Next Generation Fibers

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US ARMY RDECOM

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Overview

- Program Goals
  - Vision
- Current Projects
  - Out of house
  - In house
- NSRDEC High Performance Fiber Facility

Program Goals

- Move early stage research from academia, industry and government into late stage development (late 6.2)
  - TRL 1/2/3 => TRL 3/4/5
- Focus on multi-component spinning and nanofibers

Vision/Background

Next Generation Fiber and Textile Technology

Research, design and develop novel multi-component fibers, nano/microfibers, nanofiber textiles and composites to improve performance, decrease weight/cost and provide new functionality in Soldier system applications, using recent advances in fiber and textile technology.

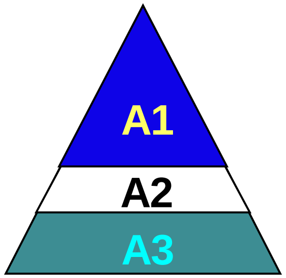
- Friend vs. Foe ID with directional optical response
- Smart fibers/textiles for environmentally responsive insulation
- Impact resistant fiber composites

Future Soldier 2030

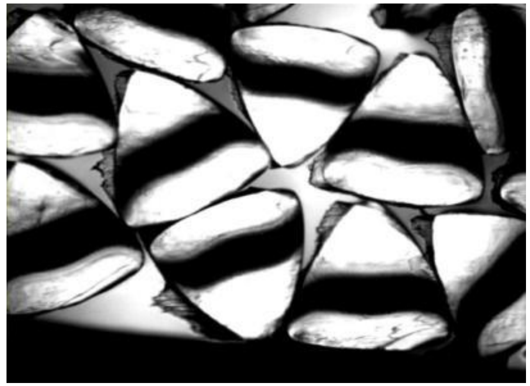
- Cut resistant fibers and textiles with inherent flame resistance
- Nanofiber textiles for high impact materials
- Electronic fibers for EMI shielding and sensor platform

Temperature Adaptive Insulation

Multi-component Fibers for Temperature Adaptive Insulation



Concept



Actual fibers

As temperature decreases, batting thickness increases

Applications:
- Cold Weather Clothing
- Sleeping Bags
- Blankets

3 different polymers - Fibers curl, batting gets thicker.

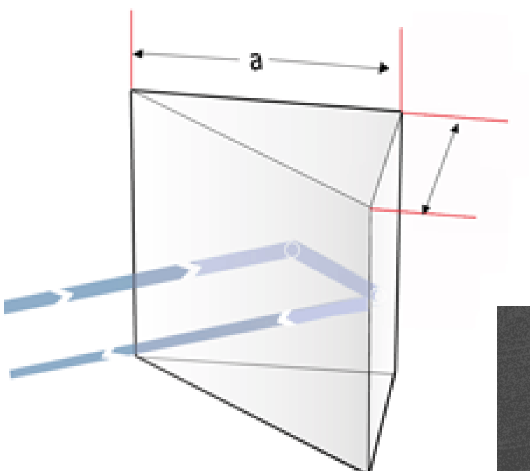
3 components using the same polymer - No curling or change in thickness

Check out our more detailed presentation during the technical session tomorrow

Retro Reflective Fiber

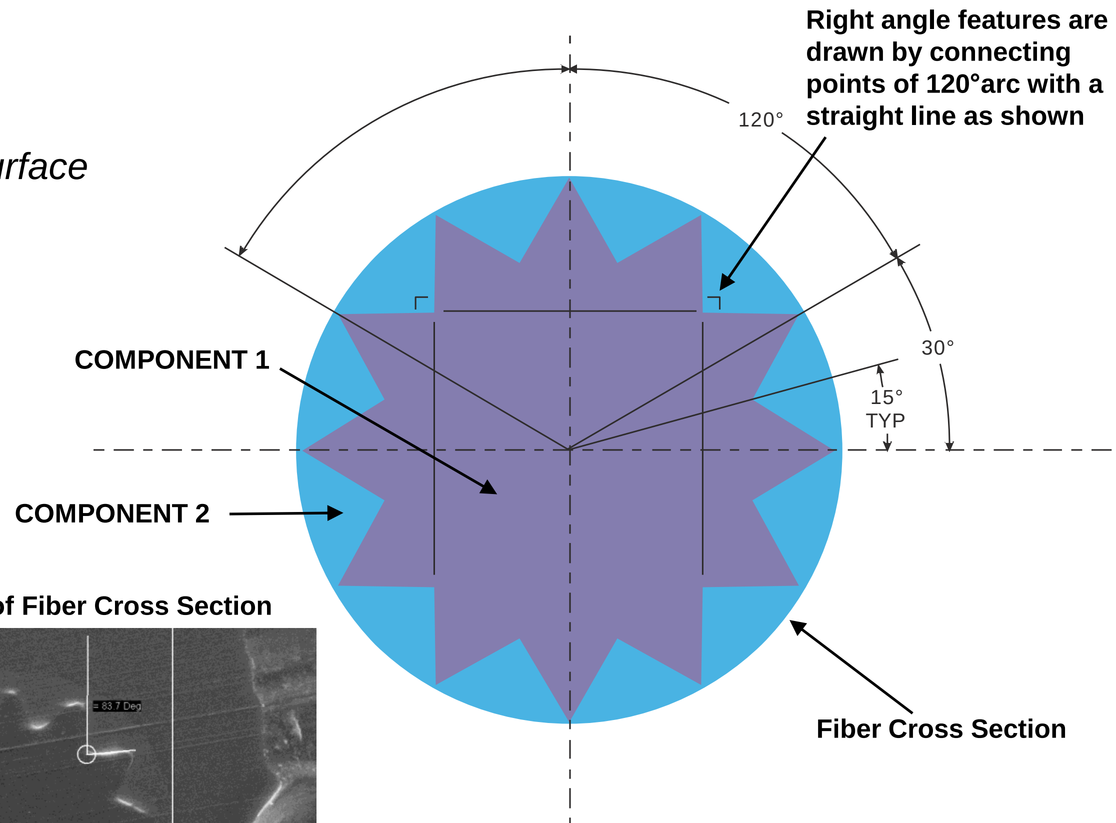
Fiber with Enhanced Optical Response

- **Right angle feature:**
  - *Redirects light back to source*
  - *Enables multiple reflections at fiber surface*
  - *Increased sensing surface area*
  - *Single, bi- or tri-component*



Retro-reflection from a right angle feature

Bi-Component Fiber



Micrograph Image of Fiber Cross Section

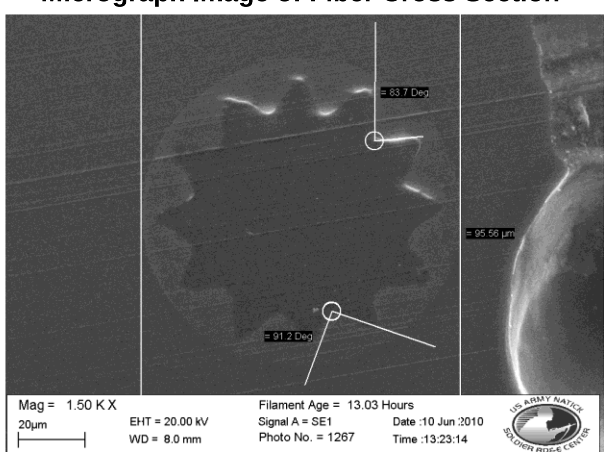
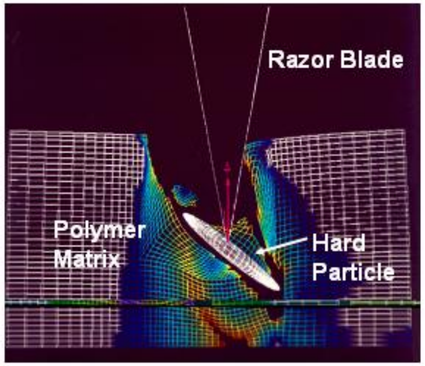


Image: D. Ziegler NSRDEC

Cut Resistant Fibers

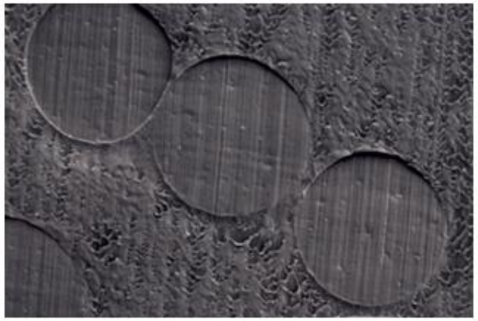
- Prof. Phil Brown, Clemson University
  - Based on bi-component wet spinning
  - Core based on Clemson Aramid Technology with hard particles.
  - Evidence for extraordinary cut resistance

Cutting Model



Filament Cross Section

Scanning Electron Micrograph 5000X

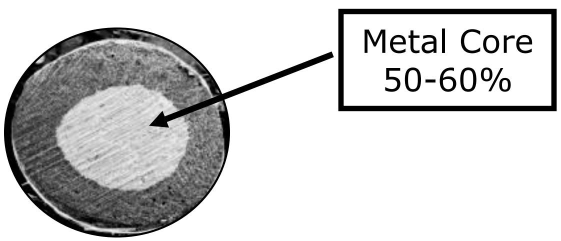


Hard particles pushed through the filament leave tracks

The blade encounters hundreds of particles in each filament more than doubling the force required to cut through

Electronic Conducting Fiber

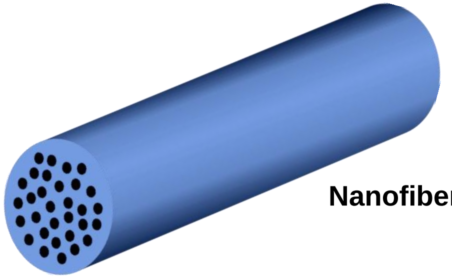
- Composed of a metal core (low melt solder) and a polymer sheath



  - Developed under an SBIR by EY Technologies
  - Trade name “iCon”
  - The goal is to produce a “textile quality” conducting fiber for e-textile applications

Longer Term Development

- Melt spun nanofibers based on “Islands-in-the-Sea” technology



Nanofiber Islands-in-the-Sea (INS)

  - Initial results presented at the New England Nanomanufacturing Summit 2010
  - http:eprints.internano.org/520/

- “Gel-electrospinning”
  - MIT, Professor Gregory Rutledge

Research-scale Bi/tri-component Fiber Extruder:

- Capacity – 1 to 6 pounds/hour
- ¾ Inch Diameter Single Screw
- Temperature Limit – 350° C
- Three Melt Pumps are Thermally Isolated
- Nitrogen Ports for Oxygen Sensitive Polymers
- Draw Speed: 500-2500 meters/min.

High Performance Fiber Facility

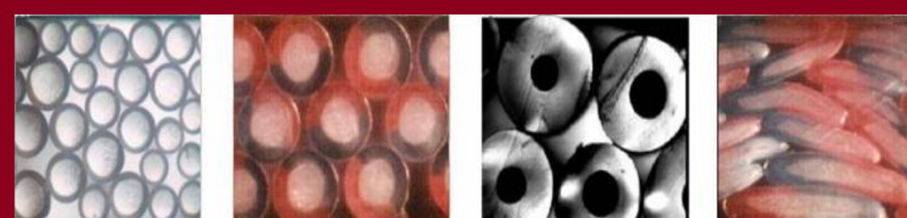
The High Performance Fiber Facility (HPFF) will combine NSRDEC, academia and industry expertise in novel fiber/textile technology to invent and rapidly transition new optical, electronic, high strength, flame retardant and reactive materials to Warfighters and First Responders

- **Optical Fibers**
  Optical Sensing and Communication
- **Electronic Fibers**
  Molten Metal Core/Polymer Sheath Fibers for E-Textile Applications
- **High Strength Fibers**
  Islands-in-the-Sea Nanofibers for Soft Armor or High Strength/Impact Composites
- **Flame Retardant Fibers**
  New Polymers or Nanoparticle Additives for Improved FR
- **Reactive Fibers**
  Tri-Component Fibers for Smart Insulation

BICOMPONENT ISLANDS-IN-THE-SEA (INS) FIBERS

Applications: Production of melt processed nanofibers or optical segregation (Nanofibers for ballistic soft armor/composites, and internal reflection fibers)

BI/TRI-COMPONENT SHEATH/CORE FIBER



Applications: Concentration of reactive components at the surface of fiber or putting a conductive material in the core, surrounded by an insulating material (CB decontamination, antimicrobials, sensors, electronic textiles)

Questions?

➢ Points of Contact

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