

NTC Annual Report 2009 - Introduction

The National Textile Center (NTC) is a research consortium of eight universities: [Auburn University \(Consumer Affairs, Engineering\)](#), [University of California at Davis](#), [Clemson University](#), [Cornell University](#), [Georgia Institute of Technology](#), [University of Massachusetts at Dartmouth](#), [North Carolina State University](#) and [Philadelphia University](#).

To view the full Annual Report of the work described in the highlight below, click on the project number. For further research details, see the project's website reported in this Annual Report or in the 2008 Research Briefs, on the web at <http://www.ntcresearch.org/pdf-rpts/Bref0608/Briefs08-TOC.pdf> or on the latest CD/ROM. You can keyword search and view all NTC Reports ever published at <http://www.ntcresearch.org/PDFindex.html> and view all reports on the CD.

To contact any principal investigator, see their bio following each Research Brief for their email address, phone, web-site address and NTC project numbers. Bios for all principal investigators who ever participated in an NTC project are continuously updated on the web at http://ntcresearch.org/PDF_BIO_index.htm and/or on the latest CD/ROM.

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NTC Annual Report by Competency Groups

Materials

Research in the design, development and measurement of natural and synthetic polymeric materials and fibers, including polymer mixtures and additives.

Efficient Biological-Chemical Protective Materials

We are developing the fundamental knowledge to design "breathable" fabrics that also provide barrier protection from biological and chemical hazards. (Gowayed with Clemson) [M05-AE11]

Functional Fibers via Biomimesis

We are developing a fundamental understanding of how liquid wets and flows in nanoporous fibers and nanofibrous substrates. (Hsieh with Clemson, Natick) [M05-CD01]

Hierarchically Designed and Conductive Elastomeric Fibers

By engineering molecular conformations, we are developing elastomeric polymers and fibers with improved mechanical properties and tunable electrical conductivity. (Jacob with UMass Amherst) [M06-GT03]

Improving Textiles with Cyclodextrins

We are exploiting the tendency of cyclodextrins to form inclusion compounds with many small molecule additives and polymers to improve/enhance textile properties. (Tonelli with Georgia Tech) [M06-NS02]

Deployable Wet-Responsive Fibrous Materials

We are designing active fibrous materials which respond to stimuli by spontaneously folding-unfolding their structures for uses, such as geotextiles that become stronger upon wetting. (Kornev) [M08-CL10]

Fiber Based Biohazard Sensor Assemblies

Sensor assemblies are created by including molecular biohazard sensors into fibers and incorporating these fibers into fabrics. (Frey) [M08-CR01]

Flexible Electrodes for Electroluminescent Textiles

We are developing inkjet printing of flexible composite transparent electrodes, based on carbon nanotubes, for electroluminescent displays. (Calvert) [M08-MD07]

Nanoscale Surface Embrittlement of Fibers

We seek to fundamentally understand the mechanism at the molecular level of fiber surface embrittlement due to free radical oxidation at melt extrusion and to find ways to minimize it. (Chalivendra) [M08-MD13]

Electrospun Composite Nanofibers for Lithium-Ion Batteries

We are developing nanofibers and composite nanofibers for lithium and lithium-ion battery applications. (Zhang) [M09-NS01]

Muscle-Like Extruded Actuators

By extruding multi-component fibers from dielectric elastomers, we are fabricating fiber actuators that can change their dimensions and generate forces when activated with electric fields. (Ghosh) [M09-NS02]

Fabrication

Research in the fabrication, processing and manufacture of fibrous structures and fabricated products.

Reinforcement Fabrics with Electronic Transmission Capability

We are developing fundamental knowledge to understand how to design geotextile roadbed liners embedded with antennae and electronic transmission capability. (Thomas) [F05-AE13]

Scent-Infused Textiles to Enhance Consumer Experiences

We are developing polymer fibers that incorporate effective, long-lasting fragrances for innovative and marketable textiles and to measure their psychology of acceptance. (Pierce) [F05-PH03]

Direct Writing Biological Patterns & Constructs onto Fabrics

We are exploring the knowledge of direct writing biological patterns and constructs onto fabrics to create textile-based bio/medical microdevices. (Huang with Rensselaer) [F06-CL02]

Ultra-fine Filament Yarns Made by Supersonic Cold Air Attenuation

We are developing the fundamental understanding to lead to a new approach towards cost-effective production of ultra-fine continuous filament yarns. (Yao) [F06-GT01]

Piezoelectric Fabrics for Energy Harvesting

Piezoelectric fabrics are ideally suited to power wearable electronics, an application where bulky batteries are very impractical. (Guillot) [F06-GT05]

Transport in 3-D Nanofab Geometries

We are developing experimental and numerical fluid transport models for 3D nanofabricated devices. (Bhowmick with UMassD, Natick)[F06-MD04]

Formation and Performance of Auxetic Textiles

We have combined our knowledge of geometry and fabric structural characteristics to produce auxetic knit structures from non-auxetic yarns. (Ugbolue with Kyiv National Univ., Ukraine) [F06-MD09]

Blue-Cured Adhesives for Bonding and 3-D Medical Textiles

We are exploring the use of blue light instead of UV to rapidly cure bonding resins and to build 3-D fabric structures for biomedical uses, such as tissue engineering. (Calvert with UMass Lowell) [F06-MD14]

Environmental Fabrics and Breathing Wall Systems

We are developing fabric and modular wall assemblies to retrofit existing buildings to combat Sick Building Syndrome and will be developing multiple skins structures. (Messinger) [F06-PH03]

Cellulose/Soy Protein Based "Green" Composites

We are developing "Green" composites with good mechanical properties using sustainable cellulosic fibers and plant-based resins based on modified soy proteins. (Netravali with Auburn) [F08-CR01]

Polymer Flow Within Elastic Boundaries: Stronger Continuous Nanofibers

We are understanding fundamental flow phenomena in bicomponent extrusion that allows the production of ultra-strong fibers from commodity polymers (Hinestroza with Cornell, Georgia Tech) [F08-CR02]

Engineered Reinforced Structures from Short Fibers

From short fibers, we are developing electrostatic webs with desired orientation and high aspect ratios to produce engineered composite structures with superior, consistent properties. (Kim with NC State) [F08-MD01]

Fiber-Based Bioreactor Media for Air Pollution Control

We are determining the efficacy of using flocked surfaces as air biofiltration media to curb air pollution and to bioconvert volatiles into useful products. (Yang) [F08-MD02]

Nanofiber Enhanced Wound Dressings

We are addressing the technical and manufacturing challenges of incorporation of performance-enhancing nanofibers into traditional textile-based wound dressings. (McCord) [F09-NS06]

Chemistry

Research in chemical applications to, and modifications of, fibers and fiber substrates, including dyeing, finishing and waste reduction.

Molten Organic Ionic Liquids for Fiber Extrusion

We are investigating using molten organic salts as solvents for the extrusion of stiff and/or polar materials, including cellulose. (Broughton with U. of Alabama) [C05-AE05]

Textiles with Highly Selective Receptors for Specific Molecules

By molecular imprinting polymers on fibers, we are designing novel functionalities with molecular recognition capability for molecular separation, isolation, immobilization and sensing. (Luzinov) [C05-CL01]

Antimicrobial Membranes for Protective Clothing

Antimicrobial membranes for protective clothing kill bacteria upon contact. (Obendorf with UC Davis) [C05-CR01]

Self-Decontaminating Textiles

We are developing chemical systems that will prevent/remove toxic contaminants from textile fabrics and surfaces. (Slaten with UC-Davis) [C06-AC01]

Effect of Silicone Finishes on the Burning Behavior of PET

To mitigate adverse silicone interactions, we are developing fundamental understanding of the impact of siloxanes on the burning behavior of polyester fibrous structures. (Drews with U of Georgia) [C06-CL01]

Hydrodynamic Lubrication in Fiber Processing

We are expanding our fundamental understanding of the mechanisms of hydrodynamic fiber lubrication to aid in the development of future generations of fibers and fiber lubricants. (Krause) [C06-NS07]

Blue Light Curable Inkjet Ink System

We are developing an ink chemical system curable using blue light to avoid the drawbacks of using UV radiation or thermal energy in digital pigment printing. (Fan) [C09-MD01]

Systems

Research in the management of product design, sourcing, production, distribution and consumption systems.

Masculine Fashion Choices: Shifting Identities

We are researching how the shifting male consumer culture thinks about fashion and lifestyle and how men evaluate and purchase clothing. (Kwon with Berry, St. Joseph's, UC Davis, Delaware, Cornell) [S05-AC02]

Fabric/Skin Interactions: Contact, Friction and Dynamic Motion

We are developing multi-scale models of physical and physiological interactions (e.g. contact/friction between fabric and skin and impact of dynamic motion (e.g. walking). (Pan with UCSF, U. Manitoba) [S05-CD04]

Strategic Sustainability and the Triple Bottom Line

We are examining how sustainability practices in the apparel-textile complex relate to economic, social and environmental goals in apparel, furnishings and artificial turf. (Kwon with Berry St. Joseph's) [S06-AC01]

Apparel Product Development for Plus-sized Tween & Teen Boys

We are investigating the physical and social-psychological dimensions of demand for apparel by tween boys (aged 9-14), particularly those who are overweight and obese. (Connell with [TC]²) [S06-AC03]

Visual Approach to Assessing Apparel Brand Personalities

We are developing a visual lexicon of brand personality that links apparel brands with the meanings a standardized set of images evoke for improved market positioning. (Kwon with Berry/St. Joseph's) [S06-AC04]

Research Network on Multifunctional Protective Clothing

We are forming a group of researchers and manufacturers to focus on multifunctional protective clothing and materials for firefighters, paramedics and police officers. (Sun with Auburn, Cornell) [S06-CD01]

Dynamic Textile Process and Quality Control Systems

This Dynamic Quality/Process Control System utilizes all structural equations known to date to design an effective, dynamically responsive system. (Suh) [S06-NS02]

Pivotal Role of Brand Image in Purchase Decisions

We are examining the pivotal role of how brand image secures favorable attitudes, purchase intentions and price premiums for U.S. apparel products in multi-channel markets. (Forsythe with Ohio State) [S08-AC01]

Scientific Approaches for Preventing Cotton Variety Identity Theft

To prevent cotton identity theft, we are developing ways to fully identify specific cotton fiber varieties not only in the raw stage but also in finished end products. (El Mogahzy) [S08-AE10]

Visual Fit Assessment Tool for Apparel Firms

We are developing a tool for capturing and analyzing fit using 3D body scan technology that can be used by apparel firms both for in-house fit models and target market customers. (Ashdown) [S08-CR03]

Integrated System to Design/Produce Engineered Knit Garments

We are developing an integrated system for the design, visualization, development and production of engineered knitted garments. (Lamar) [S09-NS02]

Logistics of Closed Loop Textile Recycling

We are developing methodologies to use in designing closed loop reverse logistic systems in the textile industry, looking at reverse demand stream estimation, etc. (Joines) [S09-NS04]

Guide to NTC Project Numbers (XNN-YYnns) where ...

X = first letter of the competency
NN = last two numbers of the NTC fiscal year (May to April) when the project was first funded
YY = university:
AC = Auburn Consumer Affairs (was A)
AE = Auburn Textile Engineering (was A)
CL = Clemson (was C)
CD = U Cal-Davis (was E)
CR = Cornell (was B)
GT = Georgia Tech (was G)
MD = U Mass Dartmouth (was D)
PH = Philadelphia U. (was P)
NS = North Carolina State (was S)
nn = number assigned by university to project
s (if present) = seed project

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[NTC Directory](#)

Principal Investigators, Operating Board, Site Directors, Staff:

- **Bios, Photos, E-mail, etc...** see http://ntcresearch.org/PDF_BIO_index.htm

Biographies for everyone who has ever been an NTC principal investigator include title, institution, academic degrees, experience, research interests, E-mail address, telephone number, personal web site address and all NTC projects they worked on.

NTC Annual Reports by Project Management

Auburn University (Consumer Affairs) Management

Masculine Style(s): Shifting Identities and Textile/Apparel

(Kwon with Berry College, St. Joseph's, UC Davis, Univ. Delaware, Cornell)..... S05-AC02

Self-Decontaminating Textiles (Slaten with UC Davis)C06-AC01

Strategic Sustainability and the Triple Bottom Line

(Kwon with Berry College, St. Joseph's) S06-AC01

Apparel Product Development for Plus-sized Tween & Teen Boys

(Connell with [TC]²) S06-AC03

Visual Approach to Assessing Apparel Brand Personalities

(Kwon with Berry College, St. Joseph's) S06-AC04

The Pivotal Role of Brand Image in Purchase Decisions

(Forsythe with Ohio State) S08-AC01

Auburn University (Engineering) Management

Investigation of Organic Ionic Liquids for Fiber Extrusion

(Broughton with U of Alabama) C05-AE05

Reinforcement Fabrics with Electronic Transmission Capability

(Thomas) F05-AE13

Efficient Biological-Chemical Protective Materials

(Gowayed with Clemson) M05-AE11

Developing Scientific Approaches for Preventing Cotton Variety Identity Theft (El Mogahzy) S08-AE10

University of California at Davis Management

<u>Functional Fibers via Biomimesis</u> (Hsieh with Clemson,Natick)	M05-CD01
<u>Fabric and Skin: Contact, Friction and Interactions</u> (Pan with UCSF, U of Manitoba)	S05-CD04
<u>Research Network on Multifunctional Protective Clothing</u> (Sun with Auburn, Cornell)	S06-CD01

Clemson University Management

<u>Molecularly Imprinted Fibers with Recognition Capability</u> (Luzinov)	C05-CL01
<u>Effect of Silicone Finishes on the Burning Behavior of PET</u> (Drews with U of Georgia)	C06-CL01
<u>Direct Writing Biological Patterns & Constructs onto Fabrics</u> (Huang with Rensselaer)	F06-CL02
<u>Deployable Wet-Responsive Fibrous Materials</u> (Kornev)	M08-CL10

Cornell University Management

<u>Hybrid Microporous Membranes Intended for Protective Clothing</u> (Obendorf with UC Davis).....	C05-CR01
<u>Cellulose/Soy Protein Based "Green" Composites</u> (Netravali)	F08-CR01
<u>Polymer Flow in Confined Elastic Boundaries: Stronger Continuous Nanofibers</u> (Hinestroza with Cornell, Georgia Tech)	F08-CR02
<u>Fiber Based Biohazard Sensor Assemblies</u> (Frey)	M08-CR01
<u>Development of Visual Fit Assessment Tool for Apparel Firms</u> (Ashdown)	S08-CR03

Georgia Institute of Technology Management

Ultra-fine Filament Yarns Made by Supersonic Jet Splitting (Yao) F06-GT01
Piezoelectric Fabrics for Energy Harvesting (Guillot) F06-GT05
Hierarchically Designed and Conductive Elastomeric Fibers
(Jacob with UMass Amherst) M06-GT03

Transport in 3-D Nanofab Geometries (Bhowmick with UMassD, Natick) F06-MD04

Formation and Performance of Auxetic Textiles
(Ugbolue with Kyiv National Univ.) F06-MD09

Blue-Cured Adhesives for Bonding and 3D Medical Textiles
(Calvert with UMass Lowell) F06-MD14

Engineered Reinforced Structures from Short Fibers (Kim with NC State) .. F08-MD01

Fiber-Based Bioreactor Media for Air Pollution Control (Yang) F08-MD02

**Carbon Nanotube Based Flexible Textile Electrodes for Electrolumi-
nescent Device** (Calvert) M08-MD07

Nanoscale Surface Embrittlement of Fibers (Chalivendra) M08-MD13

Blue Light Curable Ink Chemistry for Textile Digital Printing (Fan) C09-MD01

North Carolina State University Management

<u>Hydrodynamic Lubrication in Fiber Processing</u> (Krause)	C06-NS07
<u>Improving Textiles with Cyclodextrins</u> (Tonelli with Georgia Tech)	M06-NS02
<u>Dynamic Textile Process and Quality Control Systems</u> (Suh)	S06-NS02
<u>Challenges in Advanced Nanofiber Wound Dressings</u> (McCord)	F09-NS06
<u>Electrospun Composite Nanofibers for Lithium-Ion Batteries</u> (Zhang) ...	M09-NS01
<u>Muscle-Like Extruded Actuators</u> (Ghosh)	M09-NS02
<u>Integrated System to Design/Produce Engineered Knit Garments</u> (Lamar)	S09-NS02
<u>Logistics of Closed Loop Textile Recycling</u> (Joines).....	S09-NS04

Scent-Infused Textiles to Enhance Consumer Experiences (Pierce)..... F05-PH03

Environmental Fabrics and Breathing Wall Systems (Messinger) F06-PH03

Abbreviations

The following abbreviations are not always defined in articles.

Auburn (AE, AC): University of Auburn, Auburn AL 36849 [E=TE;C=Consumer]	M.I.T.: Mass. Inst. of Technology	UAB: Univ. of Alabama-Birmingham
Chem Eng: Chemical Engineering	NC State (NS): North Carolina State University, Raleigh NC 27695	UC Davis (CD): University of California – Davis, Davis CA 95616-8722
CivE: Civil Engineering	NMR: nuclear magnetic resonance	UCSF: University of California – San Francisco
Clemson (CL): Clemson University, Clemson SC 29634	PET: poly(ethylene terephthalate)	UD: University of Delaware
Cornell (CR): Cornell University, Ithaca NY 14853	PhilaU (PH): Philadelphia University, Philadelphia PA 19144	UG: University of Georgia
dpf: denier per filament	Poly Sci: Polymer Science	UNC-G: University of North Carolina at Greenville
DSC: differential scanning calorimetry	SEM: scanning electron microscopy	UMassD (D): University of Massachusetts at Dartmouth MA 02747
ESR: electron spin resonance	TAM: Textile and Apparel Management [TC] ² :Textile/Clothing Technology Corp	UNL: University of Nebraska at Lincoln
Fib: Fiber	TE: Textile Engineering	UNO: University of New Orleans
FTIR: Fourier Transform Infrared	TEM: transmission electron microscopy	U of PA: University of Pennsylvania
Georgia Tech (GT): Georgia Institute of Technology, Atlanta GA 30332	Tex: Textile	U of Tenn: University of Tennessee
LSU: Louisiana State University	TexE: Textile Engineering	UPR: Univ. of Puerto Rico
MAE: Mechanical and Aerospace Engineering	TFE: Textile and Fiber Engineering	URI: Univ. of Rhode Island
ME: Mechanical Engineering	TFPS: Textile, Fiber & Polymer Science	
	TRI: Textile Research Institute (Princeton NJ 08542)	

Discontinued Projects

[ordered by year, then competency, then University]

The following NTC projects were discontinued because they successfully completed their maximum three-year life span (or one-year for seed projects) or because other research was of higher priority. For their last report, see the NTC website at <http://www.ntcresearch.org>, the [November 2008 NTC Annual Report](#) (link below) or the [June 2007 NTC Research Briefs](#). You may also contact the principal investigators whose phone numbers and E-mail addresses are listed therein. New projects often grew out of completed projects (See the notes following the listings below for any new projects).

<u>Novel, High-Yield Application of Permanent Colorants</u> (Beckham)	C05-GT04
<u>Inkjet Deposition of Complex Mixtures to Textiles</u> (Carr with CCNY)	C05-GT07
<u>Boundary Lubrication and Molecular Assembly in Fiber</u> (Rojas with Cornell, UC Santa Barbara).....	C05-NS09
<u>Development of Drug Eluting Textile Stents</u> (Adanur)	C08-CL03
<u>Demand Activated Toughening in Garments</u> (Jacob).....	F05-GT04
<u>Electrospun Core-Sheath Fibers for Soft Tissue Engineering</u> (Gupta) ...	F05-NS04
<u>Nanolayer Self-assemblies: Novel, Adaptable Fiber Surfaces</u> (Hinestroza with NC State) [see F08-CR02].	F06-CR02
<u>Creation of a New Class of Cellulose Engineering Materials</u> (Frey with NC State)	M05-CR02
<u>Shape Memory Polymer Fibers for Comfort Wear</u> (Jacob with NC State).....	M05-GT14
<u>High Modulus Aliphatic Nylon Fibers via Lewis-Acid Complexation</u> (Kotek)	M05-NS05
<u>Fibers for Textile-Based Electrical Energy Storage</u> (Creager with Old Dominion)	M06-CL07
<u>Authentication/Anti-Counterfeit Fibers</u> (Frey)	M08-CR05
<u>Hispanic Characterization System (HCS)</u> (Jones)	S05-NS04