Catalyst Design for Production of Fuels and Chemicals from Biomass and Shale Gas: Towards a Molecular Level Understanding

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Biomass is the most promising form of sustainable carbon resource for fuels and chemicals. About 1.6 billion tons of biomass can be sustainably produced in US. This resource, if utilized efficiently, can offset 43% of our transportation fuels and provide alternatives for production of renewable chemicals. Hydrodeoxygenation (HDO) is a platform technology for conversion of biomass feedstocks into a range of fuels and chemicals including C1-C6 alkanes; C1-C6 mono-alcohols, polyols, and cyclic ethers. The challenge with HDO is to selectively produce targeted products while minimizing hydrogen consumption. The hydrothermal conditions in HDO cause permanent deactivation to standard catalytic materials.

In the second part of the presentation, we will focus on shale gas conversion into longer chain olefins (LCO). The advent of fracking technology has resulted in plentiful LNG resources in North America. The conversion of cost advantaged feedstocks to higher margin performance chemicals has changed in industry on a structural and strategic-planning level. Process for the conversion of light olefins into LCO typically yield complex mixtures of by-products. The oligomerization of olefins into mixtures of LCO has been demonstrated by solid acid and zeolite catalysts. Zeolitic systems have the potential to control the product distribution by judicious catalyst and process parameter selection.

Understanding the complicated reaction networks in HDO and oligomerization has aided in the design of more efficient catalysts. Future advances in developing a molecular understanding of both HDO and oligomerization processes combined with identification of structure-function relationships of the key fundamental reactions will allow the development of more efficient processes for the production of fuels and chemicals from clean feedstocks.