

Catalysis for Biofuels

Researchers at PNNL are developing economically viable processes to produce fuels and chemicals from plant-based materials. Our catalyst work is part of a larger program that spans basic science to applied technology development within PNNL's Institute for Interfacial Catalysis. We specialize in:

Fuels. We are developing the scientific and engineering foundations for converting biomass to infrastructure-ready fuels with an emphasis on diesel and jet fuel distillates.

Chemicals. Our researchers are developing a variety of catalysts for producing value-added chemicals, including robust catalysts for working in aqueous environments where conventional catalysts break down.

Hybrid processes. We are combining biotechnology with catalysis to create hybrid low-energy processes that increase the number of higher value products that can be made in a biorefinery.

EXPERTISE AND CAPABILITIES

Using our atomic and molecular understanding of catalysts, we design materials with desirable rates of reaction, specificity and stability. Our capabilities encompass catalyst synthesis, characterization, and testing as well as the integration of catalysts within new process conditions.

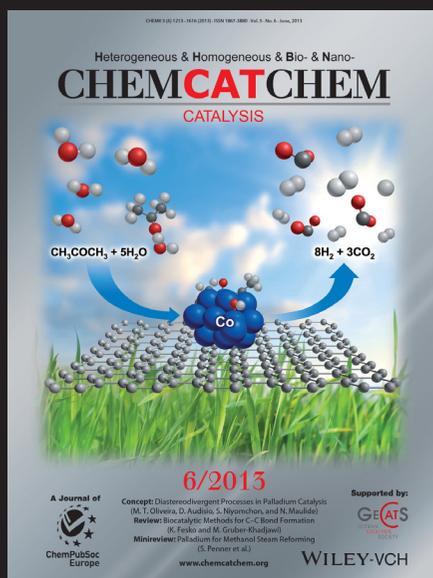
Catalyst Synthesis and Screening. This includes high-throughput parallel processes for synthesizing and testing new catalysts.

Catalyst Characterization. EMSL, the Environmental Molecular Sciences Laboratory, contains a premier collection of state-of-the-art characterization tools that help us understand catalyst properties so we can improve catalyst effectiveness and durability. These include multiple thermal analyses (DTA, TGA and DSC, some with evolved gas analysis capability), scanning and transmission electron microscopy, and the following types of spectroscopy: surface (XPS, AES, Auger, HREELS, AFM, RAMAN, FTIR), nuclear magnetic resonance (multiple liquid and solid MAS at 300-900 MHz), Mössbauer, and electron paramagnetic resonance.

Computational Chemistry. Using supercomputers and PNNL's unique high-performance software, NWChem, researchers apply computational chemistry, solid state physics, and materials science to design new, improved catalytic materials. By combining computation with experimentation and characterization, we are able to design faster, more selective and robust catalysts.

Reactors. PNNL employs a full complement of continuous flow reactors ranging from 10 cc to 20 L that can operate at high or low pressure and temperatures. We use these reactors to screen catalysts, develop process conditions, and perform long-term catalyst life studies. At the bench scale, PNNL has both fixed bed and moving bed systems—fluidized and ebullating beds. These tools allow us to make sufficient quantities of fuels and products for testing and generate data for technoeconomic and life cycle analysis.

impacts



WHY CATALYSIS AT PNNL?

The Institute for Integrated Catalysis (IIC) at PNNL facilitates collaborative research and development in catalysts for a secure energy future. PNNL's efforts tie basic science to industrial solutions and our work has been recognized by numerous awards, including being named a finalist for the Kirkpatrick Chemical Engineering Achievement Award, an award that honors the most noteworthy chemical engineering technology commercialized worldwide each year. The IIC is led by Johannes Lercher, who is internationally renowned for his work on industrially relevant reactions.



DELIVERING IMPACT

With an emphasis on deploying solutions to the marketplace, PNNL and its partners are working to improve and expand the use of cost-effective, low-carbon fuels and chemicals. Our research and development includes:

- » PNNL's *Propylene Glycol from Renewable Sources Process* is now being used at an Archer Daniels Midland processing facility in Illinois, constructed specifically for use with the PNNL process. This PNNL-developed process provides an environmentally friendly, cost competitive alternative to petroleum for producing propylene glycol, a chemical widely used in consumer products. It was awarded an R&D 100 Award in 2010 and a Federal Laboratory Consortium Award for Technology Transfer in 2011.
- » PNNL's expertise in pyrolysis is reflected in a 2009 partnership with UOP, Boeing, DOE's Biomass Program and others that achieved a unique milestone: Upgraded pyrolysis oil was used in combination with synthetic paraffinic kerosene to produce 100-percent jet fuel derived from biomass. The fuel was demonstrated in a hydroplane at Seattle's Seafair race.
- » PNNL, in collaboration with Imperium Aviation Fuels and LanzaTech, is advancing biotechnology and catalytic processes for converting biomass-based alcohols to a fuel that can be blended with traditional jet fuel.

John Holladay
(509) 375-2025
john.holladay@pnnl.gov

Rick Orth
(509) 375-6709
rick.orth@pnnl.gov

Chemical and Biological Process Development

Pacific Northwest National Laboratory
P.O. Box 999, MSIN P8-60
Richland, WA 99352



Proudly Operated by **Battelle** Since 1965



ABOUT BSEL

The Bioproducts, Sciences, and Engineering Laboratory (BSEL) is a multipurpose R&D facility that includes:

- » Modern laboratories for fungal strain and bioprocess development and optimization
- » 2,500-square-foot high-bay for technology scale up
- » Analytical chemistry lab equipped with a wide array of analytical instruments.

COLLABORATIONS

PNNL collaborates with multiple industrial partners to keep its research relevant to the needs of industry and to facilitate technology transfer to the public domain. We also have major leadership roles in the Joint BioEnergy Institute (JBEI), DOE's National Advanced Biofuels Consortium (NABC) and National Alliance for Advanced Biofuels (NAABB). We partner with world-class regional, national and international universities and have active collaborations with other national laboratories.

ABOUT IIC

Research activities at PNNL's Institute for Integrated Catalysis and affiliated efforts are greatly advancing our ability to control chemical transformations and chemical-electrical energy inter-conversions to create a sustainable global energy system. To learn more about the IIC, visit <http://iic.pnnl.gov/>.

ABOUT EMSL

EMSL, the Environmental Molecular Sciences Laboratory, is a U.S. Department of Energy national scientific user facility located at PNNL. EMSL provides integrated experimental and computational resources for discovery and technological innovations. To learn more about the science conducted at EMSL as well as the instruments and expertise available to users, visit <http://www.emsl.pnnl.gov/>.

ABOUT PNNL

PNNL's biomass conversion work is an important element in a wider portfolio of research and development funded by the U.S. Department of Energy, other federal agencies and the private sector. PNNL is a DOE Office of Science National Laboratory where interdisciplinary teams advance science and technology and deliver solutions to America's most intractable problems in energy, national security and the environment. To learn more about PNNL, visit <http://www.pnnl.gov/>.