U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

INDUSTRIAL TECHNOLOGIES PROGRAM

Nanocatalytic Conversion of Biomass into Second-Generation Biofuels

Up to 100 million tons of lignin/year may be produced as a byproduct of cellulosic ethanol manufacture—a source of feedstock that has the potential to replace or supplement much of the U.S. petrochemical demand. Recently, Oak Ridge National Laboratory (ORNL) successfully demonstrated biocatalytic and catalytic conversion of lignin to small molecular weight compounds of commercial value: including the aromatics benzene, toluene, styrene, xylenes, and subsituted alkyl phenols. These represent building block feedstocks for commodity chemical manufacture and hence a major avenue for bringing new technology based on alternative chemical pathways into the domestic chemical industry. Even though success has been achieved in the laboratory, methods for processing lignin still pose technological barriers that need to be addressed or considered in a feasibility assessment of scale up to a commercial plant. Examples of these are the high temperatures needed for pyrolysis and the corrosive conditions needed for acid catalysis. Although issues may not disqualify these technologies for future large scale use, they do need to be assessed in light of other more benign catalytic pathways available. An example of this is the use of clay-based minerals for catalytic cracking of refractory organics.

Nanocatalysts have been proposed as effective tools for cracking large refractory organic molecules. In particular, submicron layered heterogeneous particles have been developed, maximizing the surface area and hence sites available for catalytic reactions to occur. Hence, this project proposes to investigate the use of clay-based nanocatalysts to facilitate the breakdown of refractory organics from unconventional sources: namely from bitumen, oil shale, and lignin into feedstocks that can be used for fuel and for the chemical industry. Advances in the use of clay minerals as economical catalysts will be coupled with the advantages posed by nanomaterials to greatly enhance the efficiency and economics of the processing of refractory materials. In particular, lower temperature conversions and more rapid processing are predicted from the use of nanotechnology in this area. The focus in this nanomanufacturing concept definition study will be on unconventional feedstocks for transportation fuel and commodity chemicals, primarily lignin, testing novel nanocatalytic pathways for the decomposition of refractory materials into useful building block chemicals.

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