Splitting Apart Cellulose Microfibrils
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Project Overview

This project involves isolating cellulose microfibrils from native source (wood pulp), characterizing the microfibrils in terms of shape, dimensions and supramolecular structure, probing the microfibril delamination mechanism, providing experimental evidence in the hope of contributing to the fundamental understanding of the native cellulose structure at the supramolecular level.

- Isolation process-- oxidation and sonication
- Characterization of dimension and crystallinity-- AFM and XRD
- Characterization at supramolecular level-- Raman and FTIR
- Discussion on microfibril cross section model and delamination mechanism

Results and Discussion

Atomic Force Microscopy

X-ray Diffraction

FTIR Spectroscopy

Dimensions of Cellulose Nanocrystals from Various Sources

<table>
<thead>
<tr>
<th>Cellulose type</th>
<th>length</th>
<th>cross section</th>
</tr>
</thead>
<tbody>
<tr>
<td>tunicate*</td>
<td>100 nm – several μm</td>
<td>10 – 20 nm</td>
</tr>
<tr>
<td>bacterial*</td>
<td>100 nm – several μm</td>
<td>5 – 10 nm by 30 – 50 nm</td>
</tr>
<tr>
<td>algal (Valonia)</td>
<td>&gt; 1000 nm</td>
<td>10 to 20 nm</td>
</tr>
<tr>
<td>cotton*</td>
<td>200 – 350 nm</td>
<td>5 nm</td>
</tr>
<tr>
<td>wood*</td>
<td>100 – 300 nm</td>
<td>3 – 5 mm diameter</td>
</tr>
</tbody>
</table>

Effect of reaction conditions on the properties and behavior of wood cellulose nanocrystal suspensions. Endnotes
- Beck-Candanedo, Maren Roman, and Derek G. Gray, Biomacromolecules 2005 6(2), 1052-1054

Experimental Procedure

- TEMPO-mediated oxidation of cellulose
- Sonication at different time levels

Characterization with AFM, XRD, Raman and FTIR

Summary

- Oxidation followed by intense sonication can produce monolayer cellulose sheets; the dimension is a function of sonication time.
- Cellulose microfibrils are split apart preferentially along (200) planes, evidence is from AFM, XRD, Raman, and FTIR.
- Microfibril delamination mechanism proposed.

Note: a manuscript is prepared by Li and Renneckar based on the result from this project.

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