BRI
NEWSLETTER
Issue 3 May 2017

Lakehead UNIVERSITY | Biorefining Research Institute

# BRI Hosts 1st IFBC in Thunder Bay

The Biorefining Research Institute (BRI) held its first International Forest Biorefining Conference (IFBC 2017) in Thunder Bay from May 9 to May 11, 2017. The purpose of the conference was to provide an international discussion forum where researchers, industrialists and government officials coming from different backgrounds and employments can share ideas on how to build and grow the emerging Forest Bioeconomy together! Biorefineries are the oil refineries of the future where oil would inevitably be replaced by plant biomass — the most abundant and renewable resource on Earth.

IFBC 2017 was full of events and activities with a very busy 2.5 days of program with 3 plenary sessions, 10 breakout sessions, 2 workshops, a poster session, and over 60 speakers, organized around the 3 themes of the conference: Bioenergy, Biorefining, and Bioeconomy. 135 delegates from around the world gathered at the Best Western Nor'Wester Conference Center to discuss national and global topics related to Forest Biorefining and the Forest Bioeconomy.

- Of the 56 talks, 7 were given by Lakehead University students;
- 9 countries were represented at the conference (Belgium, Brazil, Canada, Finland, France, Germany, Sweden, The Netherlands, and United States);
- From the United States, four states were represented (Michigan, Minnesota, New York State and Texas);
- From Canada, eight provinces were represented (Alberta, British Columbia, Manitoba, New Brunswick, Ontario, Prince Edward Island, Quebec and Saskatchewan).

Funding for the conference was generously provided by NOHFC, NSERC, CRIBE, Thunder Bay CEDC, Domtar, FPInnovations, and Dr. Pedram Fatehi from Lakehead University. Total conference costs were estimated at $60,000.

*"Thank you for a very good conference! It was a good mix and I really appreciated all the work by PhD students."*

**Per Tomani, RISE Bioeconomy, Sweden**

## Inside this Issue



On day one of the conference, panel discussions were held with government, industry and academic speakers. A workshop with key stakeholders followed to discuss the submission of a NSERC-CREATE grant with Lakehead as the lead, in close collaboration and coordination with Finland that will take the lead on an European application to EU Horizon 2020 Co-Fund later this year. The joint project would see Canadian and European students working on biorefining projects placed in academic, government and industry settings for training purposes in both countries.

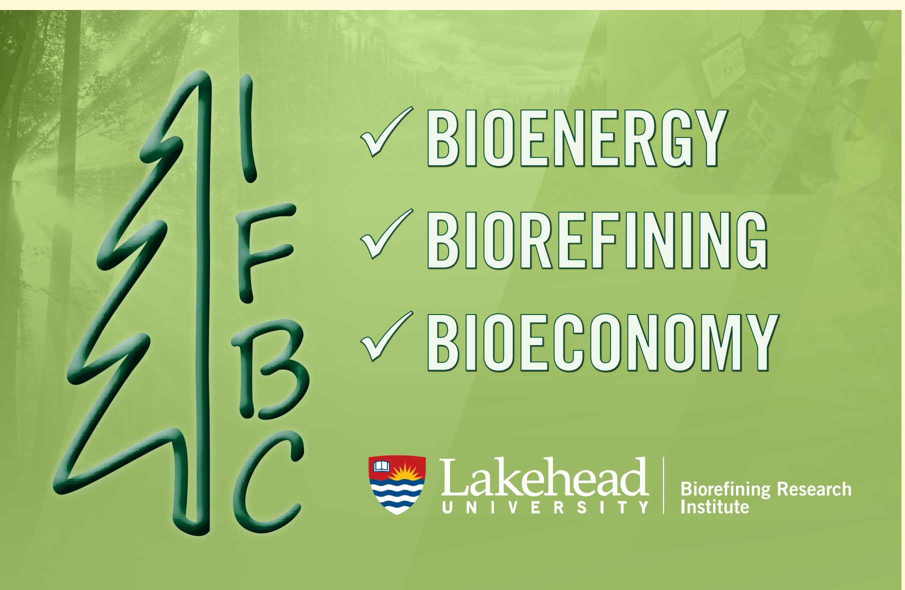
> *"The agenda and the presentations were great and gave me lots of important information."*
>
> **Joni Lehto, University of Jyväskylä, Finland**

In lieu of speaker gifts, a contribution was made in the speaker's names to a newly established Biorefining Research Institute Scholarship Award. The financial award, in the amount of $5,000, will be awarded annually to a domestic or international student entering a graduate program working on a Biorefining-related project. BRI is training a new generation of scientists and engineers who will further develop the growing biorefining and bioeconomy sector.

Many positive comments were received on the quality of the presentations, the food and event coordination. Feedback was received that the next conference should be longer so that the presentations are not held concurrently. The IFBC is proposed to be held biennially with the next conference taking place in 2019. International delegates would have liked to do more sight-seeing in the area and request the next conference be held between June and September.

The event was covered by TBTV (**www.tbnewswatch.com/video/tbt-newshour/may-9-2017-flood-damages-611321**) and the Chronicle Journal (May 11, 2017, A3), among others.

> *"Indeed, it is a great success! We really enjoyed the IFBC conference."*
>
> **Changbin Mao, FPInnovations, Canada**




THE CHRONICLE-JOURNAL Thursday, May 11, 2017 NEWS A3

Changes for Energy East review

THE CANADIAN PRESS

Prof. Lew Christopher, director of the biorefining research institute at Lakehead University, speaks about the biorefining conference being held this week at the Best Western Plus Norwester Hotel and Conference Centre.

Biorefining's future burns bright

BY BRENT LINTON
THE CHRONICLE-JOURNAL

Ideas shared for conservatory's future

Fundraiser to help a pair of one-in-a-million kids

YOUR STORIES News written by our readers.

# 1st International Forest Biorefinery Conference: A Brief Review

*Tom Bowne*

I've been to Thunder Bay regularly, as the pilot lignin extraction facilities that I developed as a manager at FPInnovations were installed there. So it was nice to see old colleagues. It was also nice to see that this conference, organised by Lakehead University's Biorefining Research Institute, featured a broad selection of solid papers, not just from Ontario-based academics but also research institutes and industrial partners from Sweden, Finland, Belgium, Brazil and the US, to name a few.

Reviews of the LignoBoost (Per Tomani, RISE Bioeconomy) and LignoForce technologies (Mike Paleologou, FPInnovations) were provided in the opening session. Later, Kirsten Maki (FPInnovations) described the LignoForce pilot plant in Thunder Bay and installation of the full-scale plant at the West Fraser mill in Hinton, Alberta. As the LignoForce process was developed by Mike and scaled up by Kirsten when they worked for me, I won't claim one is better than the other since I am clearly biased.

Michel Jean (Domtar) discussed the need to move slowly into novel bio-products or risk failure, and stressed the importance of understanding markets when doing so. Domtar has four projects on the go, having triaged a much wider set ideas:

1. Cellulose nano-filaments (CelluForce, Windsor, Quebec). This joint venture with FPInnovations now has added investments from Fibria and Schlumberger.
2. Bio-Choice lignin (LignoBoost plant, Plymouth, North Carolina).
3. 'Super pulp' cellulose filaments (Dryden, Ontario).
4. Compounding lignin with commodity thermoplastics (Espanola, Ontario).

Alan Smith (Director of Business Development, Avantium) explained that the company has spun out its core YXY technology, for converting fructose to PEF, into a joint venture with BASF called Synvina. They have also patented improvements to the classic high-acid, low temperature process for converting wood to sugars. The new technologies cover acid/sugar separation, material construction and lignin de-acidification. (If getting sulfur out of lignin is important, getting chlorine out will be no less so.) The process generates a C5/C6 sugar stream from hemicellulose, glucose from cellulose, and a sugar-free lignin. All three must be sold; the cost basis for glucose will depend on the market value of the other products, which I assume means the glucose will only be profitable if enough revenue is obtained from the other two. This will be a recurring theme in this space. There are plans for an eventual plant consuming 300,000 to 400,000 dry tonnes of wood per year.

Finally, Avantium is working on a sugar to bio-monoethylene glycol pathway which is said to be much cheaper than traditional bio-MEG routes, and competitive with petroleum-based MEG. Their partnerships with Coca-Cola and others will ensure that the techno-economic analyses will be thorough. This is one to watch.

One thing is clear: pathways to aromatics remain critical if wood-to-sugars pathways are to be economically viable. Ludo Diels (VITO) described pathways from sugars and from lignin. Low reactivity, high molecular weights and high polydispersity of lignin remain problems. An interesting way of looking at different molecules is on a plot of percent oxygen content versus percent hydrogen content [see Farmer and Mascal, in Introduction to Chemicals from Biomass 2nd Ed., Wiley, 2014]: petrochemical molecules are all along the x-axis (essentially no oxygen) while lignin and cellulose are to the left and up (lower hydrogen content, but more oxygen). In between are a range of oxygenated petrochemicals, for instance polyethylene terephthalate, $(C_{10}H_8O_4)_n$. The length and complexity of the track followed by various transformation processes from the proposed feedstock to the proposed end-product on this graph is an indicator of the difficulty of the process in terms of hydrogenation or de-oxygenation. Given this, going all the way from lignin to one of the BTX molecules is probably not necessary (or feasible), especially if you are going to re-oxygenate to PET, so intermediate lignin products with new functionalities will be critical.

Jack Saddler (UBC) reviewed bio-jet fuels. I won't go into detail here; Jack admitted that kerosene is cheap and bio-jet only works, economically, because there are policy and other non-business drivers that overcome the poor economics. My feeling continues to be that wood is too expensive to make into fuels, and that value-added products must be the primary route from wood. Fuels will come from any left-overs, not the reverse. And since the value-added pathways are more challenging, technically and economically, this is where the effort needs to be.

On the policy and analysis side, Cooper Robinson (Cap-Op Energy) described getting Renewable Fuel Credits (RFS2) and certifying a fuel under California's Low Carbon Fuel Standard (LCFS). This is a complex space where money can be made if the right accounting procedures are in place.

Peter Milley (Queen's University) described policy issues in the context of commercially viable pathways to a forest bioeconomy. The Canadian track record is not pretty, with a range of relatively uncoordinated policy approaches, applied reactively rather than as part of a long-term strategic plan, and with little in the way of follow-up once deadlines expire. He offered the Finnish national bioeconomy strategy, and reports from the OECD and EU, as examples of getting it right. That being said, I would argue the Canadian approach has been far more effective than the large grants from the US Department of Energy; Canadian funding has generally gone to successful projects and has not gotten sucked into quagmires such as KiOR or Range Fuels. As a result, progress has been slow but has tended to generate much better results per dollar of taxpayer money than in the US.

So there you have it. It was a successful conference overall, and I am looking forward to the next one!

For full article see: **http://bio-economy-tbrowne.blogspot.ca/2017/05/1st-international-forest-biorefinery.html**

## Novel Eco-friendly, Cellulose-based Textile Fibers Developed at the BRI

Natural fibers play an important role in the textile industry. Cotton and wool fibers have always dominated the markets, but in recent years, production of cellulosic fibers is on the rise that has witnessed renaissance. Rayon – the main product of regenerated cellulose fibers – is produced using a highly toxic chemical (carbon disulfide, CS2) which is the main reason why rayon manufacturing was banned in North America and Europe. To alleviate the environmental problems with conventional textile production, Drs. Nur Alam and Lew Christopher have developed an aqueous-based, environmentally-friendly process to produce novel textile yarns from cellulosic fibers using existing wet-spinning equipment available in the textile industry. The process is patent-protected. The main advantages of their invention are:

A green process that eliminates the need for the toxic CS2 solvent currently used in rayon production.

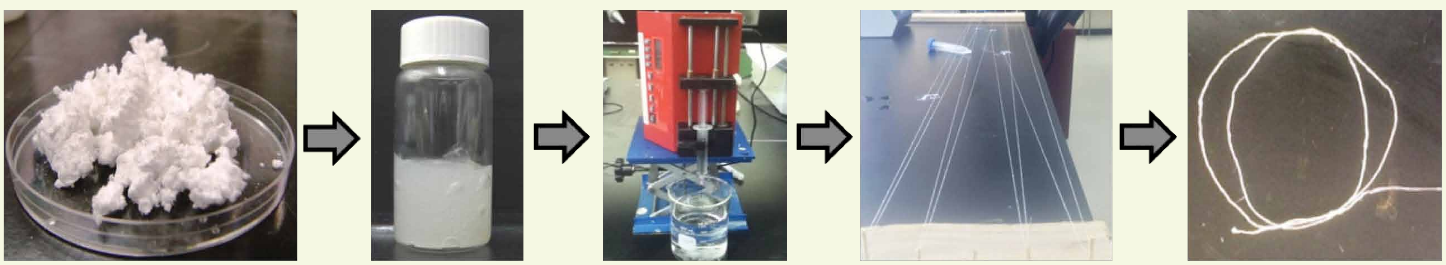
Novel textile fibers that have low water absorption capacity comparable to cotton yarns.

Chemicals used production of these textile yarns are readily available, inexpensive, and can be regenerated and reused on-site.

Compared to existing processes for textile yarn production, the method does not require prior dissolution of cellulosic material in a solvent, or cellulose regeneration during the spinning process.

Bleached kraft pulps can be used as a raw material (instead of dissolving pulp), an added benefit that significantly increases (by up to 20%) the yield of textile yarns.

The potential socio-economic and environmental benefits to Canada are enormous. Currently, Canada has to export the raw material (dissolving pulp) to Asia, where it is converted to rayon and then imported back to Canada. While the majority of man-made cellulosic fibres are used in woven applications, recent trends indicate that many producers are shifting their focus onto more lucrative markets where the cellulosic fiber properties may outweigh their cost. The novel textile fibres invented at the BRI are well suited for the use in the fast growing woven markets such as garment textiles, functional textiles and smart-textiles. Due to the apparent cost and environmental advantages, the patented process may revolutionize the textile industry in North America and Europe creating new markets and job opportunities.



**Chemically modified wood fibers (BSWK)** → **Gel prepared with chitosan** → **Gel extruded in acid bath** → **Yarns dried with controlled tension** → **Water-stable yarns**

## Biofuels from Algae

*Fatimah Alsayahan, MSc Student, BRI*

The challenges associated with the use of conventional (fossil-derived) sources of oil have prompted increased search for alternative fuel sources. Biofuels offer the chance of replacing the depleting fossil fuels. However, the food-versus-fuel conflict that exists with the use of edible crops as source of biofuels means that the non-edible, lignocellulosic biomass is the only viable source that can ensure biofuel production without trading off food production. Among the alternative biofuel sources, algal biomass may offer year-round production that uses minimal space. The addition of glucose to otherwise autotrophically grown algae has been shown to increase oil accumulation. Optimal algal mixotrophic production of oil is based on the availability of appropriate organism, the timing of sugar addition, and other culture conditions. Recently, cellulose was shown to be utilized by algae. We are currently addressing the question whether cellulose or cellulosic waste can substitute for pure glucose (expensive sugar) in boosting oil synthesis by the known oil producing *Auxenochlorella pyrenoidosa* and several other algal species isolated from decaying wood and pulp mill waste water ponds. It is expected that the study outcomes will add important new information useful in the future scale up and commercialization of biofuel production from algal oils.