The Institute of Textile Science

2025 ITS SYMPOSIUM
ABSTRACTS FOR ORAL PRESENTATIONS

JANUS-STRUCTURED AMPHIPHILIC NANOFIBERS BY CONJUGATE BUBBLE ELECTROSPINNING FOR EFFECTIVE WOUND HEALING

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Presentation time: Tuesday, March 18 at 9:00 am (MT)/11:00 pm (EST)

Introduction

Wound healing remains a critical challenge in the medical field, requiring the development of advanced multifunctional materials. In wound healing, it is equally important to manage the exudates released from the wound to protect it from bacterial growth, prevent infection, and promote the slow release of therapeutic agents to support cell proliferation at the wound site. An ideal wound dressing should efficiently absorb exudates while providing controlled, sustained drug release at the wound site. In addition to these key functions, essential criteria for an effective wound dressing include antimicrobial protection, moisture retention, oxygen permeability, comfort, and biodegradability.

Materials and Methods

In this study, amphiphilic nanofibers were fabricated using a conjugate bubble electrospinning setup. The nanofibers featured a hydrophilic side composed of polyvinyl alcohol (PVA) enhanced with chitosan (CS) and sodium alginate (SA), and a hydrophobic side composed of poly(ε-caprolactone) (PCL) and polyvinylidene fluoride (PVDF), each loaded with curcumin (Cur) and rutin (Ru). The diameter, air permeability, tensile strength, and water contact angle of the nanofibers were measured to evaluate their suitability for wound dressing applications. In vitro drug release, antibacterial tests against Vibrio and E. coli, cell viability studies on L929 cells, and in vivo wound healing tests on rats were conducted to assess their performance.

Results and Discussion

Water contact angle measurements revealed enhanced hydrophilicity with the addition of CS and SA, which are crucial for effective exudate management. The incorporation of Ru on the hydrophobic side significantly reduced hydrophobicity, while Cur had a minimal impact on the water contact angle. In vitro drug release profiles demonstrated superior efficacy for combinations featuring SA on the hydrophilic side and Ru on the hydrophobic side, with faster release rates observed in PCL nanofibers compared to PVDF.

Cell viability results indicated that nanofibers with SA exhibited the lowest toxicity and promoted robust cell proliferation. In vivo wound healing assessments showed that bipolymeric nanofibers, with PCL loaded with rutin on the hydrophobic side and SA-loaded PVA on the hydrophilic side, exhibited superior performance, achieving 95% wound recovery within 15 days. In vitro degradation studies provided insights into the nanofibers' behavior in simulated body fluid, while thermogravimetric analysis revealed their decomposition behavior up to 600°C.

Conclusion

This study highlights the potential of conjugate bubble electrospinning for the development of advanced wound dressing materials with multifunctional properties. By integrating hydrophilic and hydrophobic components, such as PVA, CS, SA, PCL, and PVDF, loaded with curcumin and rutin, we have created a wound dressing capable of both exudate absorption and therapeutic delivery. The combination of SA-PVA and PCL-rutin nanofibers demonstrated superior performance in drug release, cell viability, and antibacterial effectiveness. These nanofibers, with high hydrophilicity, facilitated a moist yet non-exudative wound environment, accelerating the healing process. The efficacy of this bifunctional material was validated through in vivo studies on rats, showcasing its potential as a superior solution for wound healing.

Keywords: Conjugate bubble electrospinning, biopolymer nanofibers, wound healing, Janus structured nanofibers.

EXPLORING THE EFFECTS OF ODOUR-MANAGEMENT TEXTILE TREATMENTS ON CONSUMER LAUNDRY HABITS

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Presentation time: Tuesday, March 18 at 9:15 am (MT)/11:15 pm (EST)

Introduction

The application of odour-management textile treatments has gained popularity in the market due to consumer's attitudes toward hygiene and the increased emphasis on an active lifestyle. Marketing for antibacterial and odour control clothing can include

claims that it does not need to be laundered as frequently as clothing without these specialized treatments. This often translates to claims of the clothing being more sustainable because of the opportunity to reduce water and energy use with less frequent laundering. However, there is little research to support these claims. The purpose of this study was to determine if consumers change their laundering behaviours when clothing has an odour-controlling treatment applied.

Methods

A survey was conducted with an experimental component, where participants were presented clothing hangtags for athletic shirts from a hypothetical clothing company. Participants were randomly assigned to one of three groups – odour-control treatment, antimicrobial treatment, or control – and asked to answer a series of questions about when they would choose to launder the hypothetical shirt given the treatment that was applied. Following the series of questions, participants were then presented with a hangtag for a different treatment and asked similar questions about when they would choose to launder the shirt so between-subject and within-subject analyses could be done. The Kruskal-Wallis test used to test for significant differences between groups and the Friedman test used to test for significant differences within groups.

Results and Discussion

There were 116 survey responses from the university population (undergraduate and graduate students and staff). Of those responses, 104 completed the experimental section and were used in the analysis. Participants believed the odour-control and antibacterial treatments could be effective; indicating clothes with these treatments would not smell as much of body odour ($p<0.001$). They believed the clothing with an antimicrobial finish would be cleaner ($p=0.023$) and more hygienic ($p=0.011$) than the untreated control. However, they did not change the number of times they would wear the t-shirt before laundering regardless of fabric treatment, how strongly the t-shirt smelled, or how heavily the shirt was sweat in during exercise.

Conclusion

While participants did acknowledge that the fabric treatments could have some benefits for the clothing – less likely to smell of body odor, more hygienic, and cleaner, there was little reported behaviour change with these treatments when it came to laundering habits. This suggests that providing information on hangtags alone is not enough to change behaviour and that we need more education for consumers about reducing laundering frequency.

WIND'S IMPACT ON THERMAL RESISTANCE: CHALLENGING EXISTING STANDARDS.

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Presentation time: Wednesday, March 19 at 11:00 am (MT)/1:00 pm (EST)

Introduction

Numerous workers are exposed to harsh working environments characterized by cold temperatures and intense winds. These conditions pose significant health risks. While standards like ISO 11092 provide valuable guidance for assessing the thermal resistance of textile assemblies, the crucial influence of wind speed and direction on actual performance is often overlooked. This presentation aims to address this critical gap by showing the effects of wind on the thermal resistance of a novel bio-based nonwoven textile assembly.

Materials & Methods

The study focused on a technical bio-based textile assembly ("BTA") composed of a unique blend of milkweed, kapok, and polylactic acid fibers. Three BTA samples with varying mass per unit area were subjected to a range of wind speeds (0 to 4 m/s equivalent to 0 to 14.4 km/h) in both horizontal and vertical directions. Thermal resistance was measured using a modified guarded hotplate apparatus, rigorously validated against the ISO 11092 standard.

Results & Discussion

Results demonstrated a significant decrease in thermal resistance with increasing wind speed for all samples. Notably, vertical wind exerted a more pronounced impact on thermal resistance compared to horizontal wind, with reductions reaching up to 81% for the highest wind speed in the vertical direction. This highlights the critical importance of considering wind direction when evaluating the thermal performance of protective clothing systems.

Furthermore, a comparison of experimental results with theoretical predictions based on the ISO 9920 standard revealed significant discrepancies. The ISO 9920 model consistently overestimated the thermal resistance of the BTA samples, particularly at higher wind speeds. These findings underscore the limitations of existing models in accurately predicting the thermal performance of textile assemblies under dynamic wind conditions.

Conclusion

This research provides crucial insights into the impact of wind on the thermal resistance of bio-based textile assemblies. The findings reveal that current standards may not fully account for the intricate interactions between wind conditions and material properties in real-world settings. These results have significant implications for the design and development of more effective protective clothing systems for workers exposed to cold and windy environments. By integrating these findings, it is possible to develop more durable and reliable protective gear that enhances workers' safety and comfort in harsh conditions.

OPTIMIZING THE PULPING CONDITIONS OF HEMP BAST FIBRE FOR LYOCELL FIBRE PRODUCTION

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Presentation time: Wednesday, March 19 at 11:15 am (MT)/1:15 pm (EST)

Introduction

Hemp bast fibre from Canadian cultivars offers a potential as a feedstock for regenerated cellulosic fibre production through the lyocell process. It exhibits alpha-cellulose contents in the range of 70%, higher than the values reported for eucalyptus and bamboo, which are the traditional feedstock materials for lyocell fibres. This study evaluates the results of pre-hydrolysis and alkali treatments of hemp fibre using different conditions to optimize the hemp fibre pulping process.

Materials and Methods

Hemp bast fibre from the Canadian cultivar Anka, supplied by Canadian Rockies Hemp Corporation, was processed through pre-hydrolysis and alkali treatment as part of the dissolving pulp preparation steps. The efficiency of the treatment was assessed in terms of alpha-cellulose, hemicellulose, lignin content as well as reaction yield. The alpha-cellulose, hemicellulose, lignin, ash, extractives, moisture, and metal content of the hemp bast fibre feedstock were also characterized.

Pre-hydrolysis was conducted using sulfuric acid and water under various temperature and treatment time conditions. The alkali treatment involved sodium hydroxide (NaOH). Three treatment times were tested for the alkali treatment. These pre-hydrolysis and alkali treatments were conducted in microreactors within a fluidized sand bath system.

The resulting pulp samples were analyzed for each condition using High-Performance Liquid Chromatography (HPLC) to determine the alpha-cellulose and hemicellulose content according to ASTM E1758-01(2020). The lignin content was characterized by gravimetry following ASTM E1721-01(2020). The yield of the reaction was computed from the results of weight measurements before and after treatment.

Results

The initial hemicellulose content in the hemp bast fibre was 9.5%, which exceeded the target of 5% for lyocell-dissolving pulp. A high content of hemicellulose may weaken the mechanical strength of the lyocell fibre produced. With a value of 3.1%, the lignin content was also too high as a high lignin content can hinder the ability of cellulose to dissolve in N-methyl morpholine N-oxide (NMMO), resulting in low-quality final fibre.

Different pre-hydrolysis conditions were explored to reduce the hemicellulose content to the desired level. For the same temperature, the acid treatment was observed to be more efficient at reducing the hemicellulose content compared to water pre-hydrolysis. Increasing the pre-hydrolysis temperature from 120 to 170°C lowered the hemicellulose content by almost 60%. It led to an alpha-cellulose content of more than 90%. Simultaneously, the yield decreased by 20%. Various alkali treatment conditions are currently being investigated using a 4% NaOH solution to reduce the lignin content to trace amounts.

Conclusions

Hemp bast fibre from Canadian cultivars demonstrates strong potential for lyocell fibre production due to its high alpha-cellulose content. While the initial composition exceeded the desired levels of hemicellulose, lignin, ash, extractives, and metal ions, pre-hydrolysis has been successfully optimized to address the high hemicellulose content. Trials with various conditions of alkali treatments are ongoing to reduce the lignin content. Further treatments, including chelation, bleaching, dope preparation, and spinning, will be conducted to refine the pulp's properties and produce high-quality lyocell fibre.

LOCALIZED INTEGRATION OF COMPLEX ELECTRONIC SYSTEMS IN WOVEN FABRICS

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Presentation time: Wednesday, March 19 at 11:30 pm (MT)/1:30 pm (EST)

Introduction

Weaving is one of the oldest and most extensively used fabric manufacturing methods involving the interlacement of two perpendicular yarn sets known as the warp and weft[1,2]. Typically, a single weft yarn extends across the entire fabric width, while a single warp yarn spans its length. However, for electronic textiles (e-textiles), integrating electronic components in specific sections is often necessary to enable localized functionality. While numerous studies have explored the incorporation of conductive materials into woven structures, the direct integration of complete electronic systems into specific fabric regions using a commercially available loom remains unexplored. This practice-based research introduces innovative weaving techniques to integrate complex electronic systems into localized areas of woven structures using a Studio Dobby Loom.

Methods and Materials

This study aims to pave the way for scalable e-textile production that retains the appearance and feel of traditional fabrics via two primary approaches: (1) an inlay technique for inserting electronically active yarn (Figure 1) along the weft for localized continuous weft positioning and (2) a second beam approach for integrating specialized materials into specific warp sections. These methods were applied to incorporate a complex electronic system, comprising a microphone, microprocessor, wire interconnects, and an electrical stimulation system (E-stim), within an 18" x 12" hand-woven fabric, restricting the electronics to a 14" x 8" area. A 3x1 twill weave was used to help conceal electronic elements. A stick shuttle facilitated the inlay of weft yarn, with electronic components wrapped in weft yarn before insertion and beat-up. Warp yarns were tied to a stick for precise localized placement along the warp, simulating an additional warp beam for enhanced control.

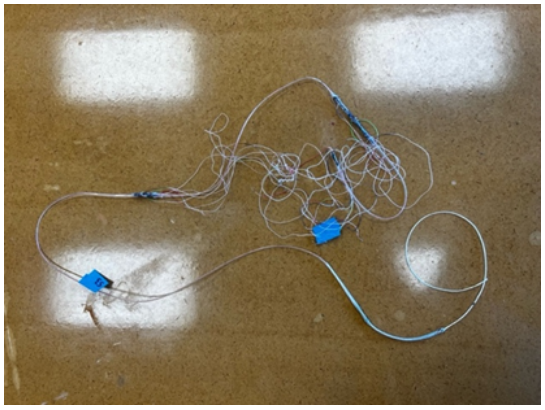

Figure 1: Complex electronic system used in this study

Figure 2: Studio Dobby Loom used for fabric production

Results and Discussion

Preliminary results demonstrate the feasibility of integrating complex electronic systems while maintaining fabric integrity and aesthetic qualities resembling traditional textiles. Figure 3 illustrates the produced sample, with overall fabric dimensions of 18" x 12" and electronic components (Figure 1) localized within a 14" x 8" area. Notably, the precise placement of the electronic system can be adjusted by modifying the bending radius of the conductive yarn or components.

The results indicate that while smaller bending radii enable tighter integration, they may negatively impact signal transfer, mainly when using stiff conductive materials. This limitation arises from increased stress on the interconnects, which can lead to microfractures or electrical discontinuities. Furthermore, the twill weave structure effectively concealed the electronic components, preserving the fabric's visual appeal. Although a double weave could provide an alternative, it would result in increased fabric thickness when using the same yarn count.

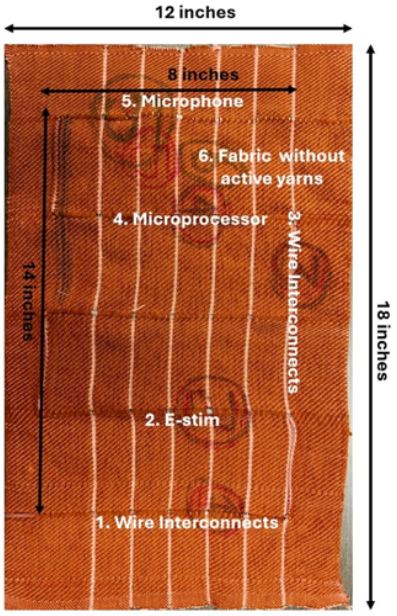

Figure 3: Manufactured fabric sample

Conclusion

This study introduces scalable weaving techniques to integrate complex electronic systems into localized regions of woven fabrics while minimizing impacts on their tactile and visual properties. The results demonstrate that fabricating e-textiles with embedded electronic systems is achievable using minor modifications to conventional weaving equipment. Specifically, adaptations such as enhanced weft insertion systems, adjustable beat-up forces, and enlarged guides for accommodating irregularly shaped components can significantly expand the capabilities of commercial looms for e-textile production. Future work will focus on optimizing weaving parameters to improve the electrical and mechanical performance of integrated systems. Furthermore, assessing the durability of these fabrics under various environmental and usage conditions will be necessary to advancing the commercial viability of woven e-textiles.

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TEXTILE STRUCTURAL COMPOSITES: HEMP-BASED BRAIDTRUDED REBARS FOR SUSTAINABLE INFRASTRUCTURES

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Introduction

The integration of bio-based fiber-reinforced polymer composites (Bio-FRPCs) into structural applications presents a sustainable alternative to conventional materials such as metal and synthetic FRPC rebars [1]. These conventional materials require energy-intensive manufacturing processes which leads to CO_2 emissions, depletion of natural resources, and recycling problems [1], [2]. Besides sustainability, conventional rebars also pose challenges such as corrosion susceptibility and higher maintenance costs over time which makes them less ideal [3], [4].

Braiding is a textile manufacturing technique that involves intertwining of yarns in various patterns to form a continuous preform structure which can be tailored by adjusting processing parameters, such as braid angle, yarn tension, and the number of carriers used in the braiding process [5], [6]. Finally, the braidtrusion process is a

combination of braiding and pultrusion which allows for continuous fiber integration, alignment and resin impregnation [7]. This research aims to study the pseudoelastic behavior of braidtruded rebars with a core-shell structure.

Materials & Methodology

The braidtrusion process was utlised to manufacture Bio-FPRC rebars which consist of hemp yarn shell braided around a unidirectional regenerated cellulose core. A two-dimensional braiding machine was utilized with 18 spools of hemp yarn operating at 40 RPM to ensure good fiber alignment and uniform density, with the core of regenerated cellulose yarn which densified to ensure compact structure and structural stability. These preforms were then impregnated with an in-house synthesized bio-resin composed of Epoxidized Linseed Oil (ELO) and Linseed Oil. The composite was cured at 150°C under vacuum to reduce void content for thorough resin infiltration.

Five Tensile tests of the braidtruded rebars were conducted by securing them in 4-inch-long tubes using 3D-printed caps and rubber stoppers with a 250 mm gauge length. High-strength epoxy resin (Sikadur® 35 Hi-Mod LV) was used to bond the rebars and cured at 38°C for 36 hours to attain maximum strength. The fully cured braidtruded rebar specimen is securely fixed within threaded tubes, as shown in figure 1. A digital imaging system tracked deformation for precise strain measurements and stress distribution.

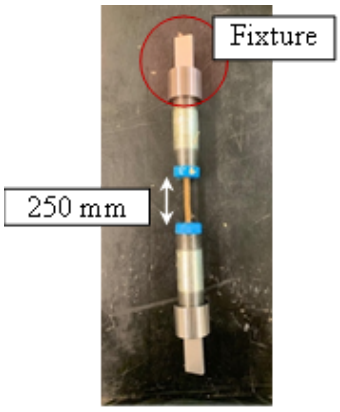

FIGURE 1 FULLY CURED AND SECURED BRAIDTRUDED REBAR WITHIN THREADED TUBES.

Results & Discussion

The mechanical response of the braidtruded rebars demonstrated pseudo-elastic behavior. During tensile testing, an initial linear elastic phase was observed, followed by a yield point at 37.72 MPa, where micro-cracks and fiber-matrix debonding initiated. As loading progressed, stress redistribution within the hemp shell led to a secondary peak at 44.83 MPa which indicated pseudo-elastic strengthening and temporary load-bearing enhancement. This behavior results from the contrasting mechanical properties of the regenerated cellulose yarn core and hemp yarn.

Conclusion

This study demonstrates the structural and mechanical benefits of textile structural composites, braidtruded Bio-FRPC rebars, for a controlled dual-stage failure. These results highlight the potential and versatility of textile structural composites for sustainable infrastructures with lower maintenance costs and recycling advantages over their conventional steel-based counterparts. Future research will focus on further optimizing these materials and evaluating their structural performance under dynamic loading conditions in real-world applications.

REUSE AND REPAIR SKILL-BUILDING – CANADIAN CLOTHING REPAIR EVENTS AND THE FACTORS AFFECTING EVENT ATTENDANCE

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Presentation time: Wednesday, March 19 at 2:00 pm (MT)/4:00 pm (EST)

Introduction

The fashion industry persists as a major contributor to widespread environmental issues, including global CO_2 emissions, water overconsumption, pollution, and landfill accumulation (Niinimäki et al., 2020). These negative outcomes are a direct result of the 'fast fashion model', which encourages excessive consumption and waste due to the vast availability and short lifespan of cheaply produced, poor-quality garments (Linden, 2016). An estimated 1.1 million tonnes of textile waste is generated in Canada each year, resulting in a per capita average of 31.2 kg/year (Cheminfo Services Inc., 2022).

Clothing repair events are a growing global initiative to address textile waste. They are organised, local community workshops that offer the materials, tools, and skilled volunteers to help people fix their damaged clothing and textile items (Repair Café, 2024). The act of mending diverts the clothing waste stream and prolongs garment life, supporting the idea of a circular economy (Diddi & Yan, 2019; Ellen MacArthur Foundation, 2013). Additionally, clothing repair events are an intervention for the general decline and loss of mending skills (McQueen et al., 2022). Participants can develop self-repair skills, build community connections, and promote environmentally sustainable habits with one another.

This study examines Canadians and their awareness of community clothing repair events, as well as the factors that influence their likelihood of attendance, by focusing on the differences between attendees and non-attendees. The goal is to identify potential gaps and opportunities, which may be addressed by repair organizations and/or relevant governing bodies, in order to further encourage clothing repair event attendance.

Methods

An online survey was developed to evaluate Canadians who had and had not attended clothing repair events. Participants were recruited using convenience sampling methods, with a focus on disseminating the survey through social media platforms (e.g., Facebook, Instagram). Additionally, active Canadian repair groups were identified and contacted to help share standardized recruitment notices. The survey questions came from literature sources with established validated scales where possible, with adaptations when necessary. Question topics included clothing repair behaviours, previous clothing repair event attendance, and factors affecting the interest and ability to attend these events. All questions were closed-ended multiple choice, with forced-choice responses.

Results & Discussion

A total of 582 valid responses were collected, of which 107 participants had previously attended a clothing repair event, whereas 475 had not. Of the non-attendees, 39 participants indicated having previously attended a repair event for non-clothing/textile items, while the remaining 436 had never attended any type of repair event. When non-attendees were asked if they had heard about clothing repair events prior to the survey, 50.1% selected “no”.

Table 1 (see Appendix) shows agreement rating results for a series of statements on the ability to attend clothing repair events, based on various physical, psychological, and environmental factors. Independent sample t- tests for statements 1, 2, 5, and 9, relating to physical capabilities and digital/transportation means, revealed that there were no significant differences between attendees and non-attendees at a significance value of 0.001. However, differences were found for statements 3, 4, and 6- 8, corresponding to psychological factors of social anxiety and confidence, and the perception of repair event occurrences, items in need of repair, and time availability. Despite a low response rate for previous clothing repair event attendance, both participant groups displayed a relative ability to attend clothing repair events.

Although the decision to attend a clothing repair event ultimately depends on the individual, the reported ability to attend by both participant groups, in addition to a majority of non-attendees not having heard about such events before, indicate a need for improved public awareness and outreach for these events.

Conclusion

In wake of excessive fashion waste and its increasingly detrimental effects, clothing repair events have become a worldwide movement towards sustainability. The conduction of an online survey revealed that a majority of Canadians had never attended a clothing repair event before or had heard about such events. Strengthening the promotion of clothing repair events would likely lead to increased participation, contributing to greater fashion sustainability.

Acknowledgments

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Appendix

Statement	Attendees	Non-Attendees
1. I believe I am physically capable of repairing clothes	6.39 ± 0.77[a]	6.31 ± 0.95[a]
2. I believe I am capable of learning and following clothing repair instructions	6.30 ± 0.83[a]	6.26 ± 0.93[a]
3. I would feel too socially anxious to attend a clothing repair event	2.62 ± 1.83[a]	3.39 ± 1.93[b]
4. I am confident that I could attend a clothing repair event if I wanted to	6.21 ± 0.96[a]	5.68 ± 1.32[b]
5. I have the means (e.g. working device, internet connection, social media) to become aware of clothing repair events near me	6.32 ± 0.99[a]	6.25 ± 0.93[a]
6. There are likely to be plenty of opportunities to attend a clothing repair event	4.87 ± 1.60[a]	4.00 ± 1.55[b]
7. I have clothing items that need repair	6.03 ± 1.20[a]	5.10 ± 1.75[b]
8. If I wanted to, I would have the time to attend a clothing repair event	5.69 ± 1.14[a]	5.13 ± 1.48[b]
9. If I wanted to, I would have the transportation means to attend a clothing repair event	6.10 ± 1.14[a]	6.04 ± 1.28[a]
Note: different super-scripted letters indicate a significant difference in agreement rating (p≤0.001)		

TABLE 1. MEAN (± STANDARD DEVIATION) FOR STATEMENTS REGARDING THE ABILITY TO ATTEND A CLOTHING REPAIR EVENT BASED ON A 7-POINT SCALE, WHERE 1 = "STRONGLY DISAGREE" AND 7 = "STRONGLY AGREE" (ATTENDEES N = 107 ; NON-ATTENDEES N = 475).

QUANTIFYING RECOVERED N-METHYLMORPHOLINE N-OXIDE (NMMO) FROM LYOCELL MANMADE CELLULOSIC FIBRES MANUFACTURING WASTEWATER

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Presentation time: Wednesday, March 19 at 2:15 pm (MT)/4:15 pm (EST)

Introduction

The lyocell process offers an exciting future for sustainable textiles. Similar to the viscose process, lyocell fibre is made from cellulose, a material naturally occurring in the environment. Cellulose is not water soluble due to its crystalized structure. As a result, cellulose pulp is dissolved in a solvent to create dope, which is then spun to produce regenerated cellulose fibre. Contrary to the viscose process, lyocell manmade cellulosic fibres (L-MMCF) are produced using a physical and non-derivatized process with the solvent N-methyl-morpholine-N-oxide (NMMO). In addition to being less toxic than carbon disulfite used in the viscose process, NMMO can be recycled at up to 99.7% and reused, thus offering an environmentally friendly strategy to produce regenerated cellulose fibre. The presentation describes the results of a pilot study where we developed a novel method using Fourier Transform Infrared Spectroscopy (FTIR) to quantify the NMMO content in aqueous solutions, which is critical to ensure maximum environmental benefits and lower cost of L-MMCF manufacturing. The quantification method was tested with NMMO recycled from L-MMF production wastewater.

Methods & Materials

The NMMO-containing wastewater used in the study was obtained from lab-scale L-MMCF production using wood dissolving pulp. The wastewater included dissolving pulp, 50 wt% NMMO/water stock solution, propyl-gallate (PG), and MilliQ distilled water.
To establish the calibration curve, several aqueous solutions with different NMMO concentrations between 0.195 and 50% wt% were prepared by serial dilution. FTIR measurements were performed on these solutions as well as on distilled water, the dissolving pulp, and PG. FTIR measurements were also done on the filtered L-MMCF production wastewater before and after evaporation using a rotary evaporator.

Results & discussion

The FTIR spectrum of NMMO showed a peak at 1116 cm-1, which was attributed to the C-N tertiary amine bond in NMMO. This peak was used to create an NMMO content calibration curve from the results obtained for the serial dilutions of the NMMO stock

solution. The calibration curve provided a limit of detection of 0.04wt% and a limit of quantification of 0.1wt% with an R-square value of 0.9995. This FTIR quantification method and the associated calibration curve successfully characterized the NMMO content in L-MMCF production wastewater before and after evaporation using a rotary evaporator. The NMMO concentration in the L-MMCF production wastewater before evaporation was 2.7wt%. After 240 minutes of evaporation at 90°C, the NMMO concentration was 51.4wt%, which is very close to the concentration of the stock solution used for L-MMCF manufacturing. A comparison of the L-MMCF production wastewater before and after evaporation showed that the NMMO had not experienced any significant degradation throughout the recovery process.

Conclusion

The pilot study successfully recovered NMMO to a concentration ready to be reused in the lyocell process without degrading the NMMO. This also provides a simple quantification method of NMMO content in aqueous solutions, which can be used to analyze L-MMCF production wastewater before and after NMMO recovery. These findings support advances in L-MMCF manufacturing and the reduction in textile environmental footprint.

THERMAL DRAWING OF ADDITIVELY MANUFACTURED PREFORMS FOR SMART FIBER FABRICATION

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Presentation time: Wednesday, March 19 at 2:30 pm (MT)/4:30 pm (EST)

Introduction

The advancement of smart fibers has gained significant interest due to their potential applications in wearable electronics, sensing, actuation, and energy harvesting. This has necessitated innovative approaches for manufacturing such fibers. Traditional fiber fabrication techniques, such as melt spinning and solution spinning, often face limitations in achieving complex material compositions and geometries. This research explores a novel approach that combines additive manufacturing (AM) and thermal drawing to fabricate multi-functional smart fibers. Additive manufacturing offers unparalleled design freedom to create intricate preforms with embedded functional elements. Thermal drawing, a well-established technique for producing optical and microstructured fibers, is adapted to process AM based preforms into smart fibers. By combining the design flexibility of additive manufacturing and the ability of thermal drawing processes to translate macro scale structures in a preform to micro scale structures within an individual fiber, we enable the scalable production of fibers with

precise control over fiber architecture and material distribution. The study aims to optimize process parameters, investigate the compatibility of AM polymers with thermal drawing, and evaluate the uniformity and performance of resulting fibers to create a consistent, promising platform for next generation smart fiber development.

Materials and Methods

Polymer preforms were fabricated using a combination of off-the-shelf and custom-built multi-material FDM 3D printers, allowing for the incorporation of various thermoplastic polymers, including polylactic acid (PLA), polyethylene terephthalate glycol (PETG), polycarbonate (PC), nylon (PA), styrene ethylene butylene styrene (SEBS), and shape memory polymer (SMP). Functional elements such as eutectic indium gallium (EGaIn) – a non-toxic room temperature liquid metal – were integrated into the preforms both during the AM process and during the draw process. The preforms were then thermally drawn in a custom-built drawing tower (Fig. 1), where parameters such as furnace temperature, feed rate, fiber uptake speed, draw ratio, tension, were systematically varied to achieve controlled fiber geometries and maintain material functionality. Scanning electron microscopy and optical microscopy was employed to assess fiber morphology and preservation of cross-sectional geometry, while electrical and mechanical characterization was conducted to evaluate conductivity, tensile strength, and flexibility.

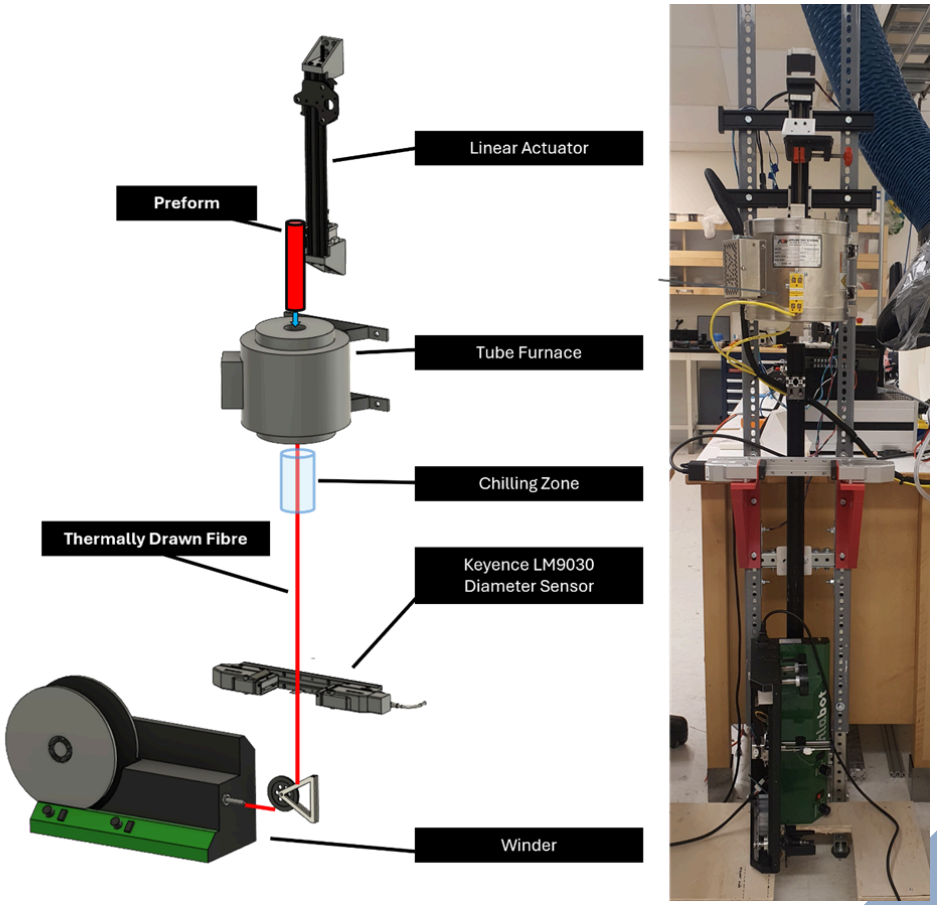

FIGURE 1: SCHEMATIC AND PHOTOGRAPH OF THE CUSTOM-BUILT LABORATORY SCALE THERMAL DRAW TOWER.

Results and Discussion

Preliminary results indicate that additively manufactured preforms can be successfully drawn into continuous fibers with diameters ranging from 200 to 800 while preserving internal geometrical features (Fig. 2). While PLA and PETG show ease of printing, higher performance polymers such as nylon and polycarbonate have exhibited better drawability and fiber strength. Appropriate selection of drawable polymers and optimization of process parameters improved the quality of fibers significantly. Nylon fibers were post-processed via cold pulling to further reduce their diameter and increase strength before being successfully knit into a fabric swatch. Liquid metals were integrated into hollow SMP and SEBS fibers to achieve actuation, electrical conductivity, and strain sensing capabilities.

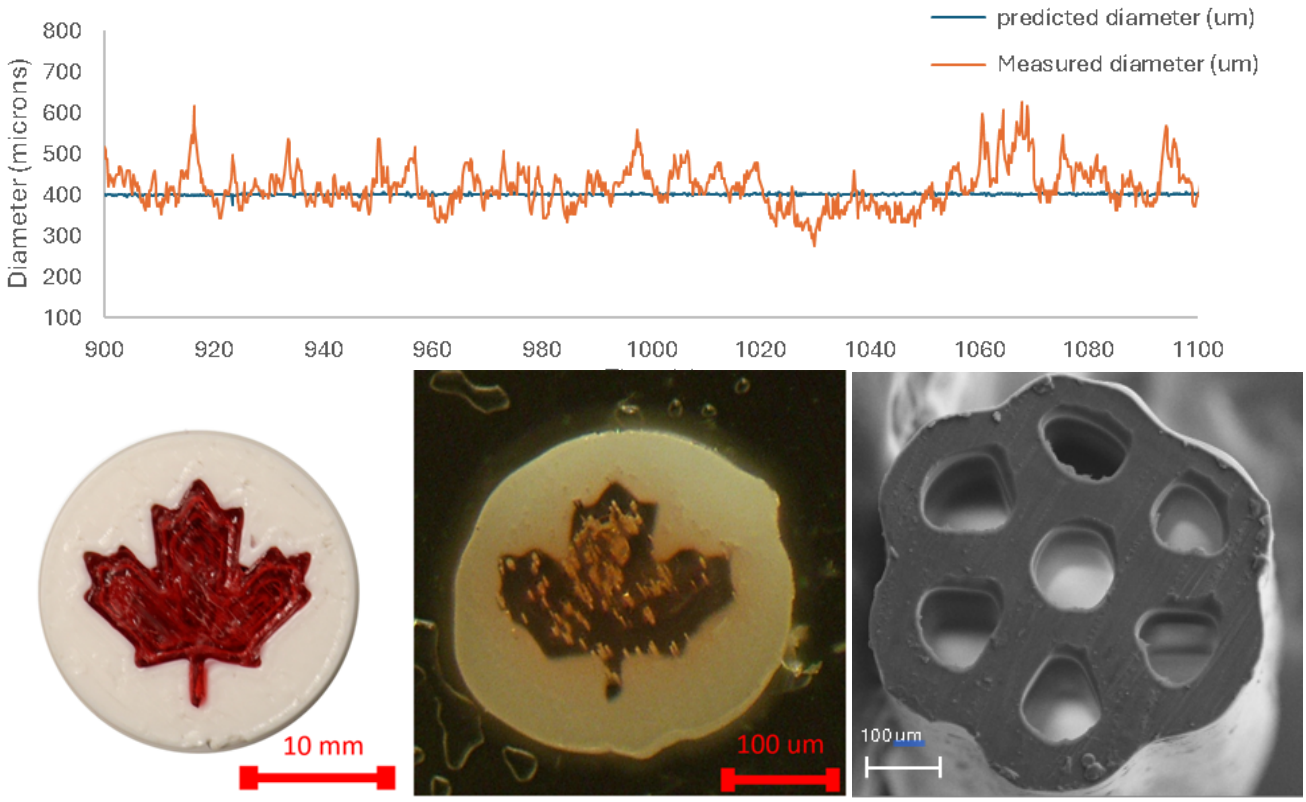

Figure 2: (Above) - plot of thermally drawn filament diameter over time. (Bottom left) - multicolor PETG Canadian flag cross section preform, and (Bottom middle) - resulting cross section of thermally drawn filament. (Bottom right) – SEM image of 7-channel EGaIn filled PETG filament.

Conclusion

In conclusion, this study demonstrates the feasibility of utilizing 3D-printed polymer preforms for the fabrication of smart fibers via thermal drawing. The ability to integrate conductive and functional materials within a controlled fiber structure opens new avenues for textile-integrated electronics, responsive fabrics, and soft robotic actuators. Future work will focus on refining material formulations, improving drawing uniformity and stability, and exploring real-world applications in wearable sensing and actuation. By bridging additive manufacturing and fiber manufacturing technologies, this approach presents a scalable and customizable pathway for next-generation textile innovations.

"MAKING DO": HOW ALBERTAN FEMALE FIREFIGHTERS ARE OVERCOMING THE CHALLENGES OF POORLY FITTED FIRE PROTECTIVE CLOTHING

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Presentation time: Wednesday, March 19 at 2:45 pm (MT)/4:45 pm (EST)

Introduction

Fire protective clothing (FPC) is a critical part of the toolkit used to protect firefighters. However, the degree of protection provided by the FPC largely depends on its fit. Poorly fitted FPC may decrease the degree of protection below the expected level. At the same time, it may create new hazards, e.g., as the garment interferes with the actions of the firefighter. Ongoing research has suggested that female firefighters face greater difficulties in finding FPC that is adequately fitted, leading to modifications of FPC, improper garment use, and overall interference of FPC with work activities. Until now, the specific challenges of Canadian female firefighters in finding FPC with adequate fit were largely anecdotal. This research aims to document the experiences of female firefighters in Alberta, Canada to understand how they are overcoming challenges associated with their FPC. Specifically, the study investigates in-process and physical modifications made to the FPC in order to allow female firefighters to do their job.

Methods

Semi-structured, in-person, subject-object interviews were conducted with structural and volunteer female firefighters working in Alberta, Canada. Participants were asked to bring their turnout gear to the interview to facilitate discussion about any changes that had been made to the gear. Interview audio was recorded, and photographs were taken to capture alterations and fit issues described by the participants. Thematic analysis was used to qualitatively analyze the interview transcripts.

Results & Discussion

Five participants with varied experience in volunteer and career firefighting were interviewed. Participants discussed their experiences with both custom fitted gear and communal gear, with varying levels of satisfaction for both types. Advocacy and solidarity among female firefighters in the fire departments were identified as themes which positively impacted access to well-fitted FPC. In contrast, communal gear pools and turnout gear sharing were identified as major barriers for female firefighters in accessing FPC, especially during training and early career. In terms of modifications made to the FPC, several themes were identified including changes to undergarments, PPE compatibility issues, in-process modifications to movements and gear, manufacturer-approved modifications, and resistance to modifications. The results indicate that access

to well-fitted protective clothing has improved over the years as more women have entered the fire service, but modifications are still often needed in order to cope with wearing FPC that was designed for a male physiology.

Conclusion

This pilot study has interviewed a small group of female firefighters to better understand how their working conditions and minority status in the workforce limit their access to FPC. Although most respondents expressed an improvement in access to suitable FPC since beginning their careers, further work is needed to ensure equitable access for all female firefighters. Moving forward, this project aims to assess, on a nation-wide scale, how modifications are used to improve the fit of FPC for female firefighters, as well as how these modifications are impacting the safety of the individuals.

The Institute of Textile Science

2025 ITS SYMPOSIUM
ABSTRACTS FOR POSTER PRESENTATIONS

SEX-BASED VARIATIONS IN BODY PRESSURE MAPPING FOR SLEEPING BAG APPLICATIONS

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Presentation time: Tuesday, March 18 & Wednesday, March 19 at 2:00 Pm (EST)
Location: Montreal

Introduction

Sleeping bags are personal protective equipment designed to keep people warm in cold outdoor conditions. However, when a person lies in a sleeping bag, body pressure compresses it, reducing its thickness and insulating air volume, decreasing its thermal resistance. Some studies show that pressure distribution is influenced by factors such as BMI, and materials used to design sleeping bags. However, these studies do not comprehensively examine the effects of sex, sleeping positions, or pressure distribution of each body part. This study aims to address these gaps by evaluating pressure distribution in sleeping bags and mats across various sleeping positions, with a specific focus on the role of sex as a moderating factor.

Materials and Methods

A sample of 20 participants (10 men, 10 women; aged 18–50, BMI 18–30) were recruited. Informed consent was obtained with ethics approval from the University of Montreal (2024-5514). A sleeping bag (Outer fabric: 100% nylon, Insulation: 100% polyester) and sleeping mat (Outer fabric: 100% nylon, Filling: 100% EVA) were applied as a textile layer. A Tactilus® Body Mapping Mattress Pad (Sensorprod, Italy) was used to measure surface contact pressure between the body and mattress. With 1612 sensors over a 2000 mm × 900 mm area, it measured pressures from 0 to 14 kPa. Tests assessed three conditions: mattress alone, with a sleeping mat, and with a sleeping bag on the mat. Participants tested supine,

prone, and side positions, repeated thrice per condition. Average pressures were analyzed using three-way repeated measures ANOVA, considering sex, body part, and test conditions. Significant main effects or interactions were further examined using post-hoc Bonferroni tests, with a significance level set at $P < 0.05$.

Results

This study analyzed average pressure across various body parts in different sleeping positions, revealing significant variations based on test conditions, body parts, and participant sex. The highest pressures were observed on the buttocks (supine), torso (side), and torso (prone), while the lowest were on the heels, shanks, and thighs, respectively. Adding a sleeping mat or sleeping bag reduced pressure compared to the pressure mat alone, attributed to the increased contact area. The differences between the sleeping mat and sleeping bag were body-part-specific; for instance, the head and buttocks experienced higher pressure with the mat in the supine position, while the head, torso, and hips had lower pressure with the bag in the side position. Statistical analysis confirmed significant interactions between test conditions and body parts across all sleeping positions ($P < 0.01$). Additionally, sex significantly influenced pressure distribution, with males exerting higher pressure on the head, shoulders, and buttocks (supine), torso (side), and head (prone). These findings highlight the complex interplay between sleeping surfaces, body regions, and individual factors in pressure distribution.

Conclusions

This study's findings significantly impact the sleeping bag industry by guiding the development of products with improved thermal insulation, comfort, and pressure distribution. Advanced materials, such as compressible insulating layers and high-surface-area textiles, can enhance product performance. This can lead to innovations in design, catering to outdoor enthusiasts and professionals, while driving competitiveness and sustainability in the industry through better material selection and manufacturing techniques.

EVALUATING THERMAL INSULATION OF BALLISTIC VEST AND TURNOUT GEAR ON FIREFIGHTER HEAT STRAIN

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Presentation time: Tuesday, March 18 & Wednesday, March 19 at 2:00 pm (EST)
Location: Raleigh

Introduction

Between 2019 and 2024, 122 incidents occurred in the USA where firefighters were shot and killed while responding to active-shooting scenarios. After firefighters became targets of violence, fire departments requested funds to make ballistic vests standard personal protective equipment (PPE). Research studies indicate the potential harmful impact on firefighter heat strain when adding additional layers and thickness to the turnout gear [1]. Wearing ballistic vests with turnout gear, therefore, may increase the risk of heat strain to the firefighters [2] due to increased thermal insulation. Thermal insulation measures the ability of a material or system to reduce the transfer of heat.

Materials and Methods

Test ensembles

To quantify the thermal insulation, six firefighting ensembles were tested: E1) station uniform; E2) station uniform+ballistic vest; E3) station uniform+turnout suit; E4) station uniform+turnout suit+ballistic vest worn under turnout jacket; E5) station uniform+turnout suit+ballistic vest worn over turnout jacket; E6) station uniform+turnout suit+ballistic vest with hard plates.

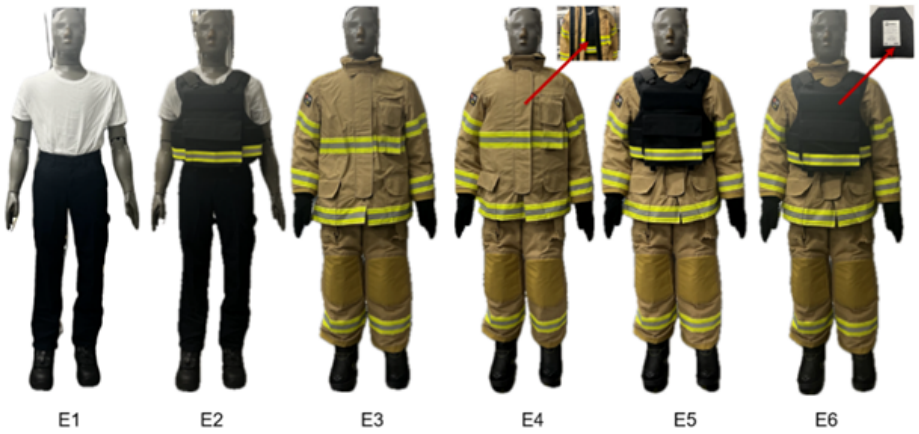

FIGURE 1. LIST OF TEST ENSEMBLES

Test conditions

Dry test was conducted to assess the thermal insulation of the clothing ensembles following the ASTM1291 standard. The mean surface temperature of the manikin was 35 °C ∓0.1 °C. The air temperature, relative humidity and wind speed in the test chamber were 15°C, 45-55%, and 0.4 m/s respectively.

Results and Discussion

The thermal insulation (Rt) values for E1, E2, E3, E4, E5, and E6 in the torso area were 0.166, 0.331, 0.463, 0.622, 0.652, and 0.631 m2·°C·W–1 respectively. The results evidently depicted a progression of thermal insulation values in the torso area with adding layers. Rt increased from 0.166 m2·°C·W–1 in E1 (baseline-without ballistic vest) to 0.331 m2·°C·W–1 in E2 (with ballistic vest added).

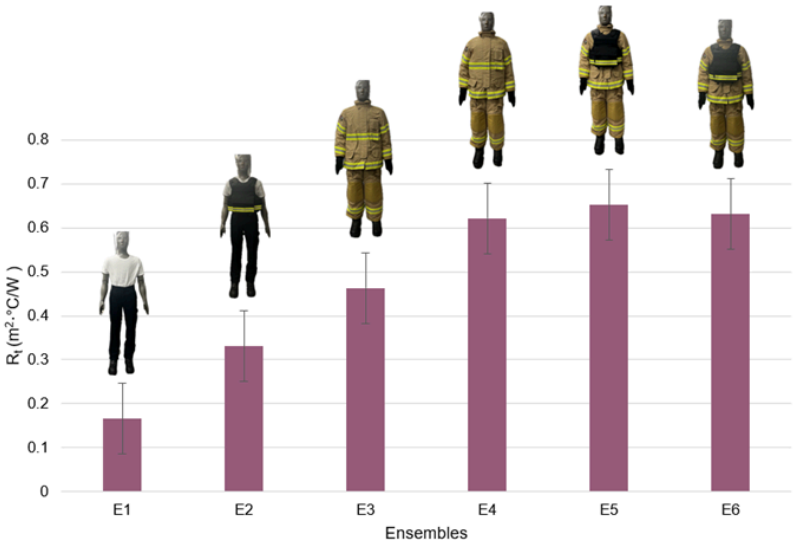

Figure 2. Thermal insulation of firefighting clothing ensemble in conjunction with ballistic vest

The relative increase in Rt from E1 to E2 is approximately 99%, which indicated twice the thermal insulation with the addition of the ballistic vest. The further increase in Rt through E3 to E6 up to 0.652 m2·°C·W–1 demonstrated the compounding effect of additional layers in the firefighting turnout ensemble. The substantial increase in Rt from E1 to E2 is due to the dense materials in ballistic vests that is designed to provide ballistic protection that inherently reduced heat transfer. The further increase in Rt through E3 (baseline-without ballistic vest) to E6 was caused by the added layers of turnout suits. The additional layer of ballistic vest in E4, E5, and E6 increased the thermal insulation further. Despite adding hard plates to the ballistic vest in E6, it had a Rt of 0.631 m2·°C·W–1 which is lower than E5. It indicated that adding hard plates reduced air gaps and created more contact points for heat transfer which led to the lowering of thermal insulation of E6.

Conclusion

The increase in thermal insulation from the ballistic vest and additional layers correlates directly with the potential for heat strain on the firefighters due to the impaired heat dissipation capacity of the ensembles. Higher thermal insulation confirms less heat transfer from the body which can lead to an increase in skin temperatures, core temperatures and cardiac output. The increase in these physiological responses can negatively affect the firefighters by causing extreme fatigue, heat-related illness, and degradation in work performance.

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OPTIMIZATION OF DISSOLVING CELLULOSE PULP PREPARATION FROM WASTE COTTON FOR LYOCELL FIBRE PRODUCTION.

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Presentation time: Tuesday, March 18 & Wednesday, March 19 at 10:00 am (MT)
Location: Edmonton

Introduction

This research focuses on recycling waste cotton to produce regenerated cellulose fibres via the lyocell process. This will not only divert it from landfills but also provide a Canadian source of regenerated cellulose fibres. This communication describes the work performed to optimize the pulping process using a finished flame-resistant cotton (FRC) fabric as feedstock.

Methods & Materials

The material used as a feedstock is a 100% cotton fabric. It is navy blue. In addition, it has a flame-retardant (FR) and water repellent finish. This fabric is employed to manufacture coveralls used in the oil and gas industry. Before applying the pulping treatment, the fabric was washed following the 6N condition (ISO 6330) to remove unfixed dyes, residual chemicals, and other impurities. Then, fabric samples were milled to extract the fibres from the fabric. Hydrolysis was conducted at three temperatures (70°C, 80°C, and 90°C) and three durations (30, 60, 120 minutes) with six sulfuric acid concentrations (0.5% to 3.0%). The optimization considered the degree of polymerization (DP) and the yield as criteria. The DP was calculated using the Mark–Houwink equation from the values of intrinsic viscosity measured following ASTM D1795-13(2021). The yield was computed based on weight measurements before and after each step of the treatment.

Results & Discussion

The initial value of the DP was 1284. The pulp DP should be between 550 to 650 at the end of the pulping process for the pulp to be appropriate for lyocell fibre manufacturing. Increasing the acid concentration from 0.5% to 3.0% reduced the DP by approximately 43%, while extending the reaction time from 30 to 120 minutes lowered the DP by about 35%. Additionally, raising the temperature from 70°C to 90°C resulted in a DP reduction of nearly 54%. The hydrolysis treatment significantly reduced the

transition metal content, which is a critical aspect for the lyocell process due to the risk of runaway thermal reactions. However, the iron content remained slightly higher than the recommended threshold of 10 ppm. This points to the need to apply chelation to the pulp, which is currently underway. It was also observed that the phosphorus content was largely retained through the hydrolysis process and remained close to the recommended range for FR-finished fabrics. Finally, there was no significant effect of the treatment conditions on the hydrolysis yield, which ranged between 95% and 97%.

Conclusion

This study demonstrates the effective preparation of lyocell dissolving cellulose pulp from waste FR cotton fabric through acid hydrolysis. The optimized process achieved a high yield and successfully reduced the DP to the recommended range for the lyocell process. Transition metals were significantly reduced during hydrolysis. The residual iron will be further reduced through chelation before the pulp is used to spin fibres which will be assessed for FR performance and tensile strength. The study's findings will help researchers, the industry, and policymakers aiming to promote sustainable practices in textile manufacturing.

OPPORTUNITIES FOR CIRCULARITY: SORTING CANADA'S TEXTILE DONATIONS.

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Presentation time: Tuesday, March 18 & Wednesday, March 19 at 10:00 am (MT)
Location: Edmonton

Introduction

The rise of the fast fashion model has encouraged excessive consumption and disposability of clothing which has led to an increase in textile waste and environmental degradation. Adopting a circular economy approach prioritizes the extended use of materials, ensuring that items remain in use for as long as possible, while non-reusable textiles are recycled to extract their value, ultimately reducing waste. By taking a closer look at the characterization of clothing and textiles donated to second-hand stores, this study aims to evaluate their potential for revaluation within a circular economy.

Materials & methods

We collected and sorted 7256 items (1,505 kg) of clothing and textiles from select non-profit thrift organizations throughout Edmonton, Saskatoon, and Toronto, determining their suitability for reuse and recycling within Canada. We analyzed key textile characteristics including the fibre content from the garment label and with Near Infrared Spectroscopy (NIRS) scanning, quality and condition, and fabric construction. Each characteristic was explored further to determine overall composition and suitability for reuse and recycling.

Results

Fibre content results from both the label and NIRS scanning revealed cotton to be the most dominant fibre (Label: 51.1%; Scanner: 45.4%), followed by polyester (Label: 29.2%; Scanner: 30.0%). Among the 2729 single-component labelled items, 54.7% were made of fibre blends with the most common blends being cotton/polyester (12%), cotton/spandex (8.6%), and polyester/spandex (7.2%). Notably, spandex was present in 18.6% of labelled garments, but only 2.6% of scanned items which was due to scanner limitations in reading fibres of a small percentage. Quality assessments revealed that 55.5% of items were in a good enough condition to be immediately considered for resale with the thrift stores, while 41.6% of the items could be reused after varying levels of cleaning or repair. Fabric construction was predominantly knit (64%), followed by woven (31%). NIRS scanning limitations presented gaps in fibre identification, especially for multi-layered and coated textiles.

Discussion

While polyester is the most globally produced fibre, our findings indicate cotton dominance amongst donated textiles, possibly due to non-apparel applications of polyester or consumer preferences for cotton in Canada. Certain textile characteristics presented constraints on recycling potential, with high amounts of spandex, fibre blends, and contaminated items unlikely to be considered feasible for recycling. With a lack of textile recycling infrastructure in Canada, mechanical recycling is largely limited to downcycling while chemical recycling remains inaccessible domestically. Design for circularity, emphasizing durability, repairability, and recyclability, could address some of these challenges.

Conclusion

This study underscores the importance of fibre content, quality, and fabric construction in determining the suitability of textiles for reuse and recycling. The results of this research indicate the importance of enhancing circularity in Canada's textile industry through investment in recycling infrastructure, public awareness, and sustainable design practices. By maximizing reuse and recycling, Canada can better manage textile waste and reduce its environmental footprint.

WATER AGEING OF PBO FABRIC – EFFECT OF WATER PHASE AND TEMPERATURE

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Presentation time: Tuesday, March 18 & Wednesday, March 19 at 10:00 am (MT)
Location: Edmonton

Introduction

Firefighter protective garments are designed to provide the required level of safety for firefighters to perform their duty and return to safety. They are manufactured using high-performance fibres to provide the required protection to the wearer. One of the polymers used to manufacture these fibres is poly(p-phenylene-2,6-benzobisoxazole) (PBO). Even though PBO fibres display exceptional performance when new, PBO proved to be susceptible to premature ageing when exposed to moisture and UV (Walsh et al., 2006). This effect was highlighted due to the failure of PBO body armours in 2003 (US Department of Justice, 2004). Residues of polyphosphoric acid (PPA), originating from the manufacturing process, have been identified as a possible reason for this sensitivity of PBO to moisture ageing (Kanbargi et al., 2017). PBO fibres are still used in blended fabrics for firefighter garments, for which exposure to water in different phases is highly prevalent. Hence, this study will focus on enhancing our understanding of the effect of water phase and temperature on the long-term performance of PBO fabrics.

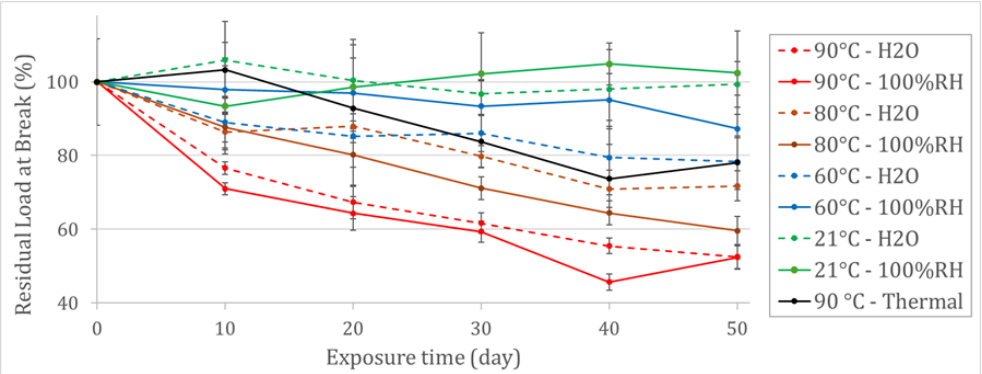
Material and Method

100% PBO fabric specimens were exposed to two water-induced ageing conditions: Hydrothermal (water immersion) and hygrothermal (100% relative humidity). To evaluate the impact of temperature, the ageing programs were conducted at 21, 60, 80, and 90°C. The aged specimens were collected after 10, 20, 30, 40, and 50 days of aging. The fabric was also subjected to thermal ageing at 90°C as a control. The residual mechanical strength of the specimens was evaluated following the ASTM D 5035 standard test method. The tensile strength data set was analysed using IBM SPSS Statistics. SEM and EDX analyses were performed to identify the topological and chemical differences on the specimen surface.

Results and discussion

The figure below illustrates the results of PBO fabric load at the break measurements at different ageing temperatures and water phase conditions as well as after thermal ageing. A decrease in strength with ageing time was observed for all conditions. After 50 days at 90°C, thermally, hydrothermally, and hygrothermally aged samples showed 22%, 48%, and 48% loss in strength.

The figure below illustrates the results of PBO fabric load at the break measurements at different ageing temperatures and water phase conditions as well as after thermal ageing. A decrease in strength with ageing time was observed for all conditions. After 50 days at 90°C, thermally, hydrothermally, and hygrothermally aged samples showed 22%, 48%, and 48% loss in strength. Strength reduction with increasing temperature can also be observed for the hydrothermal and hygrothermal conditions. On the other hand, no statistically significant difference was observed between hygrothermal and hydrothermal conditions (P=0.911). No significant morphological difference was identified through SEM between aged and unaged samples. The EDX analysis revealed the presence of phosphorus on the fabric's surface.



Conclusion

PBO fabric strength was significantly reduced when exposed to hygrothermal and hydrothermal conditions at 60°C and above. The reduction of strength increased with temperature and time, and was higher in the presence of moisture. On the other hand, the effect of hydrothermal and hygrothermal conditions was similar. The presence of phosphorus may have contributed to the higher reduction when exposed to moisture. Thermal ageing at 90°C produced a surprisingly high loss in PBO strength, considering the continued operation temperature of 310°C. These results will help improve the long-term performance of firefighter protective garments and the safety of firefighters.

NETTLE FIBRES FOR TEXTILE PRODUCTION

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Presentation time: Tuesday, March 18 & Wednesday, March 19 at 10:00 am (MT)
Location: Edmonton

Introduction

Stinging nettles (Urtica dioica L.) produce bast fibres that can be used in textile applications. Archaeological finds, traditional practices, linguistic analysis, and folk tales reveal that nettles have been used as textile plants for millennia. Today, nettle fibre is not readily found on the market. Rather, it is processed and used primarily by craftspeople interested in historical practices and sustainability. This study considered whether stinging nettles grown in northern Alberta could be processed at a craft level to produce usable textile fibres and whether investigation of this fibre can inform industrial textile production.

Materials & Methods

This study consisted of a literature review of the history of nettle fibre for textile use and experiments in processing wild stinging nettles to obtain usable textile fibres. The literature reviewed was collected through a search of the University of Alberta Library's online catalogue, using the search terms "nettle* OR stinging nettle* AND textile* OR fabric* OR cloth*". For the processing experiments, root-retted stinging nettles were harvested from three different growing environments on a farm in Barrhead County, Alberta, Canada. Nettles from each of these environments were processed by (a) breaking in a flax break, (b) tank-retting at 34°C for 4.5 days, or (c) steaming for 4 hours. All fibres were then hackled and tested to determine average fibre diameter, fibre length, breaking strength, and elongation at break. The results of these tests were compared across growing environments and processing methods and were also compared to known average values for comparable bast fibres, including flax, hemp, and ramie.

Results & Discussion

A review of the literature shows that stinging nettle and its relatives have provided fibre for textile production across the globe for thousands of years (see, e.g., Bergfjord et al., 2012; Kallenbach, 2024). Analysis of archaeological finds can now differentiate between nettles and other bast fibres to show that wild nettles were foraged for both subsistence and trade (Andresen & Karg, 2011; Viljanen et al., 2022). The Industrial Revolution prompted the first known attempts to cultivate stinging nettles for fibre in Europe, but these attempts were repeatedly abandoned due to low cost-effectiveness (Bangsbo et al., 2014). Recent research has considered various specific applications for nettle fibre, based on its unique characteristics.

The results of this study's processing experiments agree with earlier scholars; stinging nettle's relatively low fibre content and highly heterogeneous fibre diameters may not allow it to compete economically on an industrial scale with other bast fibres, even though the fibre characteristics are comparable to flax, hemp, and ramie. However, the results also show that growing environment moisture does not significantly impact nettle fibre growth or characteristics, which could be significant in a world where climate change and loss of arable land negatively affects traditional agriculture. Processing methods are more likely to affect fibre characteristics, with tank retting having the greatest impact in this study. Researchers considering textile applications for nettle fibre should therefore consider the relationship between processing methods and end-use.

Conclusion

The ancient practice of producing textiles from stinging nettle fibre can continue in Alberta. The industrial textile sector in the foreseeable future may continue to deem this plant too unprofitable to cultivate and process for fibre, but the future is uncertain. There may come a time when the unique properties of stinging nettles, beloved by craftspeople around the world, will become industrially significant.

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