

NREL Breaks New Ground in Plant Pretreatment for Biofuels

Highlights in
Science

NREL researchers use imaging technologies to broaden knowledge of plant cell wall structures and identify ideal pretreatment of plant material.

Scientists at the U.S. Department of Energy's National Renewable Energy Laboratory (NREL) and BioEnergy Science Center combined different microscopic imaging methods to gain a greater understanding of the relationships between biomass cell wall structure and enzyme digestibility. This breakthrough could lead to optimizing sugar yields and lowering the costs of making biofuels.

Using the new approach, NREL researchers discovered the localization of the enzymes responsible for deconstruction of the cell wall polymers and the effects of enzyme action on the cell wall. Unlike traditional composition analysis, the new methods allow access to the plants' polymeric carbohydrate structures without damaging the nanoscale architectures from which they are constructed. Such damage limits research.

In addition, the NREL team assessed the impact of lignin removal on biomass hydrolysis and viewed nanometer-scale changes in cell wall structures. The scientists found that the poly-aromatic non-sugar lignin in plants interferes with enzymes' ability to access the polysaccharides in the cell wall. This interference can inhibit sugar yields.

The team concluded that the ideal pretreatment of cell walls should focus on eliminating the lignin while leaving the structural polysaccharides within the cell walls intact. Such pre-treatment would leave a structure that allows easy access by the enzymes and rapid digestion of polysaccharides.

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Reference: Ding, S.-Y.; Liu, Y.-S.; Zeng, Y.; Himmel, M.E.; Baker, J.O.; Bayer, E.A. (2012). "How does nanoscale architecture correlate with enzymatic digestibility?" *Science* 338, pp. 1055–1060.



NREL author and researcher Shi-You Ding uses an atomic force microscope to image biomass and its enzymatic hydrolysis in real time.

Photo by Pat Corkery, NREL 15631

Key Research Results

Achievement

Scientists at NREL, along with collaborating partners, successfully combined different imaging methods to view the architecture of plant cell walls and the localization of enzymes key to deconstruction of cell wall polymers, which provide new insights into cost-effective biofuels production from biomass.

Key Result

Pretreatment of biomass during biofuels production should maximize lignin removal and minimize polysaccharide modification, retaining the native-like structure. This structure allows easy access by enzymes to polysaccharides and their rapid digestion.

Potential Impact

By observing where cellulase enzymes are localized and the nanostructural changes in the plant cell wall architecture that their actions produce, new strategies can be suggested for more cost-effective pretreatments and better enzymes for the production of biofuels.

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.

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