A comparison of the changes occurring in the supramolecular and ultrastructure of cellulose fiber wall during dilute acid pretreatment for poplar and switchgrass

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Introduction

Solid state nuclear magnetic resonance (NMR) methods can provide not only chemical information but atomistic structural details that are not easily accessible by other non-destructive high-resolution structural techniques. This makes solid state NMR methodology particular useful when studying structural problems in biological systems such as the changes occurring in the ultrastructure and supramolecular structure of biomass. The objective is to understand the mechanisms of recalcitrance and effect of dilute acid pretreatments on recalcitrance and the downstream processing of biomass by analysis of the changes in supramolecular structure upon pretreatment.

Pretreatment can govern:
- Accessibility of cellulose and hemicellulose
- Degree of crystallinity
- Relative % cellulose allomorphs
- Degree of acetylation
- Lignin and hemicellulose distributions
- Pore distributions
- Sugar yields

Results and Discussion

Ultrastructural changes occurring during pretreatment:
- Increase in % Crystallinity
- Increase in LFA and LFAD
- Increase in % Para-crystalline cellulose
- Increase in % Ig cellulose
- Decrease in % Ig cellulose

Suggesting either hydrolysis localized in amorphous regions or crystallite growth occurs

Conclusions

Carbohydrate and GPC
- Pretreatment removes the majority of the hemicellulose within 2 min.
- Pretreatment is fairly ineffective at lignin removal.
- GPC and sugar analysis indicate that pretreatment beyond 5 min leads to cellulose degradation.
- GPC suggest crystallinity increases is impart due to spatially localized hydrolysis in the amorphous regions.

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