Catalytic Sugar Conversion: Bridging the Gap between Catalysis Disciplines

Dr. Evgeny A. Pidko

Abstract: One of the main challenges in the valorization of carbohydrate fraction of biomass is its efficient and selective conversion to platform chemicals with a wide range of downstream applications. While different homogeneous and heterogeneous catalysts can be used to selectively convert fructose [1], the activation of the more abundant glucose sugar is much more difficult. The direct conversion of glucose represents a challenge not only for the chemocatalysis but also for biological systems. The vast majority of glucose conversion paths starts from aldose-ketose isomerization step that transforms glucose to its more reactive isomer – fructose. In industry, fructose is produced via the enzymatic isomerization of glucose syrup. Despite the high activity, the potential of the biocatalyst integration in a multistep process to produce biomass-derived platform chemicals is limited. Unlike enzymes, chemocatalysts efficiently operate within large ranges of temperatures, pressures and pH.



From this perspective, inorganic Lewis acids are particularly attractive as catalysts for the selective glucose activation. Both homogeneous and heterogeneous Lewis acids can promote the glucose to fructose isomerization. In particular, glucose can be isomerized by homogeneous systems based on Cr (II) and (III) chlorides in ionic liquids [2,3] and by heterogeneous Sn-BEA zeolite catalyst able to operate in aqueous medium [4]. There is a fundamental question regarding the systems outlined above: what do they have in common besides their isomerization activity and Lewis acidity?

In this lecture I will discuss the results of our recent computational and experimental studies on the mechanism of glucose isomerization by these very different systems[3,5]. I will demonstrate that the enzymatic and chemocatalytic systems utilize similar tools to selectively activate carbohydrates. They all make use of the dynamic and cooperative action of their active sites towards selective glucose transformation. Despite obvious differences between these catalytic systems, the structures and properties of the key intermediates and transition states are strikingly similar. The fundamental insights obtained in these studies pave the way towards a generic reactivity concept of carbohydrate activation that is necessary for the rational design of new carbohydrate conversion catalysts.

References

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