NREL
NATIONAL RENEWABLE ENERGY LABORATORY

Biomass Compositional Analysis Laboratory

Providing detailed and accurate characterization of the chemical composition of biomass feedstocks, intermediates, and products

NREL's compositional analysis team provides summative analyses of biomass and biomass-derived products for biorefinery applications.
Photo by Dennis Schroeder, NREL/PIX 19385

At the Biomass Compositional Analysis Laboratory, NREL scientists develop, refine, and validate analytical methods to determine the chemical composition of biomass samples before, during, and after conversion processing.

These high-quality compositional analysis data are used to determine feedstock compositions as well as mass balances and product yields from conversion processes.

Compositional analysis scientists provide:

- Customized analytical method development for feedstocks and process intermediates
- Publicly available Laboratory Analytical Procedures (LAPs) that are used worldwide
- Training classes on biomass analysis and method development, developed for national and international industrial and academic partners
- Comprehensive biomass analysis results backed by 20 years of experience supporting the biomass conversion industry.

Compositional analysis scientists have experience with a broad range of biomass types:

- Herbaceous and woody feedstocks including hardwoods, softwoods, agricultural residues, and dedicated energy crops
- Process samples from dilute-acid, neutral, and alkaline pretreatment, enzymatic hydrolysis, and fermentation processes
- Microalgal biomass.

Compositional Analysis Personnel and Facilities	
Personnel	A team of 15 highly-skilled and experienced scientists familiar with all biomass types
Facilities	Three specialized laboratories with dedicated biomass processing and analytical equipment
Processing and Analytical Equipment	Soxhlet and automated solvent extraction
	HPLC with various detectors (15)
	UHPLC (2)
	LC/QTOF MS
	LC/ion trap MS
	UV/VIS spectrometers (4)
	GC/FID (2)
	GC/quadrupole MS (2)
	NIR spectrometers (5)

NREL is a national laboratory of the U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, operated by the Alliance for Sustainable Energy, LLC.

Biomass Compositional Analysis Procedures

Summative laboratory analytical procedures (LAPs)

- Procedures for solid samples to measure structural carbohydrates (glucose, xylose, galactose, arabinose, and mannose), lignin, extractable materials, protein, and ash
- Procedures for liquid samples to measure oligomeric and monomeric carbohydrates, lignin, and byproducts including organic acids and sugar degradation products
- All LAPs (as well as spreadsheets to facilitate calculations) are publicly available at http://www.nrel.gov/biomass/analytical_procedures.html
- Several LAPs have been adapted by ASTM International and are used and referenced by researchers worldwide
- Researchers offer standard and customized training classes to help companies and institutions rapidly improve their analytical results.

Rapid analysis methods

- Scientists use near-infrared (NIR) spectroscopy coupled with multivariate statistics to produce calibration models for several different biomass types, including feedstocks (corn stover, sorghum, miscanthus) and pretreated materials (solids, liquids, and slurries)
- These models dramatically decrease the time required for (and the cost of) routine compositional analyses
- NREL scientists work with clients to develop, implement, and support custom rapid analysis methods for specific applications.

Knowing the chemical composition of biomass, like this corn stover, is essential for improving biofuel conversion processes. *Photo by Patrick Corkery, NREL/PIX 15647*

Associated publications

Sluiter, J.B., et al. (2010). "Compositional Analysis of Lignocellulosic Feedstocks. 1. Review and Description of Methods." *J. Ag. Food Chem.* (58:16); pp. 9043-9053.

Templeton, D.W., et al. (2010). "Compositional Analysis of Lignocellulosic Feedstocks. 2. Method Uncertainties." *J. Ag. Food Chem.* (58:16); pp. 9054-9062.

Scarlata, C.J.; Hyman, D.A. (2010). "Development and Validation of a Fast High Pressure Liquid Chromatography Method for the Analysis of Lignocellulosic Biomass Hydrolysis and Fermentation Products." *J. Chromatogr. A* (1217:14); pp. 2082-2087.

Wolfrum, E.; Sluiter, A. (2009). "Improved Multivariate Calibration Models for Corn Stover Feedstock and Dilute-Acid Pretreated Corn Stover." *Cellulose* (16:4); pp. 567-576.

Wolfrum, E., et al. (2009). "Correlating Detergent Fiber Analysis and Dietary Fiber Analysis Data for Corn Stover Collected by NIRS." *Cellulose* (16:4); pp. 577-585.

Templeton, D.W., et al. (2009) "Assessing Corn Stover Composition and Sources of Variability via NIRS." *Cellulose* (16:4), pp. 621-639.

For more information, contact:

Ed Wolfrum, 303-384-7705, Ed.Wolfrum@nrel.gov

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National Renewable Energy Laboratory
15013 Denver West Parkway, Golden, Colorado 80401
303-275-3000 • www.nrel.gov

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