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Student Presentation Abstracts

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Content

Epoxidized Canola Oil as a Compatibilizer for Poly(Lactic Acid) and Poly(Butylene Adipate-co- Terephthalate)

Quintin Litke, PhD student, University of Manitoba

PLA has been considered for use in food packaging due to its tensile strength and biodegradability; however, it is limited by poor elongation. PBAT is a biodegradable polymer with excellent elongation; therefore, blends of these polymers are auspicious for biodegradable food packaging. However, these polymers are incompatible, resulting in multiphase behaviour and poor stress transfer. Synthetic compatibilizers have been used in the past; however, there is a trend towards using cheap, renewable, and environmentally friendly alternatives such as epoxidized vegetable oils. In this work, epoxidized canola oil (ECO) was produced and characterized using hNMR and FTIR, after which ECO was blended with PLA and PBAT in a batch extruder. The thermal properties of the blend will be determined via DSC. The mixture will be dissolved and spin-cast into a thin film to measure the barrier and mechanical properties. Finally, SEM will be used to observe the microstructure of the blend.

Electro-Membrane bioreactor integrated process for the treatment of landfill leachate

Oumaima El Hachimi, PhD student, INRS

Landfill leachate (LFL) is complex wastewater generated from water percolating through a solid waste disposal site. In the absence of a confining barrier beneath or surrounding the waste disposal site, leachate can migrate and contaminate subsurface and surface water. The standalone membrane bioreactor process (MBR) has generally less efficiency for removing refractory organic pollutants (i.e., humic- and fulic-like substances). To mitigate this challenge, this project aims to study the potential of an integrated system membrane bioreactor (MBR) technology and electro-coagulation (EC) process for treating real landfill leachate. Current experiments aim to evaluate the contribution of electro-coagulation in the integrated Electro-MBR (eMBR) by evaluating the performances of eMBR for contaminants removal. Moreover, the dynamics of microbial communities and their effects on eMBR's pollutants removal under varying operating conditions (SRT and HRT) will be studied.

Investigations into the predictive dynamics of Social-Ecological System (SES) models using real-world aquatic and terrestrial ecosystem case studies: from climate change impacts on lake ice formation to biogeochemical cycles and circular economies

Aman Basu, PhD student, York University

Our understanding of social and ecological systems is instrumental in building sustainability and resilience. Interaction and association of social and ecological systems are still not adequately understood or researched, given the ongoing climate urgency. This thesis aims to enhance the relevance of Social-Ecological Resilience Systems (SES) models by evaluating their components to connect and place them in a framework that includes other related ecological models that have not been explicitly integrated into Social-Ecological Resilience Systems (SES) thinking. This doctorate explores climate change impacts on the resilience of lake ice formation and direct human effects on biogeochemical cycles, which aims to highlight different future scenarios of socioeconomic and ecological development in light of the planetary boundaries framework.

Development of biodegradable bio-composites from wood industry residues for growing trees contents

Fatma Bali, Master student, UQAT

The objective of this work is to develop new biodegradable bio-composites from wood industry residues (ash, sludge, biochar, and other organic residues) as filler with a biodegradable biopolymer as a base (polylactic acid (PLA), thermoplastic starch (TPS)...). These bio-composites will be used in plant pots for agricultural applications. Indeed, fertility, increasing yields, and improving crop quality are challenges for the sustainability of modern agriculture. However, the organic composition of its bio-composites can serve as fertilizers for plants, playing an important role in maintaining fertilization, during its biodegradation process.

To identify the effect of the reinforcement on the behaviour of the composite, the production of composites with reinforcement rates of 30-70% by extrusion followed by injection molding will be performed. Subsequently, comparative studies of rheological, physical, and mechanical properties will be performed. Analysis of the degradation rate of these composites during use will also be carried out.

The durability of biocomposites with high-performance

Khouloud Bouaziz, Master student, UQAT

The project focuses on the valorization of wood residues for the development of high-performance bio-composites. The use of biocomposites daily for industrial products brings to light the influence of environmental conditions on the evolution of mechanical and physical properties. This aging has a major influence on the lifetime of any product based on such materials. As such, the successful commercial use of biocomposites requires control of the evolution of their mechanical properties under real-world conditions. The work is conducted in the first part of the study of the physical-mechanical behaviour of wood/polymer composite by evaluating hydrothermal (immersed in water) aging behaviour. The second part of this study is based on the prediction of their durability, then the modeling of their physical-mechanical behaviour to propose a model allowing the consideration of the whole of the physical and chemical phenomena.

Dielectric performances of biobased materials

Morgan Lecoublet, Master student, UQAT

The exponentially increasing need for materials with good dielectric performance, the growth of biopolymer-based composites and the limitation of fossil resources create the basis for developing new biobased and/or biodegradable structures adapted for a large panel of the dielectric application. Although work has already been carried out in this field of materials science, many limitations of the polymer matrix still exist to fully benefit from the dielectric performance of these promising new materials. In this context, our research project aims to i) evaluate the dielectric potential of biobased and/or biodegradable polymers for the preparation of bionanocomposite polymer-particle blends, ii) study and improve the multiphysical (mechanical, microstructural) and dielectric properties of biodegradable polymer blends by incorporating different particle rates. Different polymer blends were prepared by different technology (extrusion and 3d printing) and their physical, rheological, and dielectric behaviour were studied.

Next-generation -omics approach for tailoring volatile fatty acid production by food *waste valorization*

Reema, Master student, York University

Acidogenic fermentation of food waste using mixed microbial cultures can produce high-valued bioproducts such as volatile fatty acids (VFA) via complex microbial networks and metabolism. Due to a limited understanding of microbial interplays and their resultant process operation, the present fermentation systems allow for low VFA yields. Since different microbial communities function together to control the process kinetics of each stage of fermentation, the next generation of high throughput -omics technologies can help us understand complex microbial communities. A metagenomic and meta transcriptomic study allows extraction of information on taxonomic profiling, structural and functional characterization of microbes, and community shift for both cultivable and non-cultivable microbial fractions. This study will further help us engineer and control biosystems by developing microbial consortiums for high-yield VFA synthesis by up-scaling key microbial operations, thereby driving food waste valorization as a petrochemical alternative toward a circular bioeconomy.

Characterization and valorization of Scots pine wood and residues

Sofien Elleuch, Master student, UQAT

This project aims to characterize the properties of Scots pine wood and residues for valorization purposes. Scots pine is one of the most dominant species in the boreal forest This species plays a considerable economic role in the Quebec Forest industry. Sampling was conducted in two sites located in the Abitibi Témiscamingue region of northwestern Quebec, to study the physical and chemical properties of Scots pine. The properties of wood and residues are to be characterized, including density and chemical composition with a view to valorization for various applications including bioproducts and bioenergy. The density of wood is an important physical property, it has a great influence on its mechanical properties, dimensional stability and especially it's processing. It can also be used to determine the carbon content and energy potential of wood and residues. The chemical characterization allows us to determine the potential of this wood for various bioproducts.

Hygrothermal effects on adhesively bonded CFRP-to-concrete systems

Zahir Namourah, Master student, UQAT

In the context of strengthening existing structures, the use of fibre-reinforced polymer materials has been continuously increasing as an alternative to traditional materials, due to their superior durability (absence of corrosion), lightweight, low maintenance cost, and rapid installation. Adhesive bonding techniques for strengthening existing structures, such as near-surface mounted and externally bonded reinforcement are usually considered preferable. Despite the increasing knowledge, the long-term performance under hygrothermal aging conditions of these strengthening techniques is still not clearly understood, limiting its use. This work aims to give new insights into this topic, supported by advanced and innovative numerical modelling with multiscale and multiphysics approaches for reliable predictions on hygrothermal ageing, properly calibrated with a refined experimental program to be developed in this work. These outcomes will provide new knowledge on the most influencing parameters, serving as the basis for the development of simplified design recommendations.

Chemical wood quality attributes determination for three wood species using traditional standardized approaches and near-infrared spectroscopy

Bilel Bouaziz, Master student, UQAT

Naturally grown conifers (spruce and pine) have always represented a significant part of biomass feedstock used by the Canadian wood industries. Still, some wood tissues are not or only poorly valorized. Short rotation coppice willow biomass crops on the reclaimed mine land address many environmental and economic convergent needs and represent an important biomass feedstock that the solid wood/pulp and paper industries do not use. The goal of this research is to valorize conifers' tissues in chemical and energetic applications. Non-destructive laboratory tests using ASTM and Tappi standard methods and near-infrared spectroscopy have been performed to determine chemical WQA (carbohydrates and lignin) and surface chemistry of selected white spruce, lodgepole pine, and willow clone tissues. Partial least squares regression models for quantitative prediction of wood chemical components were developed. The correlation coefficient (R^2) confirms the applicability of chemometric models for screening in breeding programmes (for lignin, cellulose and extractive content).

Detection of azithromycin in wastewater and surface water using microfluidics

Noha Hasaneen, Master student, York University

Azithromycin is a macrolide antibiotic which is extensively used for the treatment of upper respiratory tract infections, especially through the last 2 years for relieving COVID-19 symptoms. Azithromycin has been detected in Canadian wastewater effluent and is influent with a concentration of thousands ng/L. Excessive use of azithromycin and ineffective water treatment techniques results in the development of antimicrobial resistance. So, it is urgent to develop on-site simple analytical techniques to monitor azithromycin concentration at different water treatment steps. The most used technique for azithromycin detection in complex matrices is LC-MS or HPLC which requires sample pretreatment and trained personnel. In this project, we are developing a technique for selective extraction of azithromycin using molecular imprinted polymer (MIP) on magnetic particles so we can easily separate azithromycin for detection. Then comes the detection part where we are working on developing an optical portable sensor for sensitive detection of azithromycin.

The Effects of Temperature on the Growth of BTEX Degrading Strains

Ginelle Aziz, UG student, York University

In Canada, there are thousands of BTEX contaminated sites due to industrial activities. BTEX is a group of volatile organic compounds that is harmful to human health and the environment due to its mutagenic and carcinogenic nature. BTEX can be remediated from the soil through different physical, chemical, and biological soil remediation processes. While some processes like soil washing can be energy-intensive, bioremediation is eco-friendly, as it uses microorganisms to remove contaminants. However, the natural rate of bioremediation is slow, which can be improved by providing heat. An increase in temperature increases the growth rate of bacteria, thus increasing the degradation rate of contaminants. In my internship, the effect of temperature on microbial growth rates was analyzed. It was observed that the growth rate increases, which directly influences the biomass available to degrade the contaminants. The next phase of this project investigates the degradation rate of the biomass on the contaminants.