**NC170: Personal Protective Technologies for Current and Emerging Occupational and Environmental Hazards**

**Annual Meeting Report**
**October 6, 2024, 1 PM**

Chair:         Sumit Mandel
Chair Elect:   Fatma Bayter
Secretary:     Dawn Michaelson

Attendees:     Emiel Den Hartog (North Carolina State University), Fatma Bayter (Cornell University), Gang Sun (University of California-Davis), Hang Liu (Washington State University), Leslie Browning-Samoni (Texas Christian University), Lynn Boorady (Oklahoma State University), Shu Hwa Lin (University of Hawai'i at Manoa), Sumit Mandal (Oklahoma State University), Yingying Wu (Kansas State University)

The annual meeting was held on October 6, 2024, at 1 p.m., on the first day of AATCC's 2024 Textile Summit Discovery Summit in Savannah, Georgia.

Items Discussed at Annual Meeting

1. 2025 Annual Meeting
   - AATCC has stated that they will not charge us to attend next year, and they should know not long after the close of the 2024 Textile Discovery Summit where the AATCC conference will be held in 2025. Philadelphia and Savannah were named as two possibilities. They are trying to increase academic and student attendance and student applications for awards.
   - Emiel said that he has been asked to chair the International Thermal Manikins and Modeling Meeting (I3M) which he expects will be held on the NC State campus in 2025. This was offered as an alternative to AATCC that might interest NC170 members.

2. Discussion on website.
   - New members need to be added to our website.

3. Officer Elections for 2025:
   Chair: Fatma Baytar (She may be on sabbatical after May 2025)
   Chair Elect: Han Liu
   Secretary: Leslie Browning-Samoni

4. NC-170 Presentations at AATCC Textile Discover Summit 2025 Summary
   - The NC-170 oral presentation session topics and authors are included on the next page.
   - There were 31 people in the audience, including NC170 members.

The meeting was adjourned at 2:45 pm

<p align="center" style="color:red"><strong>AATCC TEXTILE DISCOVERY SUMMIT<br>NC-170 SESSION SCHEDULE</strong></p>

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## SUNDAY, OCTOBER 6, 2024

*Moderator: Sumit Mandal, Oklahoma State University*

**9:00 AM** **Welcome & Opening Comments**

**9:15 AM** **Male and Female and Male Firefighter Safety: ECG Monitoring via Apparel**
Shu-Hwa Lin, University of Hawaii & Lynn Boorady, Oklahoma State University

**9:45 AM** **Characterizing the Thermal Protective Performance of Oil and Gas Extraction Workers' Flame-Resistant Clothing**
Sumit Mandal, Oklahoma State University

**10:15 AM** **Assessment of Protective Properties of Cloth Face Coverings**
Emiel DenHartog, North Carolina State University

**10:45 AM** **Multifunctional Conductive Fibers with A Novel Heterostructure**
Hang Liu, Washington State University

**11:15 AM** **Progresses of Utilizing Vitamin Derivatives as Functional Agents in Personal Protective Clothing Materials**
Gang Sun, University of California, Davis

**11:45 AM** **Application of Colorimetric Nanofiber Sensor into PPE Coveralls: Pilot Testing**
Fatma Baytar, Cornell University & Chunhui Xiang, Iowa State University

**12:15 PM** **Assessing the Release of PFAS and Total Fluorine in Firefighter Turnout Gear**
Nur-Us-Shafa Mazumder, North Carolina State University

**12:45 PM** **Closing Comments**

**NC170: Personal Protective Technologies for Current and Emerging Occupational and Environmental Hazards**
Multistate Research Project: October 1, 2023 – September 30, 2024

**Period of Report:** October 1, 2023 – September 30, 2024

## Impact Nugget

### Alabama
An improved pattern for a PPE agricultural pesticide sprayer jacket with a removable hood was drafted for construction and user feedback.

### California
CA developed biodegradable daylight-induced biocidal fibrous membranes and films for next generation of facemasks and food contact surfaces. The materials are ideal for facemasks with improved personal protection and reduced environmental impact.

CA developed foam-based personal use highly sensitive and selective colorimetric sensors for detection of viruses, bacteria, and toxic chemicals.

CA collaborated with Iowa State University and others to develop an NIH proposal on virus protective respirators for healthcare workers.

### Florida
Evaluated structural firefighting PPE using a dynamic sweating thermal manikin housed at Florida State University in the ThermaNOLE Comfort Lab®. Assessed prototype structural firefighter turnout suits for heat stress relief and female firefighter fit and performance. Invited presenter of the National Academies of Science, Engineering, and Medicine workshop on reusable healthcare PPE. Published work on firefighter PPE air gaps, novel fibers for healthcare masks, and thermal comfort impact of compression gear for professional athletes. Continued FEMA funded study on better fitting PPC for women in the fire service.

### Georgia
The University of Georgia published a paper on 3D fit examinations of firefighter turnout boots and developed an on-body prototyping method for wearable applications to create soft breadboards using discarded leather.

### Hawaii
During and after the pandemic, Hawaii was experiencing the short fall of resourcing materials and protective devices. Our goal was to provide instruction in such a way that all testing and construction could be done at home and Laboratory, allowing students to continue testing and making masks outside of school and opening the door for students and community to teach others. Also, some engineering students are interested in exploring materials for heat protection after the Maui fire.

Kansas
K-State and Colorado State University Collaboration: K-State collaborated with Colorado State University to explore machine learning techniques for analyzing body dimensions and sizing systems. This effort yielded positive results, establishing a robust foundation for future research on firefighter body shape analysis and the development of machine-learning-enabled body dimension prediction and innovative sizing systems.

Female Firefighter PPE Advancements: K-State developed the third iteration of female firefighter turnout coats and pants. The new prototypes feature significant ergonomic enhancements, optimized seam placement, and upgraded thermal liners and moisture barriers, all adhering to industrial PPE standards for fireground use. These advancements improve fit, mobility, and safety for female firefighters.

Dr. Yingying Wu was awarded the Excellence in Innovation and Economic Engagement Award by Kansas State University. This award recognized her excellent endeavor in advancing the design and development of female-specific turnout gear. Awarding ceremony on October 18th, 2023.

Oklahoma
In this year, Oklahoma State University (OK State) mainly focused on improving the facility at our Textile and Apparel Science Laboratory (TASL). The purpose of this laboratory is to analyze the protective and comfort performance of textile materials through bench-/full-scale equipment and modeling.

Maryland
ISO 27065 C1 certified was developed as an outcome of the project.

Washington
The development of side-by-side wet-spun conductive fibers has opened up a new technology paradigm to manufacture unspinnable polymers into fibers and 3D printing technologies provide a versatile finishing solution to develop functional fabrics. Various sensors fabricated from the side-by-side conductive fibers and 3D printed fabrics have great potential applications in smart wearables.

## New Facilities and Equipment

Florida
Renovations are nearing completion for the new Textile Testing Lab across campus. A sweating guarded hot plate for fabric level heat loss measurements was also ordered.

Georgia
Embroidery machine, Jacquard loom, Knitting machine, and Portable 3D scanner

Oklahoma
Smoke and PAH Exposure System and Analysis

**Unique Project-Related Findings**

California
Developed novel biodegradable light active biocidal fibrous filtering materials for facemask funded by NIOSH (through Iowa State University).

Continued the work on personal use and wearable sensors for trace amount of chemicals and microbes in foods and environment funded by NIEHS;

Florida
Analysis demonstrated women in the fire service significantly differ from the U.S. general female population in terms of body measurements that are essential for PPE fit. Therefore, women's PPC should be designed based on population specific anthropometrics.

Georgia
The internal space of the fire boots, often decided by the shoe lasts, needs to be optimized to represent the foot morphology of the U.S. firefighter population.

Kansas
Collaboration with Colorado State University demonstrated the feasibility of using machine learning techniques to analyze body dimensions and sizing systems, paving the way for future advancements in firefighter body shape analysis and the development of predictive sizing systems tailored for firefighters.

The development of third-generation prototypes for female firefighter turnout gear revealed key insights into ergonomic design, including optimal seam placement and material layering. These findings contribute to improved fit, mobility, and protective performance, addressing the unique needs of female firefighters.

Maryland
This collaborative project addressed PPE for risk mitigation in several countries.

Oklahoma
PAH contamination on protective clothing

Washington
We have furthered our understanding of the various factors that affect the properties of side-by-side fibers. For 3D printing, we investigated the influences of printing material, printing process, and fabric substrate on printed fabric performance.

**Accomplishment Summaries**

**Objective 1**

California
Develop novel functionality and applications of materials for PPE and health/safety solutions:

a.       research novel materials and technologies that can provide desired functions;
b.       research novel textile-integrated sensing techniques
c.       evaluate the performance of the materials for personal protective applications

CA continued development of biodegradable photo-active biocidal films, nonwoven fabrics and nanofibrous membranes for various applications including facemasks and food packaging materials that can provide surface self-disinfecting functions;

CA has developed colorimetric foam-based ELISA sensors for bacteria and toxicants for protection of human and environmental health. In addition, the team has developed detoxifying sensing materials for fumigants and chemicals.

Oklahoma
Partially developed TASL at OSU to evaluate the protective and comfort performance of fabrics.

Washington
We have developed 3D printed sensors for motion detection and strain sensing. The printed fabrics have great potential in smart wearable products

**Objective 2**

Alabama
Redesigned PPE agricultural pesticide sprayer jacket with a removable hood based on updated body shape data.

Florida
All projects met objective two to assess and improve the performance of PPE and protective clothing for first responders, healthcare workers, and tactical athletes.

Georgia
To address the fit issue of firefighter boots, the set of leather and rubber firefighter boots were CT-scanned and their internal morphology was compared to the actual firefighter foot dimensions. Additional 3D wear simulation revealed the area to be optimized for a better fit.

To breakthrough the challenges of prototyping wearable PPE systems with rigid plastic breadboards that do not conform to the soft and curved body surface, a soft breadboard was developed using discarded leather scraps. With conductive threads embroidered in the standard breadboard pinhole spacing, the leather-based breadboard demonstrated a flexible and thin alternative that is compatible with conventional prototyping electronics. It will make the development process of the wearable PPE easier and more realistic.

Kansas
Improving Inclusivity and Fit in PPE for Underserved Populations - K-State conducted anthropometric research to identify the needs of underserved populations, such as female firefighters, and advanced efforts in PPE design and fit inclusivity. The third-generation prototypes for female firefighter turnout gear incorporated ergonomic enhancements and material

optimizations, addressing challenges in mobility, comfort, and safety while meeting industry PPE standards.

Pioneering Sizing Systems Through Machine Learning - In collaboration with Colorado State University, researchers explored machine learning techniques to predict body dimensions and improve PPE sizing systems. Positive results established a foundation for innovative approaches in creating more inclusive and effective sizing systems, with particular attention to underserved groups such as female and non-standard body types in high-risk occupations.

<u>Maryland</u>
Under-represented populations often use hand-held methods of application for applying pesticides. A risk assessment and mitigation tool, outcome of the an international collaborative project, was pilot tested in March 2024. The tool allows selection of PPE for mitigating risk based on risk assessment.  ISO 27065 C1 garment is required to provide minimum protection with partial and whole-body C3 PPE for additional protection.

PPE partnership project, coordinated in by ICPPE in Kenya, resulted in the developed of the first ISO 27065 C1 certified garment in that region. The grassroots approach provided an opportunity to engage male and female farmers/operators in the design and development of the certified coverall.

The project on the development of double aprons is ongoing. The second version of the C3 double apron for back protection during knapsack application was evaluated by partners in South Africa and Kenya. ICPPE partnered with Department of Forrest, Fisheries and the Environment in South Africa and BASF in Kenya. The outcome of the project resulted in the design of Version 3 of the double apron.

Coverall protypes were tested to assess compliance with ISO 27065 requirements. Additional tests were conducted in partnership with Instituto Agronomico to expand the database for C3 materials, The analysis of the data was used for identification of materials that have the potential of being used for partial and whole body garments. The database continues to be used to support the revision of ISO 27065.

**Published Written Works**

*Books*

National Academies of Sciences, Engineering, and Medicine. 2024. Reusable Health Care Textiles for Use in Personal Protective Equipment: Proceedings of a Workshop. Washington, DC: The National Academies Press. https://doi.org/10.17226/27762.

*Book Chapters*

Gang Sun, (2023). Chapter 3: Current Chemical Finishes and Measurements of Finishing Agents, Analytical Methods for a Textile Laboratory, Edited by Keith R. Beck and James Rodgers, AATCC. p51-70.

*Referred Journal Articles:*

Amaly, Noha, Ahmed Y. EL-Moghazy, Gang Sun, Pramod K. Pandey, (2024). A novel scalable polycationic melamine sponge-based filtration matrix for adsorption of anionic pollutants, Chemosphere, Vol 350, 2024, 140977.

Begum, S., Hummel, M., Mandal, S., Mahmood, S., Repon, R., Milašius, R. (2024). Thermal degradation and chemical analysis of flame-retardant-treated jute fabrics. Polymers, 16(14), 2049. *[Note: Polymers (IF: 4.7) is a peer-reviewed journal of polymer science published semimonthly online by MDPI.]*

Boisvert, R., McQuerry, M., & Schofield, S. (2024). Relationship between firefighter protective clothing design ease and heat stress. International Journal of Clothing Science and Technology, 36(5), 836-848, DOI:10.1108/IJCST-11-2023-0160 (Impact: 1.2)

Bolaji, J. & McQuerry, M. (under review). Impact of self-contained breathing apparatus on air gaps in structural firefighting personal protective clothing. *Applied Sciences. Special Issue: Innovative Functional Textiles and Their Applications.* (16 pages)

Bolaji, J., Qui, Z., McQuerry, M., & Kwon, C. (revision under review). A comparative anthropometric analysis of U.S. female firefighters versus the general female population. *Journal of Safety Research.* (23 pages)

Bolaji, J., Qui, Z., McQuerry, M., & Kwon, C. (under review). U.S. female firefighter anthropometric versus wildland firefighting protective clothing sizing standards. *International Journal of Occupational Safety and Ergonomics.* (23 pages)

Chen, K., Dardaman, S., Siebert, P., McQuerry, M., & Yentes, J. (under review). Female firefighters experience greater limitations from turnout gear when performing firefighting tasks. *Safety Science.* (38 pages)

El-Moghazy, Ahmed Y., Noha Amaly, Nitin Nitin, and Gang Sun. (2023). "A label-free electrochemical immunosensor based on decorated cellulose nanofibrous membrane for point-of-care diagnosis of amanitin poisoning via human urine." *Lab on a Chip* 23, no. 23 (2023): 5009-5017.

Jo, J., & Park, H. (2024). Fit of fire boots: exploring internal morphology using computed tomography. *International Journal of Occupational Safety and Ergonomics*, *30*(1), 90-99.

Jo, J., & Park, H. T. (2024). Machine Embroidery Enclosure for Stretchable Fiber Optic Respiration Sensor. *Advanced Sensor Research*, *3*(1), 2300017.

LaPier, Jonas, Blum, Arlene, Brown, Brandon, R., Kwiatkowski, Carol F., Phillips, Betsy, Ray, Hannah, Sun, Gang. (2023). Evaluating the Performance of Per- and Polyfluoroalkyl Substance Finishes on Upholstery Fabrics. *AATCC Journal of Research*. 2023;10(4):205-213. doi:10.1177/24723444231159856

McQuerry, M. & Dodson, A. (2024). An antimicrobial zinc ion fiber for COVID-19 prevention in nonwoven face coverings for healthcare settings. Journal of Occupational and Environmental Hygiene, 21(4), 1-8, DOI: 10.1080/15459624.2024.2310675 (Impact: 3.359)

Mitchell, J., Hwang, J., Larson, P., Agnew, J. R. Mandal, S. (2024). Preliminary analyses of accumulation of carcinogenic contaminants in retired turnout gear. Journal of Occupational & Environmental Hygiene, 21(4), 213-219. *[Note: The Journal of Occupational and Environmental Hygiene (JOEH) (IF: 2.00) publishes investigations that enhance the knowledge and practice of occupational and environmental hygiene and safety in the workplace and community]*

Nandi, S., Chowdhury, I., & Mandal, S. (2024). Nanotechnology in flame retardancy of textiles. In M. Bairagi, S. Ahmed, & W. Ali (Eds.), Nanotechnology in Textile Finishing (pp 271-311). Germany: Springer Nature.

Nasrin, S., Mandal, S., Petrova. A., Agnew, R. J., Boorady, L. M. (under proofread). Enhancing drying performance – analyzing fabric parameters in active sportwear. AATCC Journal of Research. *[Note: AATCC (IF: 0.8) has been publishing this highly reputed textile journal since 1969.]*

Pan, Bofeng, Zhao, Cunyi, Norwood, Makela, Wang, Minyuan, Liu, Gang-Yu, Sun, Gang, (2024). Highly Sensitive Naked Eye Detectable Colorimetric Biosensors Made from Macroporous Framework Melamine Foams for Onsite and Simultaneous Detection of Multiple Environmental Hazards in Flowing Through Sensing Systems, *Advanced Sensor Research*, 3(1), 2300080.

Pan, Bofeng, Ahmed Y. El-Moghazy, Makela Norwood, Nitin Nitin, and Gang Sun. (2024). "Rapid and Ultrasensitive Colorimetric Biosensors for Onsite Detection of Escherichia coli O157: H7 in Fluids." ACS sensors (2024) 9, 2, 912-922.

Pan, Bofeng, Qiyi He, Xingjian Yu, Dylan De Choch, Kit S. Lam, Bruce D. Hammock, and Gang Sun. (2024). "Versatility and stability of melamine foam-based biosensors (f-ELISA) using antibodies, nanobodies, and peptides as sensing probes." Talanta 279: 126634.

Riedy, R.*, Maya, I.**, & McQuerry, M. (2024). Analysis of physiological effects of compression gear on American college and pro-level football athletes. AATCC Journal of Research, 11(6), 433-444, DOI: 10.1177/24723444241276000

Sun, Yufa, Sasha Eckstein, Xinyi Niu, Michael Yermakov, Sergey Grinshpun, Guowen Song, and Gang Sun. (2024). "Biobased Triesters as Plasticizers for Improved Mechanical and Biodegradable Performance of Polylactic Acid Fibrous Membranes as Facemask Materials." ACS Sustainable Chemistry & Engineering, 12, 20, 7964-7975.

Sun, Yufa, and Gang Sun. (2024). "A natural butter glyceride as a plasticizer for improving thermal, mechanical, and biodegradable properties of poly (lactide acid)." International Journal of Biological Macromolecules: 130366.

Tang, Peixin, Si, Yang, Song, Xiyu, Sun, Gang, (2024). Hierarchically porous bacterial cellulose nanofibrous membranes for selective adsorption and real-time colorimetric monitoring of volatile carboxylic acids. Cellulose, 31 (1). 381-393. https://doi.org/10.1007/s10570-023-05632-8

Tushar, S. I., Anik, H. R., Uddin, M., Mandal, S., Mohakar, V., Rai, S., Sharma, S. (2024). Nanocellulose-based porous lightweight materials with flame retardant properties: a review. Carbohydrate Polymer, 339(1), 122237. *[Note: Carbohydrate Polymer (IF:11.2) is an Elsevier journal devoted to scientific and technological aspects of industrial relevant polysaccharides]*

Wu, Y., Liu, X., Morris, K., & Wu, H. (2024, January 15). An Exploratory Study of Body Measurement Prediction using Machine Learning and 3D Body Scans. Clothing and Textiles Research Journal. (SSCI. Impact Factor 2024: 2.4). https://doi.org/10.1177/0887302X241257914

Zong, W.*, Elangovan, T.*, McQuerry, M., Poley-Bogan, M.*, Simonson, N.*, Park, H. (under review). Sustainable survival jacket design for the homeless population. International Journal of Fashion Design, Technology and Education. (13 pages)

Zou, Jiahan, Jody Wong, Chih-Rong Lee, Nitin Nitin, Luxin Wang, and Gang Sun. (2024). "Protein-Based Rechargeable and Replaceable Antimicrobial and Antifouling Coatings on Hydrophobic Food-Contact Surfaces." ACS Applied Bio Materials. PMCID# PMC10951945.

## Scientific and Outreach Presentations

Al-Mashala, H., & Boorady, L. A Novel Protocol to Characterize the Smoke Particles Interaction with Wildland Firefighters' Protective Clothing, Firefighters Cancer Research Symposium 2024, Florida, USA, February 22-23, 2024.

Bofeng Pan, Ahmed Y. El-Moghazy, Nitin Nitin, and Gang Sun Rapid and Ultrasensitive Colorimetric Biosensors for Onsite Detection of Escherichia coli O157:H7 in Fluids, ACS Fall Meeting, Denver, August, 2024.

Bofeng Pan, Cunyi Zhao, and Gang Sun Development of Point-of-Use, Highly Sensitive, and Highly Selective Biosensors: From Nanofibrous Membranes to Fibrous Framework Medium, ICAFPM 2023, Donghua University, Shanghai, October 20-23, 2023

Bolaji, J., Qui, Z., McQuerry, M., & Kwon, C. (2024). U.S. female firefighters versus general female population: a comparative study. *Body Data Application Forum North America.* Stillwater, OK.

Bolaji, J., Qui, Z., McQuerry, M., & Kwon, C. (November 2024). A comparative anthropometric analysis of female firefighters versus the general U.S. female population. *2024 International Textiles and Apparel Association Conference.* Long Beach, CA.

Chowdhury, I.Z.; Mandal, S.; Petrova, A.; Agnew, R.J; Boorady, L.M.; Denhartog, E.; Analyzing Heat Transfer through Fabrics Used in Firefighters' Clothing under Different Intensity Flame Exposures, 2024 ITAA Annual Conference, California, USA, Nov. 20-23, 2024.

Country Fire Authority (CFA) (2024). Personal Protective Equipment & Clothing Summit. *Country Fire Authority.* Melbourne, Australia. https://www.youtube.com/watch?v=xc9EIds0JuQ

Gang Sun Preparation of Photo-Induced Antibacterial Polymers and Fibers By Using Vitamins, Greensboro, NC, Fiber Society Spring Conference, May 22-24, 2024.

Gang Sun, Development of Textile Materials with Detoxifying and Sensing Functions for Improved Personal Protections, Philippine National Textile Forum, Manila, Philippines, November 8-9, 2023.

Gang Sun, Environmentally Friendly and Human Safe Antibacterial and Antiviral Chemicals for Polymers and Textiles, ICAFPM 2023, Donghua University, Shanghai, October 20-23, 2023

Gang Sun, Environmentally Friendly Functional Fibers and Textiles, International Conference of Sustainability Innovation & Smart Textile Technology（SITT）2024, Shanghai, China, June 14-16, 2024.

Gang Sun, Progresses in Sustainable Textile Materials and Environmentally Friendly Dyeing and Functional Finishing, Suzhou, China, November 11-12, 2023.

Gang Sun, Sustainable Detoxifying and Sensing Fibrous Materials for Improved Personal Protections, AuxDefense 2024, Braga, Portugal. June 20-22, 2024.

Gang Sun, Sustainable Self-Detoxifying and Sensing Fibrous Materials for Improved Personal Protection, Textile International Forum and Exhibition, Taiwan, September 25, 2024

Gang Sun, Vitamin Derivatives as Edible Functional Agents for Fibers and Polymers, Hong Kong Polytech University, Virtual presentation, April 18, 2024.

Hang Liu, Wangcheng Liu "Multifunctional Conductive Fibers with A Novel Heterostructure" American Association of Textile Chemists and Colorists Discovery Summit, October 6-8, Savannah, GA.

Jahnke, S., McQuerry, M., & Sellers, B. (2024). Women's Health and Well-Being in the Fire Service. *International Association of Fire Fighters Affiliate Leadership Training Summit.* Lake Buena Vista, FL.

Jiahan Zou, Luxin Wang and Gang Sun, Sustainable Temperature Controls: A critical step for ensuring food safety and quality, Association of Pacific Rim Universities (APRU) Virtual, February 22, 2024.

Jiahan Zou, Yucen Xie, Berenice Bacilio Contreras, Luxin Wang, Gang Sun, Performances of Non-meltable, Reusable and Biodegradable Stationery Cooling Media "Jelly Ice," ACS Fall Meeting, Denver, August 2024.

Jiahan Zoua, Huitao Ling, Luxin Wanga, and Gang Sun, Engineering Bio-Based Hydrogel Coolants: Theoretical Modeling and One Scalable Fabrication Method, ACS Fall Meeting, Denver, August 2024.

Lin, Y., & Jo, J. (2024, May). LeatherBoard: Sustainable On-body Rapid Prototyping with Leather Scraps and Machine Embroidery. In *Extended Abstracts of the CHI Conference on Human Factors in Computing Systems* (pp. 1-7).

Mandal, S., Tushar, S. I., Nandi, S., Boorady, L. M., Petrova, A., Park, H., & Kubicki M. Characterizing the Thermal Behavior of Contaminated Fabric Used in the Oil and Gas Industry Workers' Protective Clothing. 2024 ITAA Annual Conference, California, USA, November 20-23, 2024.

McQuerry, M. & Easter, E. (2024). Wildland protective clothing cleaning practices in the United States. *W3192 National Institute of Food and Agriculture (NIFA) Multi-State University Annual Meeting.* Baton Rouge, LA.

McQuerry, M. & Kwon, C. (2024). U.S. women versus women in the U.S. fire service: Are female firefighters anthropometrically different from the general U.S. female population? *2024 Fire Industry Education Resource Organization (FIERO) PPE Symposium.* Greenville, SC.

McQuerry, M. & Kwon, C., (2024). Development of novel personal protective clothing designs for structural and wildland female firefighters. *FEMA FP&S R&D Annual PI Meeting.* Emmitsburg, MD.

McQuerry, M. (2024). Impact of PPE Design on Heat Stress: Optimizing ease and air gaps in structural firefighting turnout gear. *2024 Fire Industry Education Resource Organization (FIERO) PPE Symposium.* Greenville, SC.

McQuerry, M., Bolaji, J., Kwon, C., & Qui, Z. (2024). Protective clothing user needs and anthropometrics of wildland female firefighters. *W3192 National Institute of Food and Agriculture (NIFA) Multi-State University Annual Meeting.* Baton Rouge, LA.

McQuerry, M., Kwon, C., & Lehtonen, K. (2024). Fit for Her: Innovating turnout gear for female firefighters' safety and performance. *Fire Engineering Webcast.* (virtual webinar).

McQuerry, M., Kwon, C., Bolaji, J., & Qiu, J. (2024). It's not just the measurements: What we know about gear for women. *2024 Nerdstock Science to the Station.* Emmitsburg, MD.
Nandi, S., Islam, M. M., Mandal, S., Schnitzler, E., Petrova, A., Agnew, R., Chowdhury, I. Z.,

Lin, S. (2023). Smart Textile Applications from Market Analysis, Guest organization section, AATCC the Textile Discovery Summit, Sep 12-14, 2023. Greenville, SC.

PBS NOVA (10/20/2024). Building Stuff: Reach It! https://www.pbs.org/video/building-stuff-reach-it-0n0hbb/

Peixin Tang and Gang Sun, Development of Hierarchically Porous Cellulose Materials for Improved Detoxification and Sensing of Toxicants, ACS Spring 2024, New Orleans, March 17-21, 2024.

Peixin Tang, Gang Sun Self-Detoxifying and Sensing Materials for Improved Personal Protection and Safety, Fiber Society fall Meeting Philadelphia, October 25-28, 2023

Pokharel, A., Rodriguez Armada, D., Bolaji, J., & McQuerry, M. (November 2024). Impact of self-contained breathing apparatus on air gaps in structural firefighting personal protective equipment. *2024 International Textiles and Apparel Association Conference.* Long Beach, CA.

Poley-Bogan, M. & McQuerry, M. (10/7/2024). Analysis of thermal comfort cooling mechanisms to combat heat stress in the construction industry. *2024 Textile Discovery Summit, American Association of Textile Chemists & Colorists.* Savannah, GA.

Poley-Bogan, M. & McQuerry, M. (11/22/2024). Analysis of cooling mechanisms to combat heat stress in the construction industry. *2024 International Textiles and Apparel Association Conference.* Long Beach, CA.

Qui, Z., Bolaji, J., McQuerry, M., & Kwon, C. (2024). Body data application for workforce PPE. *Humanetics Future of Fit, Season 3, Episode 2.* (virtual webinar).

Tushar, S. I., Mandal, S., Chowdhury, I. Z., Petrova, A., Boorady, L. M., Preston, L., Agnew, R. Characterizing the thermal protective performance of oil and gas extraction workers' flame-resistant clothing. AATCC Textile Discovery Summit Savannah Georgia, USA, October 6-8, 2024.

Wu, Y. (2024, September), *Machine Learning Applications in Body Measurements Prediction.* Presented to Body Data Application Forum North America: Designing the Future of Human Fit and Functionality. Department of Design and Merchandising, Oklahoma State University, Stillwater, OK.

Yufa Sun, Sasha Eckstein, and Gang Sun, Biobased triesters as plasticizers for improved mechanical and biodegradable performances of polylactic acid fibrous membranes as facemask materials, ACS Fall Meeting, Denver, August, 2024.

Yufa Sun, Sasha Eckstein, Gang Sun, Development of Reusable, Biodegradable, and Biocidal Textile Materials, the 2024 International Conference of Eco-Textiles (ICET 2024) Jiangnan University, Wuxi, China, July 26-28, 2024.

Zihui Zhao, Hang Liu, "Integrating 3D Printing in the Development of Durable Textile-based Smart Wearables", International Textiles and Apparel Association Annual Conference, November 20-23, Long Beach, CA.

**Funds Leveraged**

Jo, J. (PI). (2024). Learning Technology Grant from Center for Teaching and Learning, University of Georgia, $23,799.00

Liu, H. (PI). (2024). CAREER: Processing Intrinsically Conductive Polymers for Fibers vis Side-by-Side Spinning", NSF, 3/2022 – 2/2027

Mandal, S. (Co-PI). (2024). Characterization of Carcinogenic Substances in Wildland Firefighters' Protective Clothing, American Association for Textile Chemists and Colorists (AATCC) Student Research Grant. $570.00

Mandal, S. (Co-PI). (2024). Characterization of the various workwear attributes that influence chronic PAH exposure in oil and gas workers, National Institute for Occupational Safety and Health (NIOSH) Southwest Center for Occupational and Environmental Health (SWCOEH), The University of Texas Health Science Center at Houston School of Public Health, $10,000.00

Mandal, S. (PI). (2024). Can Wearing Contaminated Workwear Affect Oilfield-workers' Physiology?, College of Education and Human Sciences (CEHS) InSPIRE STEM Program, $30,000.00

Mandal, S. (PI). (2024). Development of a Novel Light-weight Textile Materials for Personal Protective Clothing - Reducing Burn Injuries and Heat Stress for Oil and Gas Field Workers. Oklahoma Agricultural Experiment Station (OAES) College of Education and Human Sciences (CEHS), $96,000.00

McQuerry, M. (PI) & Kwon, C. (Co-PI). (9/20/20123-9/19/2026). Development of Novel Personal Protective Clothing Designs for Structural and Wildland Female Firefighters. *Department of Homeland Security (DHS), Federal Emergency Management Agency (FEMA), FY 2022 Assistance to Firefighters Grant Program.* $1,539,374.

McQuerry, M. (2024). Physiological Performance Analysis of Heated Garments for Warfighters under Arctic Conditions. *Congressionally Directed Funding (Army).* $180,890.

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