Pulp and Paper Centre's

Pulp Digest

Q1 2015

Novel Cellulose Foam Material

Light-weight foam material that is a green and renewable alternative.
Photo: Anna Jamroz

Research on a novel cellulose foam material by James Olson and Reza Korehei, Postdoctoral Research Fellow at the Pulp and Paper Centre, was one of only four feature presentations at FIBRE day of the PaperWeek 2015 Conference held in Montreal, February 2-5.
The team of reserachers, which also includes Pouyan Jahangiri and Hoda Ahmadi, are part of the Innovative Green Wood Fibre Products FIBRE Network. The presentations of exemplary work highlighted how their technological innovations can be directly applied to industry in the forest sector.

"What we've been working on is developing functionalized, low density, high porosity, cellulosic fibre material that can be used in a wide range of applications" say Olson.

A video on the work, produced by Anna Jamroz, Communications Coordinator, was part of the commercialization kit. The video can be viewed at ppc.ubc.ca/foam We encourage you to take a look to learn more about this exciting new product, including applications and applicable industries.

Visit page 4 and 5 to learn more.

New Faces

Please join us in welcoming Dr. Barbara Dalpke to the Pulp and Paper Centre:

Dr. Dalpke joins UBC as a new Instructor, stepping in to teach MECH 450 "Pulping and Papermaking" to UVic students, but she's not new to the Pulp and Paper Centre or to UBC. After studying Mechanical Engineering with a specialization in Pulp and Paper Engineering in Darmstadt, Germany (1997), she came to Canada in 1998 to work on a PhD in Mechanical Engineering at the Pulp and Paper Centre at UBC.

Dr. Dalpke received her PhD in 2002 with a thesis focused on flow in paper machine twin wire forming sections: "Modelling of Jet Impingement and Early Roll Forming". She stayed at the Pulp and Paper Centre for another 3 years as a Postdoc working on a variety of topics related to pulp rheology and low consistency refining theory. She then moved on to FPInnovations from 2005-2012 as a research scientist mainly in fibre evaluation (influence of Mountain Pine Beetle and other influences on fibre quality). There, she coordinated all Mountain Pine Beetle work done within FPInnovations' pulp and paper division. Later Dr. Dalpke coordinated a joint industry project with AIF Cornerbrook with the goal of bringing research advances in fibre quality measurements, the understanding of influence of fibre quality on pulp quality, and understanding of influences on fibre quality depending on growth conditions in the forest, together to obtain advantages at the mill production level.

Now back at UBC, Dr. Dalpke says "my favourite thing about teaching is getting to know the students. I love extending my knowledge about pulp and paper to people that had little to do with it so far, and the more you involve students, the more I feel I'm succeeding at this". When asked about career advice for younger students, Dr. Dalpke notes that if a student enjoys research and the challenge of coming up with new solutions, the area of biorefiniery, which is still in the development stage, might be right for them.

Awards

Valmet Tissue Technology Award 2015

Congratulations to PPC researcher Zhaoyang Yuan for receiving 2nd prize in the **Valmet Tissue Technology Award** competition. Zhaoyang is a Ph.D. candidate of Chemical and Biological Engineering working with Professors Mark Martinez and Rodger Beatson.

Valmet's mission is to convert renewable resources into sustainable results, with a focus on research and product development activities on sustainable technology solutions. The purpose of the award is to provide sustainable solutions and to promote university students' and scientists' work to develop environmental sound innovations for the tissue making process.

Abstract:

The research is focused on the removal of silica from bamboo for the production of dissolving pulp. An extensive literature review regarding silica in bamboo, removal of silica from non-wood materials, and desilication of the spent liquor are included. The specific objectives include: 1) examine silica distribution in the bamboo culm, 2) test mechanical methods of silica removal, 3) chemical desilication of bamboo chips, and 4) recovery of chemicals used in chemical desilication. Some of the pertinent work has already been completed. Fresh bamboo trees have been used to obtain silica location and silica content in the bamboo stem. Both gravimetric analyses and scanning electron microscopy with energy dispersive X-ray spectroscopy studies indicated that silica is more concentrated in the outermost cell layers of the culm, but more than 50% of total silica is located in the middle layer of bamboo stem. Silica removal results showed that about 30% of silica in chips could be removed by washing with water at 35°C for 10min. Moreover, it was observed that treatment with 12% NaOH (w/w) at 85°C for 55 min (liquid to wood ratio of 4 : 1) removed about 87% of silica (based on the dry weight of washed chips) at a chip yield of about 80%. At 100°C, with 18% (w/w) NaOH for 60 min, about 96% of the silica could be removed from the chips. Data from more than 70 runs conducted under variable chip size, NaOH charge, temperature, and time were used to develop a kinetic mod el of alkali-based silica removal. According to the model, NaOH concentration and temperature were the two most significant variables for the removal of silica from bamboo chips. In proposed experiments, a mechanical method of removing the epidermal region of the bamboo stem to minimize silica input into the pulping system and the recycle of silica and other chemicals from the silica spent liquor with carbon dioxide will be investigated. In addition, the quality of the final dissolving pulp, including the yield, alpha-cellulose content, viscosity, reactivity, and brightness, will be assessed to evaluate whether the desilication methods are suitable for commercial pulping operations. Accordingly, these attempts will be helpful in solving silica problems encountered in bamboo pulping.

To summarize, this work will establish a series of methods to obtain maximum silica removal from bamboo wood, bamboo chips and spent liquor to improve the quality of final pulp and the efficiency of chemical recovery. In addition, this research will be a guide to improving chemical recovery in pulping of non-wood materials as well as help optimize present dissolving pulp processes in order to obtain high quality dissolving pulp at high yield.

Publications

Journal

Mahadeva, Suresha; Walus, Konrad; **Stoeber, Boris**, "Paper as a Platform for Sensing Applications and Other Devices: A Review", ACS Applied Materials & Interfaces. Accepted for publication.

Boris Stoeber, PPC Faculty Associate

Abstract: Paper is a ubiquitous material that has various applications in day to day life. A sheet of paper is produced by pressing moist wood cellulose fibers together and offers unique properties; paper allows passive liquid transport, it is compatible with many chemical and biochemical moieties, it exhibits piezoelectricity and is biodegradable. Hence paper is an attractive low-cost functional material for sensing devices. In recent years, researchers in the field of science and engineering have witnessed an exponential growth in the number of research contributions that focus on the development of cost-effective and scalable fabrication methods and new applications of paper-based devices. In this review article, we highlight recent advances in the development of paper-based sensing devices in the areas of electronics, energy storage, strain sensing, microfluidic devices and bio-sensing, including piezoelectric paper. Additionally, this review includes current limitations of paper-based sensing devices and points out issues that have limited the commercialization of some of the paper-based sensing devices.

Conference Proceedings

Suresha Mahadeva discussing the teams poster at IEEE.

S. K. Mahadeva, Konrad Walus, and **Boris Stoeber**, "Piezoelectric paper for physical sensing applications," Proceedings of the 28th Annual IEEE International Conference on Micro Electro Mechanical Systems (MEMS 2015), Estoril, Portugal, Jan. 18-22 2015, pp. 861-864.

Abstract: We have developed robust and mechanically flexible piezoelectric paper. The fabrication process involves functionalization of barium titanate ($BaTiO_3$) nanostructures onto wood fibers, followed by activation in a suspension of the commercially available paper-strength-enhancing additive, carboxymethyl cellulose (CMC), which improves fiber-fiber bonding. This leads to piezoelectric paper with both high tensile strength and flexibility. We have investigated the effect of CMC concentration (2-6 wt%) on the tensile properties of the paper and found the highest tensile strength at 6wt% CMC. This piezoelectric paper has the largest piezoelectric coefficient reported for paper to date (d_{33} = 37 - 45.7 $\pm$ 4.2 pC/N) and is comparable to that of commercially available piezoelectric polymers such as polyvinylidene fluoride with d_{33} = 30 pC/N. In addition, we have demonstrated the application of this paper as a tactile sensor.

Nuwan S. Kapu at Paper Week 2015

Nuwan S. Kapu, Xuefeng Chang, Joel Kumlin, Colby Song, Z. Yuan, Rodger Beatson, Mark Martinez, Heather L. Trajano, "Pre-hydrolysis of bamboo: A kinetic study" Paper Week 2015 Conference, Montreal, QC, Feb. 2-5, 2015.

Abstract: Due to its fast growth and high abundance, especially in Asia, bamboo is an attractive lignocellulosic feedstock for a biorefinery platform. However, it is still an understudied feedstock and significant technological advances are needed to utilize its full potential. A successful biorefinery requires clean fractionation of the individual components of lignocellulose in high yield, and pre-hydrolysis is a process by which the majority of hemicellulose in the feedstock can be solubilized and separated from remaining feedstock components. In order to establish a kinetic model of pre-hydrolysis, we subjected bamboo chips to water-only (autohydrolysis) and dilute acid (up to 2% w/w H2SO4) treatment at different temperatures for varying times. While negligible hemicellulose removal occurred with autohydrolysis at 150°C, approximately 80% of the hemicellulose was hydrolyzed when treated with 1% w/w H2SO4 at 161°C for 90 min. In current models the effect of factors such as initial acid concentration, proton generation from biomass, neutralization capacity of the feedstock and the time-variable temperature on the kinetics are unexplored in a comprehensive manner. Consequently, different mathematical expressions are required to describe autohydrolysis and dilute acid hydrolysis. We have addressed these limitations and established a single set of kinetic expressions that describe both autohydrolysis and dilute acid hydrolysis under non-isothermal conditions. We believe these contributions are of significant value and interest to a wide audience working on both fundamental and applied aspects of biorefining technologies.

Zhaoyang Yuan, Nuwan S. Kapu1 Rodger Beatson, Mark Martinez, "Developing Bamboo as an Alternative Feedstock for Biorefinery Applications: Solving Silica Problem" Poster presentation at Paper Week 2015 Conference, Montreal, QC, Feb. 2-5, 2015.

Paper Week 2015 Review

By Reza Korehei, Postdoctoral Research Fellow, Pulp and Paper Centre

The central message from all keynote speakers at PaperWeek 2015 can be summed up as follows: the Canadian forest industry should continue in the new and exciting direction which is bolstered by an impressive array of innovation, new products and advanced processes. It was emphasized that innovation will create exciting opportunities in the forest sector road map for the future, known as *Vision 2020*. This vision set three important goals: to refresh the workforce by creating more job opportunities; to generate more income and improvement in economic activities of the forest sector; and to further reduce the environmental footprint and improve sustainability.

The FIBRE Network, which involves more than 700 academic researchers from 26 universities across Canada, was also highlighted. It was emphasized that the forest sector in Canada has directly benefited from the innovative work FIBRE researchers are currently developing. The efforts of the FIBRE Network over the last several years has resulted in great innovation and production of new materials such as nanocrystals, bioactive papers, new light-weight biomaterials, bio textiles, new wood construction application and many more. From all these new materials, the top four "shovel-ready" innovations for commercialization were presented in a forum. It was a great achievement that *Foam Paper*, created by researchers at the Pulp and Paper Centre, was one of the four features – you can read about it on the following page.

Below: Pulp and Paper Centre reesarchers at PaperWeek 2015

A brief summary of the other 3 FIBRE Networks presentations:

Using Bacteriophages (good virus which kills harmful pathogens), Sentinel researchers from the University of Guelph have produced biocontrol packaging materials containing phages to control the growth of various food-borne pathogens in several food matrices. Biocontrol packaging using bacteriophages in food controls the growth of pathogens such as ready-to-eat meat, cantaloupe and sprouts. It was shown that the phages can be printed on any surface of packaging materials using an inkjet printer. This packaging option is effective at low temperature, where some pathogen such as Listeria can still grow despite refrigeration. It was illustrated that this new packaging solution can be used for modified-atmosphere and vacuum packaged meats. The new phage assisted packaging has the potential to enhance food safety.

Researchers from McGill University have invented a non-toxic process that creates super-absorbent fibres with the same strength, stretch and volume as comparable man-made fibres. It was shown that the new fibres can be spun at industrial speed and drawing rate in a pilot spinneret trial. The researchers have functionalized fibre to give fibre more attributes. The unique super-absorbent fibre is recyclable, renewable and can be easily spun on current commercial equipment. It was claimed that the newly created fibres offer the opportunity to give cellulose fibres interesting attributes and create value-added products that rayon cannot match.

Finally, researchers from Dalhousie University have created new academic software which addresses ecological and economic issues of strategic forest management simultaneously. This software can handle overlapping layers without collapsing. It can also model economic accounting for harvest location, transportation, mill type and allocation of by-products. This software has been designed in such a way that it can produce a manageable number of sound forestry-based sustainable prescriptions.

PaperWeek 2015 has once again proven to be an exciting opportunity to learn about novel technologies and products that can continue to drive the forest sector forward.

Research Excellence: "Foam Paper"

AERO CHOCOLATE-STYLE PAPER COULD CREATE BUBBLES IN THE CONSTRUCTION AND PACKAGING SECTORS

By Sylviane Duval for FIBRE.

No, it's not mouth-wateringly delicious, or even edible—but it is 100 percent natural, biodegradable and carbon neutral. Not many products in the construction, renovation, packaging and environmental remediation sectors can lay claim to that.

James Olson, FIBRE researcher at University of British Columbia, and his team have developed a light-weight, low-density cellular fibre "scaffold" that is suitable for applications such as sound absorption, thermal insulation, packaging and air filtration.

Wood fibres are added to a micro-bubble soap-and-water suspension which, when it dries out, leaves a very light-weight, porous scaffold. Add antibacterial properties, for example, and it can be functionalized for more applications, such as soil reclamation. The porosity gives it a massive surface area with which to interact with its target.

"The innovations are exciting," says Olson. "The material itself, the way we make it, the ingredients and the way we functionalize it."

The current material of choice for filtration and electrical, thermal and acoustic insulation is fibreglass. Cheap, plentiful and easy to use, yes. Non-renewable and hazardous to health, unfortunately, also yes.

"Fibreglass insulation is effective," admits Olson. "But our product won't destroy your lungs or emit possible carcinogens—and the process is very easy and cheap."

Composite incorporates bioactive live additives.
Photo: Anna Jamroz

The scaffold can be shaped into batts like the familiar pink insulation or customized for particular shipping applications. Sending a Ming vase by mail, for example, would require sure-footed handlers as well as stiff packaging that forms to the shape of the vase to prevent any movement whatsoever within the box. "We can do that," says Olson.

Shipping fresh lobster from the East Coast to Saskatchewan, however, requires a softer, thermally insulated packaging that will keep the contents cold whatever the weather.

"We can do that, too," says Olson. "In fact, we can make it into ceiling tiles; air filtration systems for hospitals, airplanes or other public places; sound-absorbent wall panelling for homes... you name it."

The product isn't on the market yet. The next step is to expand the physical properties (strength and rigidity) of the foam and its chemical properties for a wider range of applications. Then the team will look for a key partner with which to narrow the focus down to one or two applications and develop an actual product on a commercial scale.

The benefits to the partners could be important: this is, after all, a unique green material that has a wide range of applications in their core markets and shifts Canada towards a bio-economy.

Who thought a chocolate bar look-alike could do all that!

Left: Acoustics and Noise Lab, UBC. Pouyan Jahangiri tests sound absorption and acoustical properties of foam paper using a two-impedance tube.
Photo: Anna Jamroz

Introduction to Pulp and Paper Technology Course

A three-day course sponsored by the Advanced Papermaking Initiative (API) at the University of British Columbia

Who should attend:
This introductory-level course is suitable for current engineering students, including coop, along with recently hired engineers working in BC pulp and paper mills and supporting industries. Suitable for both technical and non-technical individuals who want to understand basics of BC's natural resource, chemical and mechanical pulping, bleaching, recovery, papermaking, and paper grades and properties.

Description:
This hands-on course will consist of lectures during the mornings, and lab exercises in the afternoons to re-emphasize material and enhance understanding of process.

The course will provide an overview of:
- Natural Resources
- Mechanical Pulping history, theory and comparisons with chemical pulping
- Kraft Pulping, Bleaching and Recovery
- Pulp processing equipment, theory and operation of pulp screening, cleaning and low consistency refining
- Papermaking theory of forming, pressing and drying
- Chemical additives in the wet end of the paper machine
- Future bio-products and the transformation to a sustainable bio-economy

April 13-15, 2015
Cost of 3-day course is $500/student.
Register at www.ppc.ubc.ca/API/Course

Technical Training Course

As part of the Pulp and Paper Centre's *Professional Development Series*, current UBC Engineering students, including Co-op, have an opportunity to enroll in a 3-day, hands-on course which will provide an orientation of the workshop, safety training, and an overview of:

- *Safe Operation of Machine Shop Tools*
- *Hand tools*
- *Precision Measurement and Layout*
- *Pipe and Tube fittings*
- *Pumps and Valves*
- *Swagelok Fluid System Components*

Comprised of theoretical lectures, demonstrations and videos, learning will be reinforced by building a project from start to finish using industry standard tools and methods. The course Instructor is a Certified Machinist and Engineering Technician.

Summer dates will be released shortly, visit www.ppc.ubc.ca/courses for more information and to register.

Intro to Machine Shop Course

Part of the Pulp and Paper Centre's *Professional Development Series*, students now have an opportunity to enroll in a 9 hour, hands-on course.

Introduction to Machine Shop will teach participants the fundamental skills required for basic machine shop operations. Through a combination of lectures and project work, students will learn how to use precision measurement tools such as micrometers and vernier calipers, learn the processes required for semi-precision layout, cutting speeds and feeds, Horizontal Band Saw operation, Sensitive Drill Press and drilling operations, threads types and thread cutting.

Comprised of theoretical lectures, demonstrations and videos, learning will be reinforced by building a project from start to finish using industry standard tools and methods. The course Instructor is a Certified Machinist and Engineering Technician.

Summer dates will be released shortly, visit www.ppc.ubc.ca/courses for more information and to register.

Fluid Systems Course

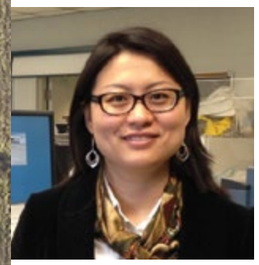
As part of the Pulp and Paper Centre's (PPC) *Professional Development Series*, Engineering students now have an opportunity to enroll in a 9 hour, hands-on course.

Fluid Systems will teach participants the fundamental skills required for rudimentary pipe and tubing assemblies. This course focuses on pipe and tube, and an introduction to pumps and valves. Students will learn how to identify sealing thread types, the differences between pipe and tube, pipe fitting basics including pipe thread cutting and assembly, compression tube fitting and bending, and methods for fluid system leak testing. Learn how to identify and apply different types of pumps and valves.

Comprised of theoretical lectures, demonstrations and videos, learning will be reinforced by hands-on work using industry standard tools and methods. The course Instructor is a Certified Machinist and Engineering Technician.

Summer dates will be released shortly, visit www.ppc.ubc.ca/courses for more information and to register.

CHBE Speaker Series



The Department of Chemical and Biological Engineering hosted distinguished guest Dr. Ning Yan, Faculty of Forestry at the University of Toronto, for a Speaker Series Seminar on March 31st.

Dr. Ning Yan is a Professor and Endowed Chair in Value Added Wood and Composites with cross-appointments at the Department of Chemical Engineering and Applied Chemistry at UofT. Dr. Yan is also an Associate Director of the Pulp and Paper Centre and a founding member of the Centre for Bio-composites and Biomaterials Processing at the University.

Dr. Yan's talk was on "**Bark Bio-refinery: Conversion of Bark Biomass Residues to Valued Added "Green" Chemical Products".**

Being a biomass residue material available in large quantities, bark contains all major types of wood polymers plus polyphenols and other extractives. With its unique physical and chemical characteristics, bark is well suited to be converted into chemical precursors to synthesize a wide range of chemical products substituting petroleum-derived feedstock. Over the last five years, with the support of a large number of public and private partners, Dr. Yan's research group at has done extensive work to develop enabling technologies for a "bark biorefinery" focused on using bark as feedstock to make a portfolio of industrial chemical products. Her team has successfully developed several chemical conversion platform technologies that can use bark as raw material to produce bark-based adhesive, foam and resin industrial products. These environmentally friendly bio-based products have potential applications in a number of industries ranging from construction to automotive sectors. An overview of these conversion platform technologies was given at the seminar together with some fundamental understanding of the compositional and performance characteristics of the resulting novel bark-based chemical products. Opportunities and challenges associated with commercialization efforts of these products was also discussed.

Seminar Notice

"INNOVATIONS IN FOREST PRODUCTS INDUSTRY AND THE ROLE OF A CHEMICAL ENIGINEER"

AMAR NEOGI, Director, Renewal Research, Weyerhaeuser

WHEN: Tuesday April 21, 2015
TIME: 1:00-2:00 pm
WHERE: Pulp & Paper Centre, Room 101
WHO: Open to students, faculty & industry

ABSTRACT:

Forest products is a major industry in North America employing a large number of Chemical Engineers who play important roles. One such role is in the conception/development/implementation of new and improved products and processes. The author will present a series of recent innovations (processes/products) and analyze/identify additional skill requirements for a chemical engineer. He concludes that a major need exits in proficiency in creativity and innovation tools to accelerate the process of innovation. Dr. Neogi will elaborate on the techniques of creative problem solving, further emphasizing their importance in successfully taking advantage of major emerging growth opportunities for the industry.

BIO:

Amar Neogi received a Ph. D in Chemical Engineering from the University of Washington, 1970. After working for E.I. DuPont Company for several years, he joined Weyerhaeuser Company in the mid- seventies and has been with the company for almost 40 years. Dr. Neogi is currently the Director of Renewal Research at Weyerhaeuser Company R&D and is located in Federal Way. Dr. Neogi has 150+ patents & patent applications to his credit.

Upcoming Events

2015 Transit Plebiscite
Voting: MARCH 16-May 29, 2015
Take a stand: Get informed, make a choice, plan to vote in the Metro Vancouver transit referendum. Visit transportation.ubc.ca/vote for more information

Engineering Excellence Celebration 2015
APRIL 9, Four Seasons Hotel, Vancouver
Awards are presented in categories such as Lifetime Achievement, Community Service and Young Alumnus. RSVP required.

Women in Leadership and Technology
April 15, 9:00-11:30 am, Pharmaceutical Sciences Building, Room 101
A UBC IT Talks Event with Tina Nunno and Rachel Kuske. Exploring gender issues that impact women in leadership, technology, science, engineering and trades.

PaperCon 2015
April 19-22, Georgia World Congress Centre, Atlanta, GA
Designed by industry professionals, PaperCon brings together CEOs, mill managers, superintendents, scientists, process engineers and suppliers for the largest pulp and paper technical program in the world. Learn more at papercon.org

Spring Graduation
MAY 20-27, Chan Centre, Vancouver, UBC
Tuum est. The day is yours. Learn about your graduation day including how to get to the venue, the schedule of the day and reception. Details at graduation.ubc.ca

ERMP Steering Committee Meeting
June 10, 8:30-5:30pm, Fairmont Chateau, Whistler, BC
The Energy Reduction in Mechanical Pulping (ERMP) research group will meet with their industrial partners at the bi-annual Steering Committee meeting. Project updates, product forum and guest speakers make up the agenda. RSVP required.

PACWEST Conference
June 11-13, Whistler, BC
Six PPC researchers will be presenting technical papers and presentations at the upcoming PACWEST Conference. Join us to learn about the latest innovations! Program details can be found at www.pacwestcon.net

Reminder: The University is closed Friday April 3 and Monday April 6

Social Media

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Visit us online: www.ppc.ubc.ca

Thanks for all your TWITTER support. Below we share a few of our recent tweets:

UBC Pulp & Paper Centre @ubcPPC 5 FEB
James Olson and team wrapping up at #PaperWeek where their research on Novel Cellulose Foam Material was featured (video)

UBC Pulp & Paper Centre @ubcPPC 26 JAN
9hr, hands-on Fluid Systems Course offered this semester. Open to all Eng. students. More at ppc.ubc.ca/courses @UBCevents

UBC Pulp & Paper Centre @ubcPPC 22 JAN
ProDev courses this semester! Gain technical skills, knowledge, and hands-on experience. More at ppc.ubc.ca/courses @ubcengineering

BC Government News @BCGovNews 21 JAN
BLOG: How a specialty wood product creates #BC jobs: http://ow.ly/HIe08 #woodisgood @WoodWORKSBC_CWC

UBC Pulp & Paper Centre @ubcPPC 6 JAN
Have you seen @_atasina_ @TEDxRCW talk? Available online now: youtu.be/CjlGZOIBQ1c @TEDTalks #tedx #innovation #ubc @ubcengineering

Contact

To submit items to *PPC's Pulp Digest* **or to join our mailing list, please contact Anna Jamroz, PPC Communications Coordinator at: anna.jamroz@ubc.ca**