Pacific Northwest NATIONAL LABORATORY

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In the United States, 1.3 billion tons of non-food dry biomass are available annually and could be used to produce 130 billion gallons of liquid transportation fuels. Significant new technology developments are needed to realize this potential for renewable fossil-fuel replacements.

U.S. DEPARTMENT OF ENERGY

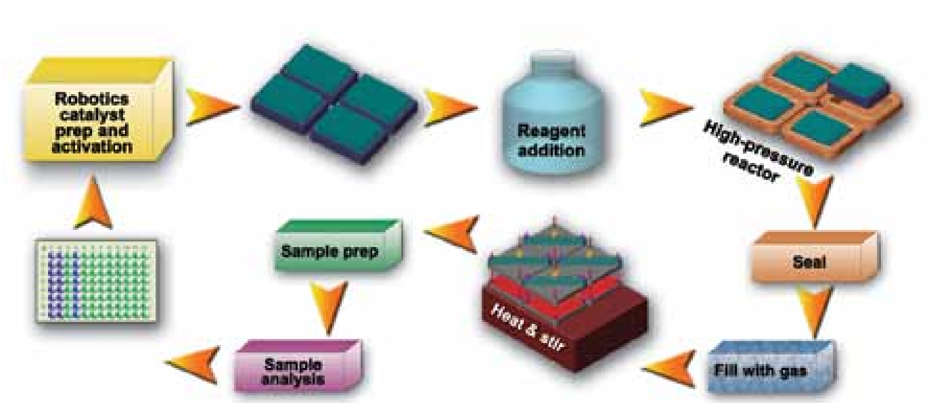
Pacific Northwest National Laboratory:

INSTITUTE FOR INTERFACIAL CATALYSIS

Biomass Conversion

Rising oil prices and increasing environmental concerns have made biomass-derived fuels an attractive alternative. Over the long term, however, bio-based refineries must have a diverse product base to remain economically viable in the absence of government subsidies. Research is providing the pathways to produce various high-value industrial and consumer products from biomass less expensively than from petroleum.

Pacific Northwest National Laboratory's (PNNL's) Institute for Interfacial Catalysis and its partners are focusing on new catalyst formulations and low-cost use of lignocellulose and sugars to make biomass conversion technically and economically feasible.



The Combinatorial Catalyst Laboratory (Combicat) is an integrated system for high-throughput catalyst experimentation at near-processing conditions, as can be seen in this schematic. This combination of high-throughput and processing conditions is unmatched at universities or other national laboratories.

We are a leading research institute in the fundamental understanding and development of novel, highly active and highly selective catalysts for biomass conversion. We have extensive experience in formulating, synthesizing, and testing catalysts for chemical production applications, including

- Hydrogenation of organic acids and sugars to monomers, esters, and solvents
- Oxidation of oils and sugars to produce monomers and esters
- Dehydration, esterification, decarboxylation, and deamination in biomass conversion.

We also have extensive experience in converting biomass into fuels, including our work in thermochemical gasification of biomass for syngas and methane, and upgrading bio-oils to transportation fuels

IMPROVING PROCESSING EFFICIENCY OF BIO-OIL FUEL

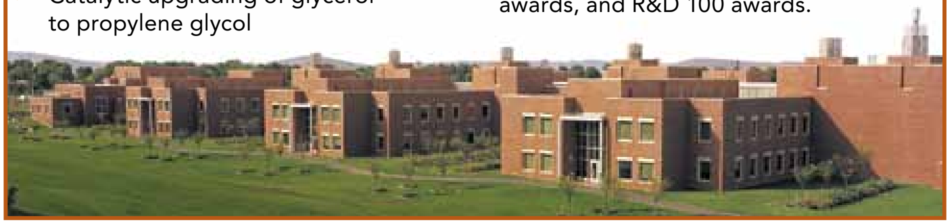
For bio-oil from fast pyrolysis of biomass, we are evaluating new catalysts and a bench-scale continuous flow reactor operated with bio-oil feedstock and feedstock fractions to determine kinetic parameters for conversion as well as catalyst deactivation.

▶ LEADING THE FIELD IN BIOMASS CONVERSION

The Institute for Interfacial Catalysis is conducting state-of-the-art research projects in converting biomass Examples of our work include

- Catalytic hydrogenation of biomass pyrolysis oil to produce refinery feedstock and chemicals
- Separation of corn fiber and conversion to value-added products
- Low-temperature catalytic hydrothermal gasification of wet biomass
- Development of catalysts for upgrading sugars to polyols, such as propylene glycol and ethylene glycol
- Catalytic upgrading of glycerol to propylene glycol
- Development of solid acid catalysts for conversion of sorbitol to isosorbide
- New biorefinery platform intermediate-3HP and its catalytic conversion to acrylic acid
- Efficient continuous conversion of sugars to sugar alcohols
- Development of technology leading to low-cost carbon fiber from pulp and paper mill byproducts.

In nearly 30 years of developing and applying novel thermal, chemical, and biological processes to biomass conversion, we have received numerous honors, including the Presidential Green Chemistry Award, Federal Laboratory Consortium awards, and R&D 100 awards.



Previous studies focused on using petroleum-refining technology for analogous bio-oil processing steps. Progress advanced to laboratory demonstrations; however, recent developments in catalyst formulation for use with biomass-derived materials in the presence of the large amounts of water normally present in bio-oil are expected to improve the overall processing efficiency through reduced hydrogen requirements, reduced processing severity, and improved catalyst longevity.

TURNING CORN INTO INTERMEDIATE BUILDING BLOCKS

With our industrial partners, we are developing an economic process for recovering glucose, xylose, and arabinose from corn fiber and converting some of these components via fermentation to ethanol and/or direct aqueous phase catalytic conversion to propylene glycol, ethylene glycol, and glycerol. The byproduct will be a protein-rich stream capable of use in animal feed.

UNDERSTANDING CATALYTIC DEPOLYMERIZATION OF CELLULOSE

To develop catalytic techniques for converting cellulose to fuels and intermediate chemicals, we are investing in developing a detailed structural and functional understanding of cellulose hydrolysis under aqueous conditions, using an array of surface science and spectroscopic techniques. These insights, on pretreated cellulose or partially hydrolyzed cellulose, are absent in the literature. Using computational and experimental chemistry, we are formulating catalysts and reaction conditions for rapid, selective hydrolysis of cellulose.

PRODUCING GLYCEROL WITH CATALYTIC-ENHANCED HYDROGENOLYSIS

To generate markets for glycerol, a byproduct of biodiesel production, we are working with an industrial partner to develop a proprietary series of catalysts to break the carbon-oxygen bonds in glycol and produce the more valuable propylene glycol.

ABOUT PNNL

Pacific Northwest National Laboratory, a U.S. Department of Energy Office of Science laboratory, solves complex problems in energy, the environment, and national security by advancing the understanding of science. PNNL employs more than 4000 staff, has a business volume of $750 million, and has been managed by Ohio-based Battelle since the lab's inception in 1965.

For more information about the **Institute for Interfacial Catalysis**, contact:

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