

Module 4E

Forensic Examination of Fibers

Forensic Science Teacher Professional Development

Part 5 Forensic Examination of Fibers

The examination of fiber evidence includes physical examination and chemical analysis.

A guideline for forensic fiber examination has been developed by the Scientific Working Group on Materials Analysis (SWGMAT)

(formerly the Technical Working Group on Materials Analysis [TWGMAT]).

Part 5 Forensic Examination of Fibers

Classification of Fibers

- The examination of fibers can normally be conducted to determine the type or color of the fiber.
- Such examinations will sometimes indicate the type of garment or fabric from which the fiber could have originated.
- Questioned fibers can be compared with a suspect's clothing to determine whether or not they could have originated from this clothing.

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Classification of Fibers

➤ Fibers can be classified into two categories:

1. Natural fibers

- Vegetable fibers: seed hairs (cotton, kapok, akund); bast fibers (flax, hemp, jute, sunn, ramie); leaf fibers (sisal, abaca, henequen, phormium); others (coir, yucca cattail)
- Animal fibers: wool, silk, other (alpaca, mohair, cashmere, angora, camel)
- Mineral fibers
- Asbestos

2. Man-made (synthetic) fibers

- Acetate, acrylic, anidex, aramid, Azlon®, Teflon®, glass, lyocell (Tencel®), imidazole, melamine, metallic, modacrylic, novoloid, nylon, nytril, olefin, polyester, polyactic acid, rayon, Saran®, spandex, sulfar triacetate, vinal, vinyon, bicomponent, microfiber, etc.

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Classification of Fibers

- For forensic examination of fiber evidence, ASTM (American Standard of Testing and Materials) has published a series of guidelines:
 - E2224-02 Standard Guide for Forensic Analysis of Fibers by Infrared Spectroscopy
 - E2225-02 Standard Guide for Forensic Examination of Fabrics and Cordage
 - E2228-02 Standard Guide for Microscopic Examination of Textile Fibers

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Classification of Fibers

- Fiber trace examination terminology:
 1. A known sample is a subset of a larger population or sample originating from a verifiable source. Known samples are collected as representatives of that larger grouping, for example, a 2" x 2" section of carpet from a suspect's living room.
 2. Questioned samples are foreign materials collected from items of evidence that have a known location, for example, loose fibers collected from a victim's clothing or taped fibers from a suspected area.

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Classification of Fibers

- Fiber trace examination terminology:
 3. Class characteristics are common characteristics found in all members of a group (such as color, size, and general composition).
 4. Individual characteristics are features or signatures that define and identify an item as unique and exclusive of all other items. Individual evidence may be defined as a unique item that is identified as itself to the exclusion of all other items.

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Classification of Fibers

- Common analytical methods for fiber evidence examination include the following
 - Physical (morphological) examination: microscopy, pattern examination of fabrics and cordage
 - Chemical analysis: microspectrophotometry, Thin-Layer Chromatography (TLC) of dyes in textile fibers, pyrolysis-gas chromatography, infrared spectroscopy

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Classification of Fibers

- Analytical methods for the examination of fiber evidence may be varied due to the different resources that are available within a trace laboratory.
- The various analytical methods available for fiber analysis yield different kinds of information.
- It is highly recommended to select a combination of analytical methods and apply them in an order that provides the most exclusionary information first.
- By doing this, the examiner optimizes accuracy, precision, and production while most effectively using the laboratory's resources.

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Microscope

- A trace lab should have a variety of microscopes for fiber evidence examination:
 - A stereomicroscope
 - A comparison microscope
 - A compound light microscope equipped with polarized light capability
- Fiber identifications consist of determining the generic class of fiber type, which generally follows the Federal Trade Commission Guidelines.

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Microscope

- Identification of fiber by morphology can be achieved by microscopic examination.
- Fiber comparisons are performed to determine if a questioned fiber exhibits the same chemical, microscopic, and optical properties as a known sample.
- This type of fiber comparison requires an examiner to complete at least two of the analytical techniques listed for each of the following categories:
 1. Generic class
 2. Physical characteristics
 3. Color

Part 5 Forensic Examination of Fibers

Microscope

- The techniques selected should independently confirm the results obtained. It should be noted that some techniques have greater discrimination power than others when similar samples are examined.

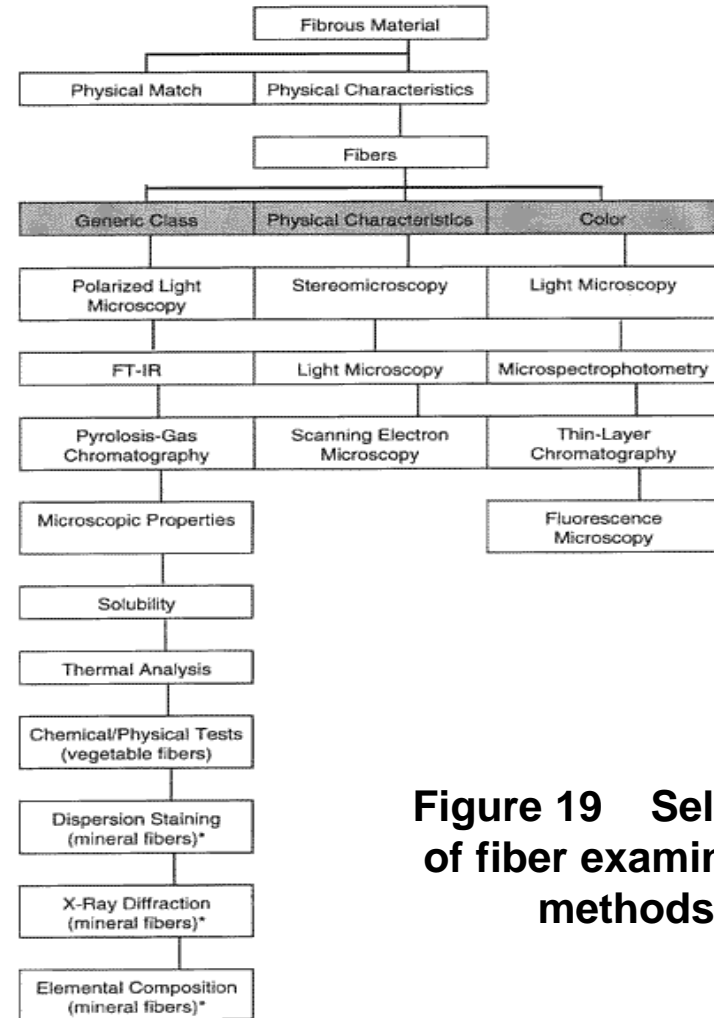


Figure 19 Selection of fiber examination methods

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Microspectrophotometry (MSP)

- MSP is an analytical technique that combines UV/VIS spectrometry and microscopy.
- It allows the collection of UV/VIS spectrum from fiber evidence under a microscope.



Figure 20 An example of the use of microspectrophotometry on fiber UV/VIS analysis

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Micro Colorimetry

- The color of a single strand of fiber can be measured by a micro colorimetry.
- The measured signal can then be used for the purpose of comparison. Color perception is subjective.
- An objective description of color can be obtained by using a “color space” described by the CIE (Commission Internationale de l'Éclairage, the “International Commission of Illumination”) chromaticity diagram.

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Micro Colorimetry

- The color space describes color by overlaying a grid on the diagram of visual perception.
- The grid allows colors to be described by numerical (chromaticity) coordinates, which can minimize subjective description of color.

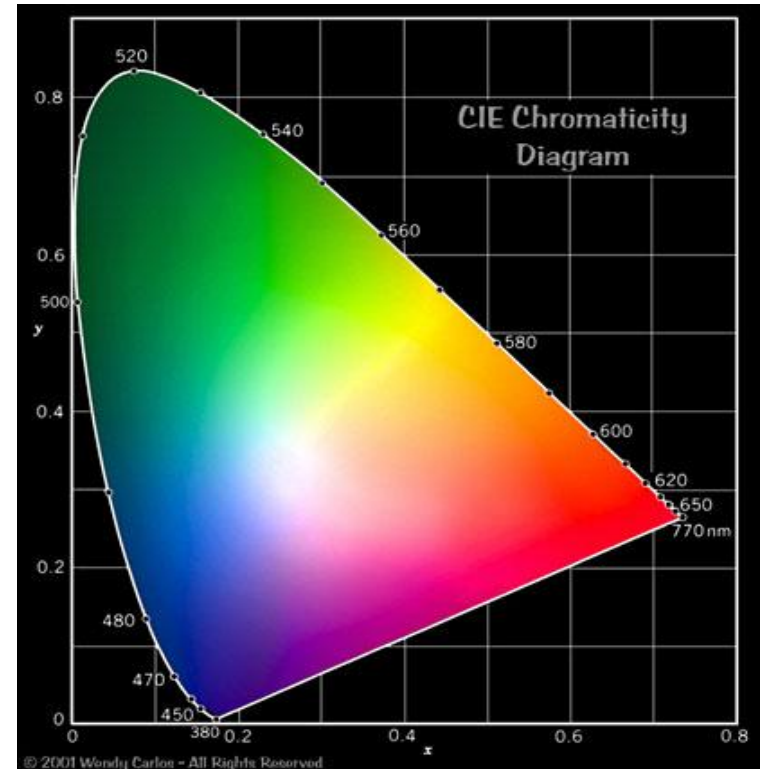


Figure 21 A CIE Chromaticity Diagram

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Micro Colorimetry

- The ultimate goal of fiber evidence examination is to identify the source of fiber. The probative weight, providing evidence of this value, is dependent upon the following factors:
 - Fiber type or types found
 - Fiber color or colors
 - Number of fibers found
 - Fiber location or locations
 - Fabric type or types
 - Multiple fiber associations
 - Nature of contact
 - Fiber transfer and persistence

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Micro Colorimetry

- There are several factors that may influence the transfer of fiber evidence:
 - The area of the surfaces in contact
 - The number of contacts
 - The force or pressure of contact
 - The nature of the recipient garment
 - Fragmentation of fibers during contact (an important mechanism in fiber transfer)

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Micro Colorimetry

- Fibers can be transferred by several mechanisms:
 - Transfer of loose fragments already on the surface of the fabric
 - Loose fibers being pulled out of the fabric by friction
 - Transfer of fiber fragments produced by contact

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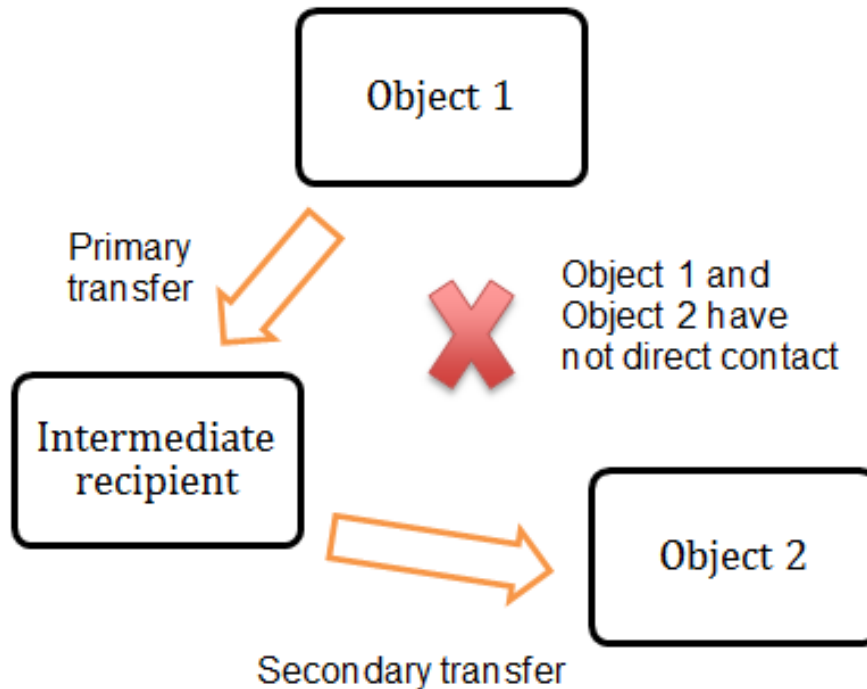


Figure 22 A schematic diagram showing a secondary transfer of a fiber between Object 1 and Object 2 through an intermediate recipient

Micro Colorimetry

- Secondary transfer of fiber is possible; this occurs when a fiber from one object is transferred to another object. It may be possible without direct contact between the two objects.

Part 5 Forensic Examination of Fibers

Summary

- In crime scene investigation, it is important to collect clothing from complainants and suspects as soon as possible after an alleged offense.
- Because fibers are so readily lost and retransferred, fiber evidence should not overstate the significance of the distribution.
- Failure to find fibers matching the victim's clothing on a suspect does not necessarily imply lack of contact between the victim and the suspect.
- Evidence of contact, and hence association, found through comparison of transferred fibers will generally involve recent transfers.
- It is vital to the integrity of fiber evidence that good contamination prevention procedures are in place.

Part 5 Forensic Examination of Fibers

Review the following links:

Forensic Fiber Examination Guidelines

www.swgmat.org/Forensic%20Fiber%20Examination%20Guidelines.pdf

Forensic Fiber Examination Guidelines

Scientific Working Group on Materials Analysis
(SWGMAT)
(formerly the Technical Working Group on
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Fiber Subgroup

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THE FBI FEDERAL BUREAU OF INVESTIGATION

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Read about ...
Acknowledgments
Chapter 1. Introduction to Forensic Fiber Examination

A web version of the guideline can be found from the following link:

<http://www.fbi.gov/about-us/lab/forensic-science-communications/fsc/april1999/houcktoc.htm>

End of Module 4E

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