

Margaret Frey

Web Bio

Information

Biography

Biographical Statement

Positions Held:

Director of Graduate Studies, Department of Fiber Science & Apparel Design, College of Human Ecology, Cornell University (August 2009- present)

Associate Professor, Department of Fiber Science & Apparel Design, College of Human Ecology, Cornell University (July 2008 – present).

Lois and Mel Tukman Assistant Professor of Human Ecology, College of Human Ecology, Cornell University (July 2005 – July 2008)

Assistant Professor, Department of Textiles and Apparel, College of Human Ecology, Cornell University (July 2002-present).

Manager of Material Development, Champlain Cable Corporation, (January 1998 – April 2002).

Materials Specialist, Johnson Filaments, (June 1995 – December 1997).

Technical Specialist, Helene Curtis Industries, (August 1988-August 1990).

Staff Scientist, TRI Princeton, (July 1987-August 1988).

Department Website Summary

My research focuses on nanofibers with chemical, biological and mechanical properties relevant for uses including micro total analysis systems and in vitro microfluidic devices and pattern those fibers in specific location, geometry and density for incorporation into microfluidic devices. My research focuses on creation of functional fiber structures and application of fibers for novel uses. Specific targets include controlling phase separation during fiber formation in electrically charged jets to 'self-assemble' co-axial fibers with different phases at the core and shell. Examples include hydrophobic core with hydrophilic shell, liquid crystal core with polymer shell. Additionally, formation of fibers with pH sensing, chemically reactive, conductive or +/- charged capabilities via incorporation of small molecule, reactive compounds is pursued. Functional nanofibers are incorporated into nano-fiber fabrics, conventional fabrics, or microfluidic devices in specific patterns to create fiber-based devices.

Professional

Current Professional Activities

- **American Chemical Society - Division of Cellulose and Renewable Materials:** Councilor, Treasurer, Member-at-Large and Symposium Chair,

- **Fiber Society:** Symposium Chair
- **Society of Women Engineers:** Participated in Cornell STEM recruiting

Research

Current Research Activities

Research themes in my laboratory fall under two interconnected umbrellas: rapidly renewable polymers as engineering materials and interfacing fiber science and nanotechnology. The success and the range of the research have resulted from strong collaboration with researchers in both related and dissimilar fields. Combining the tools and capabilities of fiber science with expertise in fields including entomology, horticulture, biological and environmental engineering, materials science, chemical and biomolecular engineering and biomedical engineering has resulted in synergistic leaps in materials research that would not be possible without close collaboration between experts in diverse fields.

RAPIDLY RENEWABLE POLYMERS:

Two major rapidly renewable polymers have been used extensively in my research: cellulose and polylactic acid (PLA). PLA/cellulose nanocrystal nanocomposites, formed into fibers by electrospinning, have been used as a base material to build controlled release agricultural chemical delivery systems and biohazard recognition fabrics.

INTERFACING FIBER SCIENCE AND NANOTECHNOLOGY

The second research theme, interfacing fiber science and nanotechnology, has resulted in particularly fruitful collaborations. Properties of fiber-based materials include:

- high specific surface area
- incorporation of multiple dissimilar materials in a single fabric or device
- strength and flexibility
- high porosity with adjustable pores size
- functional fibers including chemically reactive sights, conductivity, positively or negatively charged surfaces, nanoparticles and phase changing properties

These properties can combine with some of the unique physics and high reactivity that have been discovered at the nano-scale to create useful and functional materials. Several variations on this theme have created an ever-expanding circle of projects.

Extension

Education

Education

Education:

Cornell University Chemical Engineering B.S. 1985

Cornell University Fiber Science M.S. 1989

North Carolina State University Fiber and Polymer Science Ph.D.1995

Courses

Courses Taught

- FSAD 1350 - Fabrics, Fibers and Finishes
- FSAD 1360 - Fiber Laboratory
- FSAD 2370 - Structural Fabric Design
- FSAD 6660 - Fiber Formation Theory and Practice
- IGERT Module: Sustainable Industry Practices
- IGERT Module: Nanomaterials for Biosensors

Websites

Related Websites

NSF IGERT: <http://www.ccmr.cornell.edu/igert/>
Internships for Public Science Education: <http://www.ipse.psu.edu/>
Science of Small - Super Cloth:
http://www.csrees.usda.gov/newsroom/partners/21/super_cloth.html

Administration

Administrative Responsibilities

Director of Graduate Studies

Publications

Selected Publications

Cho, D. W.; Matlock-Colangelo, L.; Xiang, C. H.; Asiello, P. J.; Baeumner, A. J.; Frey, M. W., Electrospun nanofibers for microfluidic analytical systems. *Polymer* **2011**, *52*

Cho, D.; Bae, W. J.; Joo, Y. L.; Ober, C. K.; Frey, M. W., Properties of PVA/HfO₂ Hybrid Electrospun Fibers and Calcined Inorganic HfO₂ Fibers. *Journal of Physical Chemistry C* **2011**, *115* (13), 5535-5544

Rebovich, M.E., D. Vynias, and M.W. Frey, *Formation and functions of high-surface-area fabrics*. International Journal of Fashion Design, Technology and Education, 2010. **3**(3): p. 129 - 134.

Li, L.L. and M. Frey, *Preparation and characterization of cellulose nitrate-acetate mixed ester fibers*. *Polymer*, 2010. **51**(16): p. 3774-3783.

- Li, L., M.W. Frey, and K.J. Browning, *Biodegradability Study on Cotton and Polyester Fabrics*. Journal of Engineered Fibers and Fabrics, 2010. **5**(4): p. 42-53.
- Hendrick, E., et al., *Cellulose Acetate Fibers with Fluorescing Nanoparticles for Anti-counterfeiting and pH-sensing Applications*. Journal of Engineered Fibers and Fabrics, 2010. **5**(1): p. 21-30.
- Buyuktanir, E.A., M.W. Frey, and J.L. West, *Self-assembled, optically responsive nematic liquid crystal/polymer core-shell fibers: Formation and characterization*. Polymer, 2010. **51**(21): p. 4823-4830.
- Min Xiao, Margaret W. Frey, "Study of cellulose/ethylene diamine/salt systems." Cellulose 16 (3):381-391. 2009.
- Chunhui Xiang, Yong L. Joo and Margaret W. Frey , "Nanocomposite Fibers Electrospun from Poly(lactic acid)/Cellulose Nanocrystals." Journal of Biobased Materials and Bioenergy 3 (2):147-155. (2009).
- Min Xiao, Margaret W. Frey*, "Rheological Studies of the Interactions in Cellulose/Ethylene Diamine/Salt Systems", Journal of Polymer Science, Part B – Polymer Physics, 46, 2326-2334(2008).
- Margaret W. Frey*, "Electrospinning Cellulose and Cellulose Derivatives", Polymer Reviews, 48, 378-391 (2008).
- Dapeng Li, Margaret W .Frey*, Dionysios Vynias, Antje J. Baeumner "Availability of biotin incorporated in electrospun PLA fibers for streptavidin binding", Polymer, 48, 6340-6347 (2007).
- C.Xiang, M. W.Frey*, A.G. Taylor, M. Rebovich, "Selective chemical absorbance in electrospun nonwovens", Journal of Applied Polymer Science, 106, 2363-2370 (2007).
- Margaret W. Frey*, Dapeng Li, Tina Tsong, Antje J. Baeumner, Yong L. Joo, "Incorporation of biotin into PLA nanofibers via suspension and dissolution in the electrospinning dope", Journal of Biobased Materials and Bioenergy, 1, 219-227 (2007).
- Margaret W. Frey* and Lei Li, "Electrospinning and Porosity Measurements of Nylon-6/Poly(ethylene oxide) Bi-component Fibrous Mats", Journal of Engineered Fibers and Fabrics, <http://www.jeffjournal.org/papers/Volume2/Frey-Li.pdf>.
- Min Xiao and Margaret W. Frey*, "The Role of Salt on Cellulose Dissolution in Ethylene Diamine/Salt Solvent Systems", Cellulose, 14, 225-234 (2007).
- D. Li, Y.L. Joo, M.W. Frey*, "Characterization of Nanofibrous Membranes by Capillary Flow Porometry", Journal of Membrane Science, 286, 104-114 (2006).
- L.Li, M.W.Frey*, T. B. Green," Modification of air filter media with Nylon 6 nanofibers", Journal of Engineered Fibers and Fabrics. http://www.jeffjournal.org/papers/06Aug_AirFilterMedia.pdf (2006).
- L.Li, L.Bellan, H.Craighead and M.W. Frey*, "Formation and Properties of Nylon-6 and Nylon-6/montmorillonite Composite Nanofibers by Electrospinning", Polymer, 47,6208-6217(2006).

D. Li, M.W. Frey*, A.J.Baeumner, "Electrospun Polylactic Acid Nanofiber Membranes as Substrates for Biosensor Assemblies", *Journal of Membrane Science*, 279(1-2), 354-363(2006) .

M. W. Frey*, L. Li, M. Xiao, T. Gould, "Dissolution of cellulose in ethylene diamine/salt solvent systems", *Cellulose*, , 13(2), 147 – 155 (2006).

M. W. Frey* , H.Chan, and K.Carrancko, "Rheology of cellulose/KSCN/ethylene diamine solutions and coagulation into fibers and films" *Journal of Polymer Science, Part B: Polymer Physics*, 43, 2013-2022 (2005).

C.-W. Kim, M. W. Frey, M. Marquez and Y.L. Joo*, "Preparation of Electrospun Cellulose Nanofibers via Direct Dissolution, *Journal of Polymer Science, Part B: Polymer Physics*, 43, 1673-1683 (2005).

M. W. Frey* and M. H. Theil, "Calculated Phase Diagrams for Cellulose/Ammonia/Ammonium Thiocyanate Solutions in Comparison to Experimental Results", *Cellulose*, 11 56-63 (2004).

J. A.. Cuculo*, N. Aminuddin and M.W. Frey "Solvent Spun Cellulose Fibers", *J. A in Structure Formation in Polymeric Fibers*, 296-328, D.R. Salem Ed., Hanser Publishers: Munich (2000).

M.W. Frey, S.A. Khan* and J.A. Cuculo, "Rheology and Gelation of Cellulose/NH₃/NH₄SCN Solutions", *Journal of Polymer Science, Part B: Polymer Physics Ed.*,34, 2375-2381 (1996).

M.W. Frey, R. Spontak* and J.A. Cuculo, "Structure of the Cellulose/NH₃/NH₄SCN system by PLM and SEM", *Journal of Polymer Science, Part B: Polymer Physics Ed.*,34,2049-2058 (1996).

M.W. Frey, J. A. Cuculo*, A. Ciferri, and M.H. Theil, "A Review of Lattice Theory for Lyotropic Liquid Crystalline Polymers, Spinodal Decomposition and Gel Formation", *The Journal of Macromolecular Science - Reviews in Macromolecular Chemistry and Physics*, 35(2) 294