

an introduction to



GRADUATE SCHOOL



Intellectual Curiosity

Do you have an innate curiosity about the world around you?

Did your undergraduate experience leave you wanting to know more?

Do you like problem solving, discovering and learning new things?

Do you want to do something important for society?

Then graduate school could be the right option for your future. Earning a graduate degree requires completion of coursework and research leading to the thesis or dissertation. Your graduate committee will help you to develop a Plan of Study that details the required coursework and frames the body of your research project.





Why cellulose? The Future of Fiber

Cellulose is the most abundant naturally occurring organic molecule on the planet. It is renewable, sustainable, and recyclable. The thousands of potential uses for cellulose are still being discovered. Your research could help to unlock the potential of trees!





Pulp and Paper Science

For over one hundred years people have been studying paper science. In the early years, people knew how to make paper but didn't understand how hydrogen bonded the fibers together. Then scientists and engineers researched how to make paper faster and fine tune the process for specific products and uses. Today, there is still much to learn in pulp and paper science. Bioactive papers, microfluidics, printed electronics, and nanocellulose are a few of the fascinating new fields in the emerging field of functional papers.

- **Bioactive papers** – currently are paper-based sensors that can identify various contaminants in food and water or kill any pathogens that come in contact with the paper.
- **Microfluidics** – is a multidisciplinary field intersecting engineering, physics, chemistry, microtechnology and biotechnology, with practical applications to the design of systems in which such small volumes of fluids will be used. Microfluidics emerged in the beginning of the 1980s and is used in the development of inkjet printheads, DNA chips, lab-on-a-chip technology, micro-propulsion, and micro-thermal technologies.
- **Printed Electronics** – is a set of printing methods used to create electrical devices on various substrates. Printed electronics is currently being used to facilitate widespread, very low-cost, low-performance electronics for applications such as flexible displays, smart labels, decorative and animated posters, and active clothing.
- **NanoCellulose** – is expected to enhance the fiber-fiber bond strength and, hence, have a strong reinforcement effect on paper materials. Nanocellulose may be useful as a barrier in grease-proof type of papers and as a wet-end additive to enhance retention, dry and wet strength in commodity type of paper and board products. It can also be used as a reinforcing material for plastics, or used as coatings and films, paints, foams, packaging.

Other potential uses for Nanocellulose include hygiene products, oil recovery, medical, cosmetic and pharmaceuticals.



Bioprocessing and Biosystems Engineering

Cellulose is the solution to many of our planet's problems. This one little molecule could even be the cure for our addiction to oil. Many of the graduate schools which at one time focused entirely on paper now work in bioprocessing. Nobody knows how to take apart a tree better than the pulp and paper industry. Bioprocessing includes research in the areas of advanced biofuels, biobased chemicals, bioenergy, biopolymers, and bioplastics. Your research could help the world develop sustainable sources of bioenergy, biobased chemicals, and biopolymers.

Where to start:

Choose a research project you are passionate about. Find a professor whose research interests are aligned with yours. Your undergraduate professors may be helpful in recommending a faculty advisor for your graduate studies. So how do you find a grad supervisor?

Well, you should already have a few suggestions from the Professors that you've talked to about your interests in grad school. Start by doing a bit of research on those Professors. Look at their website and learn about their research.

But sometimes Professors are slow to update their webpages so you have to do a bit more work. Join TAPPI www.tappi.org as a student member and search the e-library for technical papers in your interest area. If you are interested in bioenergy or related topics in addition to TAPPI you could try the Bioresources Journal at <http://www.ncsu.edu/bioresources/>.

Now that you've done some reading about the Professor's research you are ready to contact them. Write a short, but informative email to inquire about graduate opportunities in the Professor's lab.



The email needs to convey a range of information. Such as:

- who recommended that you contact them
- your name
- where you are doing your undergrad degree
- your undergrad major
- your research experience
- your goals for grad studies
- why you are interested in their research

All of this needs to be written in 8-12 sentences. If it is too long the Professor may not have time to read it.



Schools to Consider

Aalto University, Department of Forest Products Technology
Åbo Akademi University, Chemical Engineering
Ecole Polytechnique
Federal University of Viçosa, Forestry Engineering
Georgia Institute of Technology, Institute of Paper Science and Technology
Graz University of Technology, Technical Chemistry, Institute for Paper, Pulp and Fibre Technology
Grenoble INP-Pagora, Grenoble Institute of Technology
Lakehead University, Chemical Engineering
Miami University, Chemical and Paper Engineering
North Carolina State University, Forest Biomaterials
SUNY-ESF, Paper and Bioprocess Engineering
University of British Columbia, Pulp and Paper Center
University of Maine
University of Pardubice, Department of Wood, Pulp and Paper
University of Quebec in Trois-Rivières, Chemical Engineering
University of Toronto, Chemical Engineering & Applied Chemistry, Pulp & Paper Centre
Western Michigan University, Paper and Chemical Engineering



Research Topics to Consider

Bioactive papers
Biocomposites
Biofuels
Biomaterials
Biopolymers
Bioproducts
Biorefineries
Biotechnology
Chemical Engineering of Cellulosic Materials
Coating Technology
Colloids and Surfaces
Energy and Chemical Recovery
Environmental Technologies
Fluid Mechanics in Pulp and Paper
Functional Coatings
Green Chemistry
Lignin Characterization and Utilization
Materials Science of Paper
Nanocellulose
Nanotechnology
Nonwovens
Packaging Science
Paper and Fiber Physics
Paper Science and Engineering
Paperboard
Printed Electronics
Process Simulation
Renewable Materials Engineering
Renewable Materials Engineering
Sustainable Engineering Management
Tissue and Towel
Wood Science



STUDENT PROFILE: Ying Xua from Hangzhou, China

A recent Ph.D. graduate from North Carolina State University (NCSU), Ying received her degree in Forest Biomaterials in 2011. Previously, she earned an E.I.T. in Chemical Engineering, also from NCSU, and a B.E. in Light Chemical Engineering (with a co-major in Business Administration) from South China University of Technology. Ying, it is safe to say, understands the value of education which is why one of the first steps she took upon graduating with her doctorate was to apply for membership in TAPPI.

Ying's career path to the Pulp & Paper industry was greatly influenced early on in her educational pursuits. As an undergraduate intern, she visited a P&P company and was impressed by the smart design of the mill configuration, which she described "as sophisticated as a small town with its own power generation and wastewater treatment systems, in addition to complicated production processes." At the time, Ying thought, if you can understand the unit operations in a P&P mill, you would be a very strong chemical engineer.

In addition, NCSU's student TAPPI chapter was very active. While she was not yet a member, she attended a meeting where working professionals in the field shared their career stories. Ying said that attending this first formal meeting had a great impact on her and at that very moment changed her degree from a Master's to a Ph.D. in Forest Biomaterials. "That meeting convinced



me that this was the field for me," Ying said, "I love science and always wanted to go for a doctorate but up until then had not made up my mind which field of study." Ying also felt that the Pulp & Paper industry generously supports young professionals when they make the decision to pursue careers in it.

Ying is now a full-time Research Associate in the Fiber Technology Group at International Paper's Cincinnati Technology Center. She works on fiber line process optimization, trouble shooting and mill startup technical support. She calls it her "dream job" because it allows her to combine scientific research and trials with the ability

to apply solutions in the real production world. "Process optimization and troubleshooting are challenging which makes it even more rewarding when you accomplish a goal," she said. She also credits her co-workers. "With generous help from my tech center colleagues and engineers from the mill, and through teamwork with really knowledgeable people, I am learning a lot. This is what excites me about my work."

