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Biomass Program

Biochemical R&D

Targeted Conversion Research

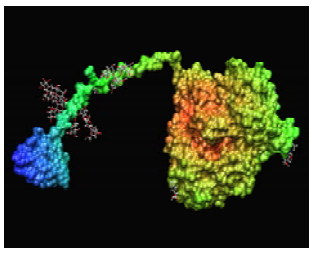
A key technical barrier to the attainment of OBP's 2012 ethanol cost goals is the high cost and relative inefficiency of producing fermentable sugars from lignocellulosic biomass. This project is designed to extend our understanding of pretreatment and enzymatic saccharification reactions beyond the engineering level, to the cellular and molecular scale. Such enhanced knowledge of chemical and biological biomass conversion science will directly support process unit engineering conducted in parallel.

In order to increase the rate and yields of sugars from lignocellulosic biomass, a better understanding of the physical-chemical nature of the interaction of enzymes with plant cell walls modified by dilute acid chemical reactions is necessary. For example, the migration of lignin during and following pretreatment is a concern for enzyme efficiency. Researchers will work to define the impact of this condition and seek ways to mitigate the effects of re-precipitated lignin on biomass saccharification. Furthermore, chemical reactions leading to the production of sugar degradation products are largely unstudied and will be another area of focus for this project.

Hemicellulose (HC) solubilization increases the accessibility of cell wall cellulose to cellulase action. However, during dilute acid pretreatment, HC is released in a multi-phasic process. The slow down of HC release results in longer pretreatment residence times and thus more degradation product formation. Researchers are thus working to determine the structural and chemical basis for HC release so that improvements in pretreatment can be made. Finally, understanding how cellulases interact with the cellulosic substrates within lignocellulosic biomass is critical for developing an enzyme system that can efficiently convert biomass to sugars.

R&D Pathway

This project will employ integrated computer modeling and experimental studies to increase our understanding of the chemical and structural changes that occur in biomass during thermochemical pretreatment and subsequent enzyme saccharification. This combined approach will be applied to: 1) sugar degradation reactions occurring in pretreatment hydrolysates, 2) cellulase structure/function problems, and 3) the structure of the cell wall microfibrils. Advanced surface analysis tools will be used to study biomass and the enzymes that act upon it. A laboratory dedicated to biomass surface characterization (BSCL) has been created to support this work.



CBH I cellulase from *T. reesei* is the subject of protein engineering studies

Benefits

- **Enhance understanding of the interaction mechanisms of dilute acids and enzymes with energy plant cell walls**
- **Enable a substantial reduction in pretreatment cost**
- **Reduce sugar loss from acid degradation reactions**

Applications

Coordinating studies that address pretreatment chemistries and cellulase mechanisms have the potential to substantially reduce sugar costs.

Project Participants

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Project Period

FY 2003 – FY 2010

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