The Study of Plant Cell Wall Using Atomic Force Microscopy
M.S. Proposal
Jelena Kitisgege
M.S. Candidate
Dept. of Forestry, Wildlife and Fisheries
Graduate Seminar
Wednesday 19, November
12.20 – 1.10 pm
Room 160 PBB

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

Components...

Cellulose
30–50%

Other types of sugars
20–30%

Lignin
15–25%

© Institute of Food Research

Pereira et al., 2001

Jesper et al., 2005

Xu et al., 2006
**Dicotyledonous vs Monocotyledonous Plants**

- **Type I**: all dicots and many monocots cellulosic microfibrils crosslinked with xylotetrarotyranoses
- **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.

*David et al., 2007*

**Lignin**

*Chapple et al., 2007*
**Pretreatments**
- Chemical
- Biological
- Physical: Electron beam
  *change several chemicals and molecular bonds

---

**Electron microscope?**

---

**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
Monte Carlo simulation & X-ray spectrum of complex sample geometries

Sample Preparation

- Embedding in Epoxy resin
- Polishing: Zimmermann et al., 2006

Image Processing
Measure the tip enhancement every time!

*Know tip’s angle (10°)
*Height of cellulose (8–14 nm)

\[ \tan x = \frac{b}{h} \]

Jesper et al., 2003

---

Image Analysis...

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

Pereira et al., 2001

---

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
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

Fig 33: Signal generated from electron-solid interaction.