

**Special Topics in Organic Chemistry**  
**8833A Pulping and Bleaching Chemistry**  
**Fall 2005**

**Instructor:** Art. J. Ragauskas, Institute of Paper Science and Technology Building 500  
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**Course Description:** This course focuses on developing an understanding of the fundamental chemistry associated with pulping and bleaching of wood. The subject material encompasses: (1) the detailed analysis of the chemical structure of the major wood components, (2) the nature and scope of the reactions of pulping and bleaching reagents with typical carbohydrate and lignin functional groups, and (3) the underlying factors which explain differences in the degree of lignin vs. carbohydrate degradation during pulping and bleaching stages. The focus is on alkaline/NaSH pulping and ClO<sub>2</sub>, H<sub>2</sub>O<sub>2</sub>, O<sub>2</sub>/NaOH, O<sub>3</sub> bleaching chemistry of chemical and H<sub>2</sub>O<sub>2</sub> bleaching mechanical pulps.

**Course Objectives:**

1. To provide a fundamental understanding of the chemical components present in wood and their relationship to modern pulping, bleaching and biorefinery principles.
2. To develop an advanced understanding of chemical mechanisms involved in the modern pulping, delignification, and chromophore removal reactions.

**Course Outline:**

Wood component structures

Lignin

- Basic structures in wood
- Structural dependency on wood species

Cellulose/Hemicellulose

- Structure (crystalline and amorphous, polymorphs of cellulose)
- Reactivity under acidic and basic conditions

Extractives

- Structures
- Tall Oil Production

Chemistry of Pulping

Lignin reactions during chemical and mechanical pulping

- Depolymerization reactions
- Condensation reactions

Carbohydrate reactions

- Peeling and stopping reactions
- Formation and hydrolysis of hexenuronic acids
- Formation of lignin-carbohydrate complexes.

#### Chemistry of Bleaching and Biorefinery

Reactivity of lignin and carbohydrates with

- Chlorine-containing reagents (i.e., Cl<sub>2</sub> and ClO<sub>2</sub>)
- Oxygen-based reagents (i.e. H<sub>2</sub>O<sub>2</sub>, O<sub>2</sub>/NaOH, activated peroxide and O<sub>3</sub>)
- Biobleaching

#### Course Format:

The course is taught in a seminar style by the professor and students. Literature articles will be assigned for reading and will be reviewed at class meetings. Students will be assigned course topics for which they will research the literature and present their findings to the class in an oral and written report.

#### Course Grading:

Midterm Exam:	20%
Term Paper/Presentation:	30%
Presentation/Review:	30%
Final Exam:	20%

#### Reference Texts:

1. Sjoestrom, Eero. **Wood Chemistry: Fundamentals and Applications, 2nd Edition.**
2. Dence, Carlton W.; Reeve, Douglas W.; Editors. **Pulp Bleaching: Principles and Practice.** (1996),
3. Hon, David N.-S.; Shiraishi, Nobuo; Editors. **Wood and Cellulosic Chemistry, Second Edition.** (2001),
4. Fengel, Dietrich; Wegener, Gerd. **Wood: Chemistry, Ultrastructure, Reactions.** (1988),

#### Principal Journals:

Carbohydrate Research, Cellulose, Carbohydrate Polymers, Can. J. Chem., Holzforschung, J. Wood Chem. Technol., Angew. Chem. Int. Ed. Engl., Ind. Eng. Chem. Res., Nord. Pulp Pap. Res. J., Acta Chem. Scand., J. Pulp Paper Science, Tetrahedron Letters., Enzyme Microb. Tech.

## **Class Schedule**

<u>Week</u>	<u>Topics</u>
August 23th 25 <sup>th</sup> (5:00 – 7:00pm)	Introduction Lignin Structure
September 1	Lignin Structure
September 8	Cellulose Structure
September 15	Hemicellulose Structure
September 22	Wood Extractives Kraft Pulping – Lignin Chemistry
September 29	Kraft Pulping – Lignin Chemistry
October 6	Kraft Pulping – Lignin Chemistry Mechanical Pulping - Mechanochemistry
October 13	Kraft Pulping – Carbohydrate Chemistry
October 20	Kraft Pulping – Carbohydrate Chemistry
October 27	Review and Exam
Student Presentations	
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November 3rd	Oxygen Delignification Bleaching Chemistry
November 10 <sup>th</sup>	Ozone Bleaching Chemistry
November 17 <sup>th</sup>	Chlorine Dioxide – Chlorine Bleaching Chemistry
November 24 <sup>th</sup> –Turkey:Holiday	
December 1 <sup>st</sup>	Hydrogen Peroxide Bleaching Chemistry
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December 8 <sup>th</sup>	Biobleaching/Review
December 12-16 <sup>th</sup>	Final Exam Week