Aalto University
School of Chemical
Technology

CHEM-E2140 Cellulose-based fibres, 5 cr

Eero Kontturi
Department of Bioproducts and Biosystems
School of Chemical Engineering

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Learning outcome

After this course, the student will be able to

- Tell the physical and chemical distinctions between natural fibres, regenerated fibres, and nanofibres
- Describe the basic structures, properties and functions of common hemicelluloses and lignins
- Master the morphology of the native cellulose microfibril and acknowledge how it affects nanocellulose preparation and properties
- Detect the major obstacles and difficulties in cellulose dissolution and regeneration through basic laws of physical chemistry
- Explain the main pathways to chemical modification of cellulose
- Apply basic structure-property relationship to cellulose-based fibres and understand their implications in most common modern applications (excluding paper and board)

Novel uses for plant-based materials

Source of biofuels
- Involves breaking polysaccharides into monosaccharides

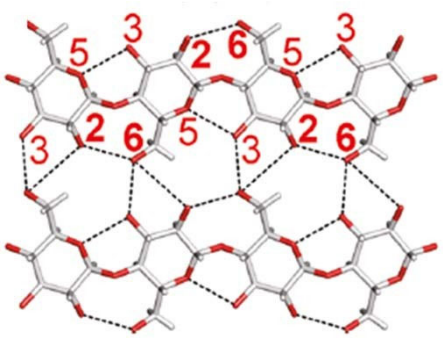
→ Fermentation into ethanol
(NOT dealt with during this course)

Source of commodity chemicals
- Small molecular compounds derived from polysaccharides/lignin

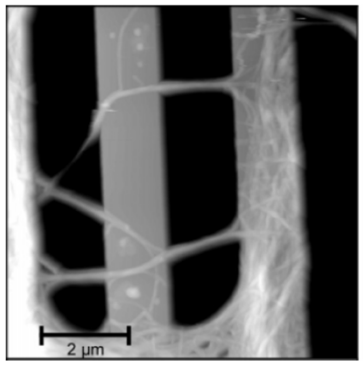
(NOT dealt with during this course)

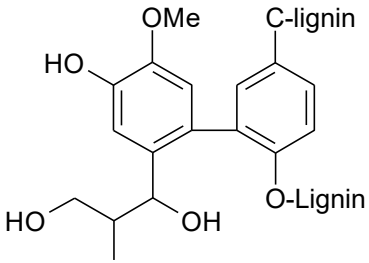
Source of (nano)materials
- Plastic surrogates
- New sources for textile fibres
- New uses for paper-based materials
- More sophisticated usage (biomedical, high level security etc.)

Course motivation



Profound, molecular level and nanoscale understanding is required to utilize the full potential of cellulose-based fibres and nanofibres





Course content

- 12 lectures during Period I (Tue 14-16; Thu 14-16, in Zoom)
- Oral examination (~ 1 h exam + 20 h preparation)
- Laboratory project with literature work (90 h; Period II), including:
  - Identifying the main research problem, writing the experimental plan (5 h)
  - Laboratory work for ca. 1.5 weeks (60 h)
  - Preparation of a report and seminar presentation (10 h)
  - Attending final seminar, giving a seminar presentation (5 h)

Lecture schedule

The backbone of the course is formed by 12 lectures:

(1) Plant fibres: cell wall structure and structure of cellulose (14th September)
(2) Cellulose morphology: the microfibril (16th September)
(3) Cellulose: dissolution (21st September)
(4) Cellulose: regeneration (Prof. Michael Hummel) (23rd September)
(5) Lignin: structure and properties (Prof. Mikhail Balakshin) (28th September)
(6) Cellulose: modification (30th September)
(7) Cellulose: regenerated fibres (5th October)
(8) Hemicellulose: structure and properties (7th October)
(9) Nanocellulose: preparation and modification (12th October)
(10) Nanocellulose: properties and characterization (14th October)
(11) Fibres and nanofibres: structure-property relationship (19th October)
(12) Modern applications of cellulose-based fibres and nanofibers (21st October)

Oral examination

- Based on the lecture material
- One student at a time
- Duration generally 45-60 minutes
- More discussion than a traditional exam with just questions and answers
- On average, students score much better in oral than in written exams

Oral exams will take place after the final lecture (15th October onwards); the dates and times will be agreed upon with each student individually

Laboratory project

- Performed in groups of 2 students
- Focused on a contemporary research topic
- Designed to include a concise body of laboratory work of ca. 60 hours (efficient working hours – it can take longer in the calendar)
- Outcome: a report and a seminar presentation

How the laboratory project proceeds

(1) Decide your group (find a pair for you)
(2) If you cannot find a pair, use the discussion forum on the course homepage
(3) Think about what kind of a general topic you would like to work on
(4) Browse through the topics on the course homepage and select one
(5) We agree on a topic and you will get background information on it
(6) Identify the main research problem and write a detailed experimental plan
(7) We agree on the plan and you get to work
(8) Perform the laboratory work and collect the results
(9) Write the report, including critical comparison with scientific literature
(10) Prepare the seminar presentation
(11) You give the final seminar presentation

About the laboratory project

- The working period is throughout Period II
- Effective working hours in the lab should be around 60 hours
- However, the time it takes to complete the lab work is generally much longer than two weeks
- It does not matter when you attend the laboratories but you must perform the required amount of work and collect the results well before the end of Period II – i.e., the lab work should be finished by the beginning of December, the latest

Topic selection for laboratory project

(1) Think about a general topic you would like to work on – examples:

- Cellulose reactions
- Cellulose nanofibres
- Cellulose nanocrystals
- Nanopaper (paper made of nanofibres)
- Hemicellulose (materials or chemistry)
- Lignin (materials or chemistry)
- Regeneration of cellulose (films / fibres)
- Dissolution of cellulose

(2) Topics will be published on MyCourses homepage later in September; if nothing suits you contact course coordinator (me: Eero Kontturi)

Note: You can also say: Just select any topic for me

Topic selection – important

Before the end of Exam Week (22nd October 2021), all groups must have their topics selected and the experimental plan accepted.

- In practice, this means that by the end of October, everyone should be aware of what to do and then you have the next month to perform the experiments according to your own (and your supervisor's schedules)
- Labwork should be finalized by Friday 3rd December

How it works after the topic selection

- Each group will be given a supervisor (PhD student or postdoc)
- He/she will give you literature and general advice on the selected topic
- You study the literature and work out an experimental plan
- You go to the lab and check what you need to perform the experiments
- Some of the analytical work may have to be performed by experts on a demonstration basis

Project report

- Contains
  - An introduction to the topic
  - A concise description of the experimental work
  - A summary of results with appropriate graphical representation
  - Discussion on the results, including *critical comparison to research on the same topic* (at least 4-5 literature references)
  - Conclusions

- Deadline for the project reports: Friday 10th December 2021

- Submission via Turnitin in the course homepage (MyCourses)

- More detailed instructions for the lab report will be sent to you during November

Seminar presentation

- Based on the report but must be presented in an approachable manner to other students in the course
- 15-20 minutes
- Presentations are given in a seminar that must be attended by all presenters throughout
- Seminar includes discussion after the presentation; be prepared to answer questions

- Seminar(s) take place in early December; dates will be agreed in a Doodle poll once the names of all attendees are known

Final grade from the course

50% - Oral examination from the whole course

50% - Laboratory project

Important dates – once more

- 22nd October: topic selected for the lab project
- 3rd December: experimental work completed
- 10th December: laboratory project report due
- Beginning of December: project seminar
- During October-November-December: oral examination (feasible also later)

Contact

Follow the updates on MyCourses webpages

Topics and supervision for the laboratory project work are available from me personally; do not hesitate to contact me

Any questions, please contact me:

Eero Kontturi
Office 327 (PUU 1)
Phone: +358 50 344 2978
email: eero.kontturi@aalto.fi