

The Study of Plant Cell Wall Using Atomic Force Microscopy

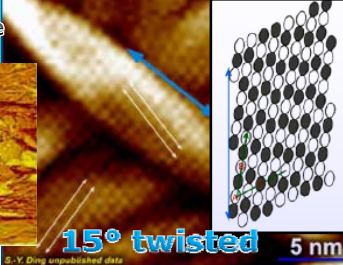
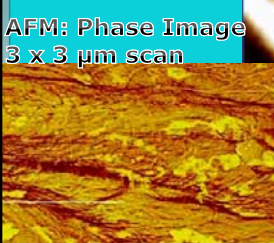
M.S. Proposal
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Graduate Seminar
Wednesday 19, November
12.20 – 1.10 pm
Room 160 PBB © Institute of Food Research

Introduction and Justification

"Thought is impossible without an image." –Aristotle, 325 B.C.

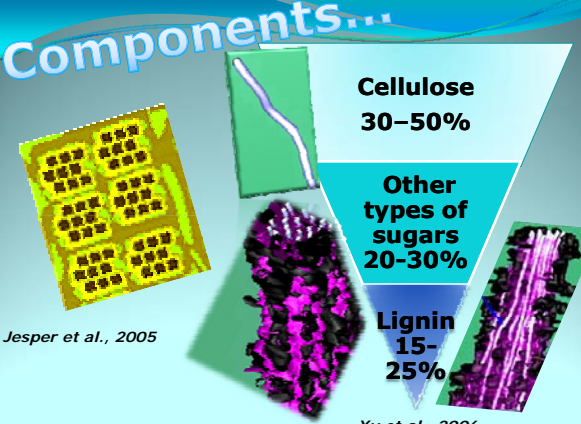
AFM: Phase Image
3 x 3 μm scan



15° twisted 5 nm

Pereira et al., 2001
S.Y. Ding unpublished data

Components...



Cellulose
30–50%

Other types of sugars
20–30%

Lignin
15–25%

Jesper et al., 2005
Xu et al., 2006

Dicotyledonous vs Monocotyledonous Plants


- **Type I:** all dicots and many monocots cellulose microfibrils crosslinked with xylogucans
- **Type II:** grasses and related monocots glucuronoarabinoxylans (GAXs) are the major crosslinking glycans

McCann et al., 2008

Cellulose

1. The size and its organization
2. The density
3. Interactions between cellulose microfibrils and the lignin-hemicellulose matrix.

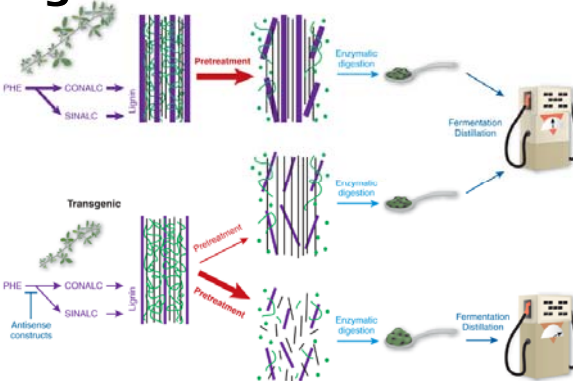
amorphous



crystalline

David et al.,

Lignin

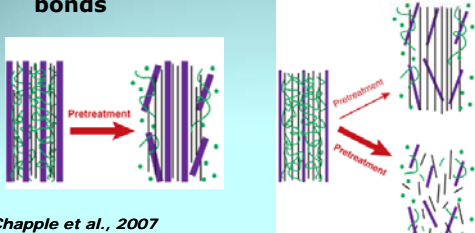


Chapple et al., 2007

Pretreatments

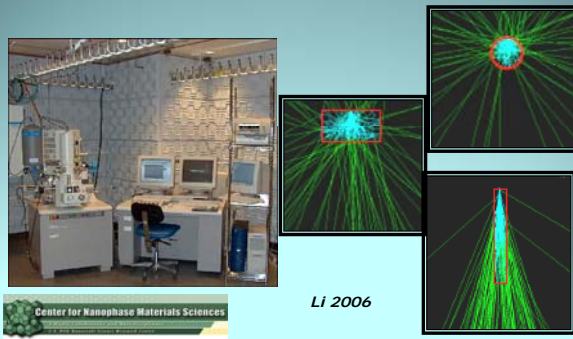
- Chemical
- Biological
- Physical: Electron beam

*change several chemicals and molecular bonds



Chapple et al., 2007

Electron microscope?



Center for Nanophase Materials Sciences

Li 2006

Why Atomic Force Microscopy?

- Light microscope?
 - *nanophase materials
- SEM or TEM?
 - *radiation damage from electron

Objectives


- To quantify the effect of electron beam to anatomical and chemical structure of plant cell walls using atomic force microscopy
- To study the interaction between samples and electron beam

Materials and Methods

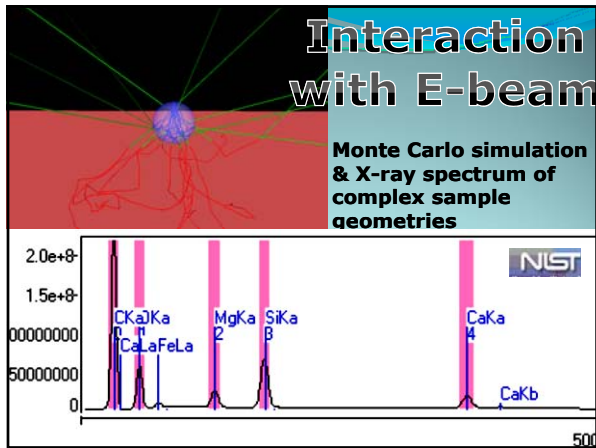
- **Sample Preparation**
 - southern yellow pine
 - yellow poplar
 - switchgrass
 - lignin
 - cellulose
- **Image Processing**
- **Image Analysis**

Pretreatments

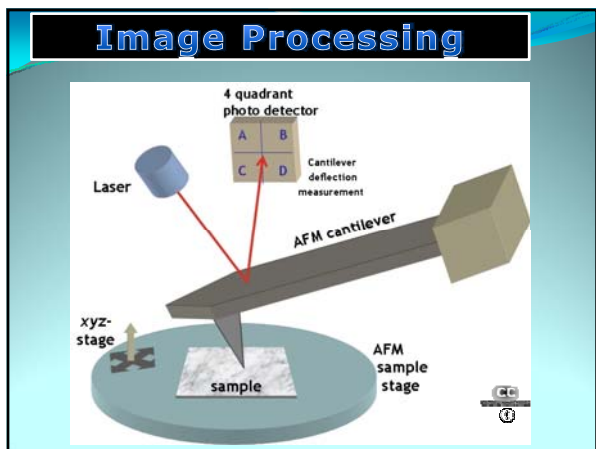
- **Physical pretreatment using electron beam**
- **9 energy levels: 3 of low, medium and high**
 - Using both electron microscope and

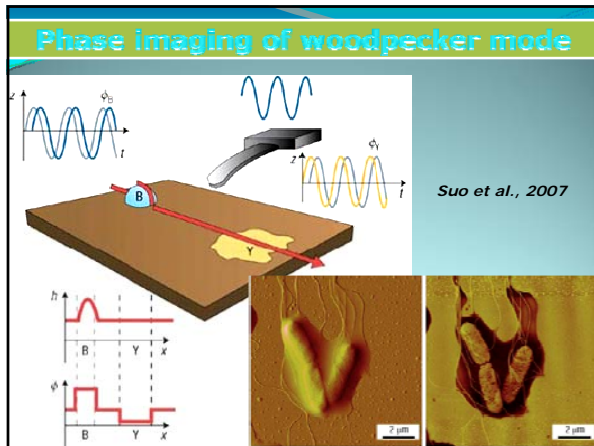


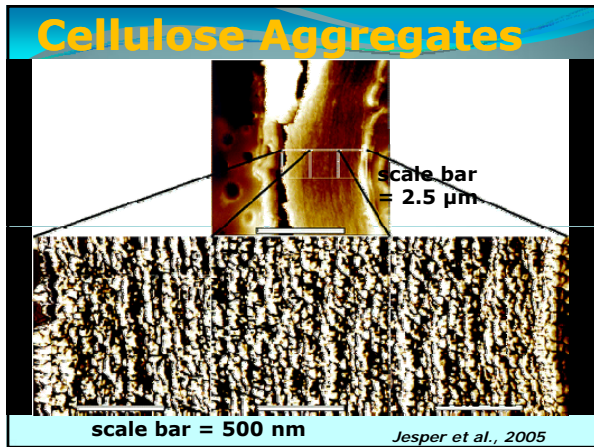
Sterilization Alternatives
Electron Beam Radiation





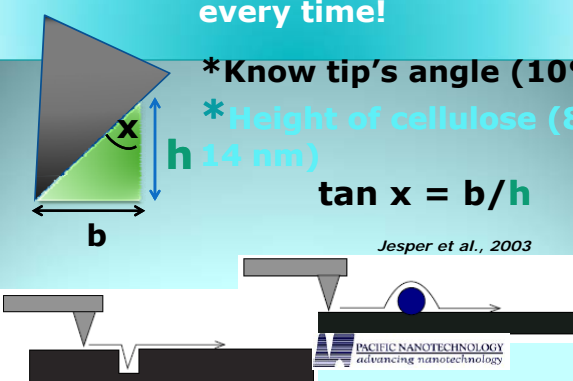








Measure the tip enhancement every time!

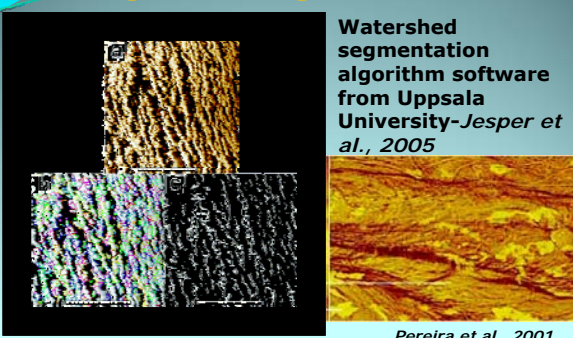


*** Know tip's angle (10°)**
*** Height of cellulose (814 nm)**
 $\tan x = b/h$

Jesper et al., 2003

PACIFIC NANOTECHNOLOGY
advancing nanotechnology

Image Analysis...



Watershed segmentation algorithm software from Uppsala University-Jesper et al., 2005

Pereira et al., 2001

Scion Products

Statistical Analysis

*** Factorial in CRD with sampling**

Mean of cellulose aggregate width (nm)

Mean of lignin area (nm)

All tests performed at $\alpha = 0.05$ using SAS® system

Acknowledgements

Asst. Prof. Dr. David P. Harper
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Distinguish. Prof. Dr. David C. Joy
Dr. Jaewoo Kim
Dr. John Dunlap
TFPC staffs



Questions ?

- Human hair is about 200 microns.
- A sheet of paper is one million Ångstroms thick.
- 1 nm = 10 Å = billionth of a meter

• Source: Under the microscope, William

Choi Young thesis

