NREL
NATIONAL RENEWABLE ENERGY LABORATORY

NATIONAL
BIOENERGY CENTER

R&D WITH NREL'S **FUEL SYNTHESIS CATALYSIS LABORATORY (FSCL)**

CORE CAPABILITIES AND APPLICATIONS

The FSCL is a purpose-built facility designed for evaluating the performance of heterogeneous catalysts in converting biomass intermediates and waste streams into chemicals and fuels.

NREL researchers use a variety of reactor systems, customized for the challenges of bio-intermediate upgrading, to test a wide array of catalysts and process conditions. The reactor systems were designed for customizable feed mixtures that can be preheated and pressure controlled over a large range of pressures, as well as provide direct online sample analysis and liquid product isolation and collection. Full process automation allows for continuous operation up to thousands of hours, full product analysis, and logging of process conditions.

The FSCL team works closely with catalyst design, advanced characterization, and fuel analysis teams to derive the greatest value from every experiment.

Product analysis is achieved through online and offline techniques:

- Chromatography and mass spectrometry
- Nuclear magnetic resonance
- High-performance liquid chromatography
- Scanning electron microscopy with X-ray microanalysis
- Transmission electron microscopy
- X-ray diffraction
- UV-visible, infrared, and Raman spectroscopies.

Top Photo: An NREL researcher loads catalyst into a reactor tube in the FSCL. *Photo by Dennis Schroeder, NREL 51105*

CATALYST SCREENING AND PERFORMANCE EVALUATION

The FSCL includes six unique, custom—and customizable—reactor stations. Meeting rigorous safety standards and using state-of-the-art hardware, NREL researchers find the optimal catalysts and conditions to produce energy-dense renewable fuels that seamlessly blend into traditional transportation systems.

KINETIC MODEL DEVELOPMENT

The FSCL's reactors are designed to minimize temperature and concentration gradients, providing the high-quality data needed for kinetic models. Our analytical tools provide rigorous and accurate product analyses across a broad range of chemical matrices.

COMPARE BOTTLED VERSUS REAL SYNGAS

Reactors in the FSCL can be operated with syngas produced on-site with an integrated gasification, reforming, and gas conditioning system. This provides an inexpensive way to test catalyst performance in the presence of impurities before investing in pilot-scale equipment and operations.

BRING YOUR OWN SYSTEM

The FSCL's reactor bays are equipped to handle new designs or customer-supplied equipment. Test equipment is designed for a broad range of catalysts and reactions and can be modified to meet special requirements. In-house developed, partner-supplied, and purchased catalysts can be tested across operating conditions that span 0 to 2,000 psig, room temperature to 1,800°F, permanent and condensable gases, liquids, and vaporizable solids.

RECENT SUCCESSES

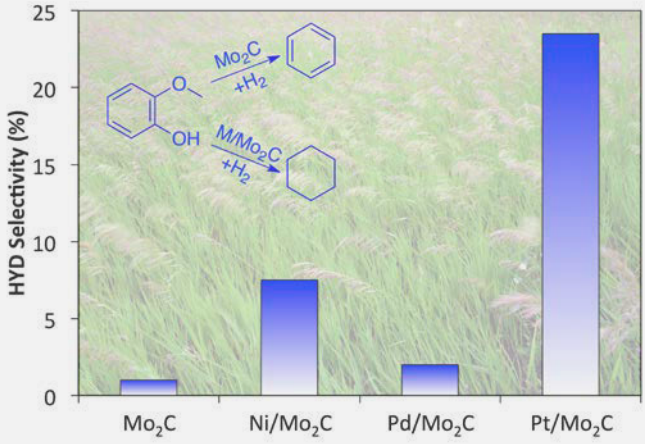
FSCL Testing and Upgrades Enhance Data Collection

NREL researchers recently completed an integrated gasification, reforming, gas cleanup, compression, and high octane gasoline synthesis project using FSCL reactors. More than 300 hours of continuous operation was logged, producing liquid gasoline samples for fuel performance testing. Additionally, upgrades were recently completed to allow FSCL researchers to control reactor systems with their mobile devices, further increasing the ability to collect high-quality data at all hours.

The FSCL lab manager adjusts operating conditions on a fixed-bed reactor system from his mobile device. *Photo by Dennis Schroeder, NREL 51047*

NREL Shows Path to Improved Catalyst Performance in Catalytic Fast Pyrolysis

The production of liquid hydrocarbon fuels via *ex situ* catalytic fast pyrolysis of biomass has potential as a cost-competitive alternative to fossil fuels, but because the process must operate at both low hydrogen pressure and high temperatures, bifunctional catalysts must be developed. In a recent paper, NREL researchers demonstrated that the addition of platinum and nickel to molybdenum carbide resulted in enhanced hydrogenation during the deoxygenation of guaiacol. These results suggest that deoxygenation and hydrogenation can be balanced to generate an improved product for downstream upgrading.



FSCL reactors enable evaluation of multifunctional catalysts under differential and integral conditions with complex feed streams.

Highlighted Publications

F. Baddour, et al. "Late-Transition-Metal-Modified β-Mo_2C Catalysts for Enhanced Hydrogenation during Guaiacol Deoxygenation." *ACS Sustainable Chemistry & Engineering.* DOI: 10.1021/acssuschemeng.7b02544.

C. Farberow, et al. "Exploring Low-Temperature Dehydrogenation at Ionic Cu Sites in Beta Zeolite to Enable Alkane Recycle in Dimethyl Ether Homologation." *ACS Catalysis.* DOI: 10.1021/acscatal.6b03582.

M. Griffin, et al. "An Investigation into Support Cooperativity for the Deoxygenation of Guaiacol over Nanoparticle Ni and Rh_2P." *Catalysis Science & Technology.* DOI: 10.1039/C7CY00261K.

Find Out More

For more information and collaboration opportunities, contact:

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