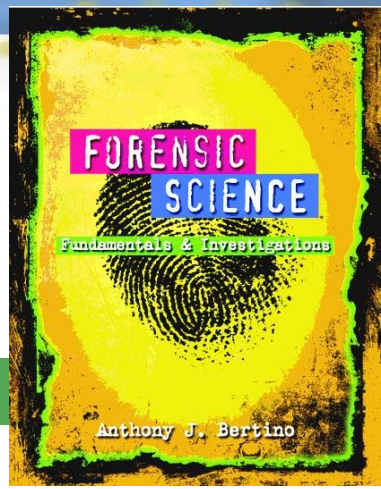
Chapter 4

A Study of Fibers and Textiles

By the end of this chapter you will be able to:



- Identify and describe common weave patterns of textile samples
- Compare and contrast various types of fibers through physical and chemical analysis
- Describe principle characteristics used to identify common fibers
- Apply forensic science techniques to analyze fibers

Introduction

- Fibers are used in forensic science to create a link between crime and suspect
- Through normal activities
  - We shed fibers
  - We picked up fibers
- Very small fibers are classified as trace evidence
- Collecting fibers within 24 hours is critical

How Forensic Scientists Use Fibers

Fiber evaluation can show

- Type of fiber
- Color
- Possibility of violence
- Location of suspects
- Point of origin

Sampling and Testing

- Shedding—common form of fiber transfer
- Microscopes reveal characteristic shapes and markings
- Infrared spectroscopy reveals chemical structures to differentiate similar fibers
- Destructive Testing Methods
  - Burning fibers
  - Dissolving fibers in various liquids

Sampling and Testing

Fiber Burn Analysis Key

When fiber is removed from flame,

1a.	It ceases to burn	Go to 2
1b.	Fiber continues to burn	Go to 3
2a.	Fibers have the odor of burning hair	Go to 4
2b.	Fibers do not smell like hair	polyester
3a.	Fibers produce a small amount of light ash residue	rayon
3b.	Fibers produce a gray fluffy ash	cotton
4a.	A hard black bead results from burning	wool
4b.	A brittle, black residue results	silk

Compare fibers found on different suspects with those found at the crime scene

Fiber Classification
–Natural Fibers

Animal fibers (made of proteins):

- Wool and cashmere from sheep
- Mohair from goats
- Angora from rabbits
- Hair from alpacas, llamas, and camels
- Silk from caterpillar cocoons (longer fiber does not shed easily)

woven wool textile

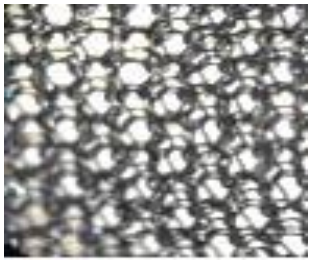
Fiber Classification –*Natural Fibers*

Plant fibers (made of the polymer cellulose):

- Absorb water
- Insoluble in water
- Very resistant to damage from harsh chemicals
- Dissolvable only by strong acids
- Becomes brittle over time

Fiber Classification —*Natural Fibers*

Plant fibers:



- Cotton—most common textile plant fiber (picture)
- Coir from coconuts is durable
- Hemp, jute, and flax from stems grow in bundles
- Manila and sisal from leaves deteriorate more quickly

Fiber Classification —*Natural Fibers*

Mineral Fibers:

- Fiberglass—a fibrous form of glass
- Asbestos—a crystalline structure

Fiber Classification –*Synthetic Fibers*

- 50% of fabrics are artificially produced
- Examples:
  - Rayon
  - Acetate
  - Nylon
  - Acrylic
  - Polyester

Fiber Classification
–*Synthetic Cellulose Fibers*

Regenerated Fibers (derived from cellulose):

- Rayon
  - Most common in this group
  - Imitates natural fibers, but stronger
- Celenese®
  - Cellulose chemically combined with acetate
  - Found in many carpets
- Polyamide nylon
  - Cellulose combined with three acetate units
  - Breathable and lightweight
  - Used in performance clothing

Fiber Classification
—*Synthetic Polymer Fibers*

Synthetic Polymer Fibers

- Petroleum base
- Very different from other fibers
- Monomers join to form polymers
- Fibers are spun together into yarns
- No internal structures
- Uniform diameters

Fiber Classification
–*Synthetic Polymer Fibers*

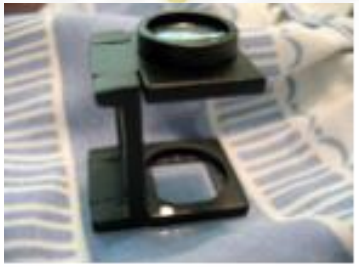
spandex nylon

- Polyester
  - "Polar fleece"
  - Wrinkle-resistant
  - Not easily broken down by light or concentrated acid
  - Added to natural fibers for strength
- Nylon
  - Easily broken down by light and concentrated acid
  - Otherwise similar to polyester

Fiber Classification –Synthetic Polymer Fibers

- Acrylic
  - Inexpensive
  - Tends to “ball” easily
  - Substitute for artificial wool or fur
- Olefins
  - High performance
  - Quick drying
  - Resistant to wear

Comparison of Natural and Synthetic Fibers



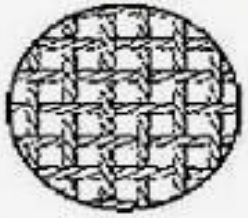
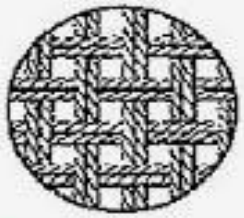
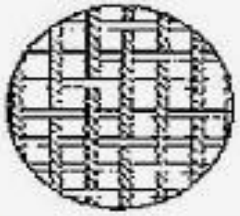
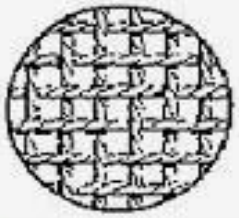
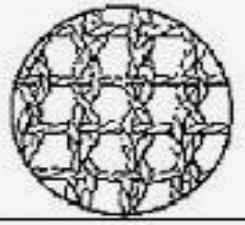
Visual Diagnostics of Some Common Textile Fibers under Magnification

Cotton	Flax	Silk	Wool	Synthetic
◆ Flattened hose appearance ◆ Up to 2 inches long tapering to a blunt end ◆ may have a frayed "root" ◆ hollow core not always visible	◆ "bamboo stick" appearance ◆ straight with angles but not very curved ◆ "nodes" are visible every inch or so ◆ often occur in bundles of several fibers	◆ do not taper, yet exhibit small variations in diameter ◆ may be paired (raw silk) with another fiber ◆ no internal structure	◆ surface scales may be visible ◆ hollow or partial hollow core ◆ fibers up to 3 inches long tapering to a fine point	◆ vary widely in cross-sectional shape and diameter ◆ generally straight to gentle curves ◆ uniform in diameter ◆ may have surface treatment that appears as spots, stains, or pits

Yarns, fabrics, and textiles

- Yarns—fibers (of any length, thick or thin, loose or tight) twisted or spun together
- Blending fibers meets different needs (e.g., resistance to wrinkling)
- Fibers are woven into fabrics or textiles
  - Threads are arranged side by side (the warp)
  - More threads (the weft) are woven back and forth crosswise through the warp

Weave Patterns

Plain / Tabby	Basket	Satin	Twill	Leno
				
◆ firm and wears well ◆ snag resistant ◆ low tear strength ◆ tends to wrinkle	◆ open or porous weave ◆ does not wrinkle ◆ not very durable ◆ tends to distort as yarns shift ◆ shrinks when washed	◆ not durable ◆ tends to snag and break during wear ◆ shiny surface ◆ high light reflectance ◆ little friction with other garments	◆ very strong ◆ dense and compact ◆ different faces ◆ diagonal design on surface ◆ soft and pliable	◆ open weave ◆ easily distorted with wear and washing ◆ stretches in one direction only

. . . . . Summary . . . .

- Fibers are a form of class evidence.
- Fibers are a form of trace evidence.
- Fibers are spun into yarns having specific characteristics.
- Yarns are woven, with different patterns, into clothing or textiles.
- Fiber evidence is gathered using different techniques.

Summary

- Fibers are analyzed using burn tests, tests for solubility in different solutions, polarized light microscopy, or infrared spectroscopy.
- Fibers are classified as natural or synthetic.
- Natural fiber sources include:
  - Animal hair
  - Plant seeds, fruit, stems, or leaves
  - Minerals.