NREL NATIONAL RENEWABLE ENERGY LABORATORY | NATIONAL BIOENERGY CENTER

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 19385

At the Biomass Compositional Analysis Laboratory, NREL scientists have more than 20 years of experience supporting the biomass conversion industry.

They 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 Personnel and Facilities

- A team of highly skilled and experienced scientists familiar with a wide variety of biomass types
- Three specialized laboratories with dedicated biomass processing and analytical equipment
- Processing and analytical equipment includes: HPLC with various detectors, UHPLC, LC/QTOF MS, LC/ion trap MS, UV/Vis spectrometers, GC/FID, GC/quadrupole MS, and NIR spectrometers.

Compositional Analysis Service Capabilities

Analytical Methods	Publicly available Laboratory Analytical Procedures (LAPs) that are used worldwide
	Customized method development for feedstocks and process intermediates
Training	Custom tailored training on biomass analysis and method development
Compositional Analysis	Comprehensive wet chemical biomass analysis results for feedstocks and process intermediates
	NIR rapid calibration models predictions of chemical composition for a variety of feedstocks and process intermediates
	NIR rapid calibration models available for license and customization
	Advanced chromatography techniques for determination of lignin degradation products found in hydrolysates

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Biomass Compositional Analysis Procedures

Summative Laboratory Analytical Procedures

- 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 adopted 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.

Preparing biomass for rapid NIR compositional analysis. Knowing the chemical composition of biomass is essential for biofuel conversion processes. *Photo by Dennis Schroeder, NREL 26563*

Relevant publications

Sluiter, A.; Wolfrum, E. (2013). "Near infrared calibration models for pre-treated corn stover slurry solids, isolated and in situ." *Journal of Near Infrared Spectroscopy* (21:4); pp. 249.

Wolfrum, E.J.; Ness, R.M.; Nagle, N.J.; Peterson, D.J.; Scarlata, C.J. (2013). "A laboratory-scale pretreatment and hydrolysis assay for determination of reactivity in cellulosic biomass feedstocks." *Biotechnology for Biofuels* (6:1); pp. 162.

Laurens, L.M.L.; Wolfrum, E.J. (2013). "High-Throughput Quantitative Biochemical Characterization of Algal Biomass by NIR Spectroscopy; Multiple Linear Regression and Multivariate Linear Regression Analysis." *J. Agric. Food Chem.* (61:50); pp. 12307-14.

Sluiter, A.; Sluiter, J.; Wolfrum, E.J. (2013). "Methods for Biomass Compositional Analysis, in Catalysis for the Conversion of Biomass and Its Derivatives." M.a.A.D. Behrens, Ed. Berlin, Germany: *Max Planck Research Library for the History and Development of Knowledge, Proceedings 2* pp. 213-254.

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.

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.

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