Fiber Findings

Introduction

Crime scene investigators obtain many different types of evidence at a crime scene, including samples of fibers. With this kit you will identify the type of fiber left at a crime scene by performing a series of three tests on the obtained evidence.

Concepts

- Physical and chemical properties
- Chemical bonding
- Forensics

Materials

Congo red dye bath, shared
Water, tap
Boiling stone
Forceps, metal
Hot plate
Multifiber test fabric, 3-cm
Paper towels
Pencil
Weighing dish or aluminum foil

Background

Fibers are the smallest component of a textile material. They are used to form fabric, rope, carpet, etc. Fibers gathered as evidence at a crime scene may arise from numerous scenarios. They may be transferred via personal contact between suspect and victim or they could be transferred to other items at the crime scene, such as furniture, weapons or flooring, due to a physical struggle.

Fibers may be analyzed by visual inspection based on their appearance and comparison with known samples. Identifying fibers based on appearance requires the use of a microscope to view miniscule details. Natural fibers are easier to distinguish under a microscope. Synthetic (man-made) fibers are traditionally less descriptive under a microscope because they can consist of practically any strand diameter or color. Synthetic or man-made fibers typically have a more uniform diameter and appearance than natural fibers. Therefore, while helpful as an ancillary test, microscopic analysis is not the main determining test used to identify fibers.

Fabrics are also identified based on how chemical dyes bond to them. How well a dye is attracted to a piece of cloth (its *affinity*) depends on both the fabric and the dye molecules. Chemistry thus plays an important role in how and why dyes work. Dyes are charged water-soluble compounds. Animal fibers, such as wool, are composed of protein molecules and are usually easier to dye than plant fibers such as cotton, which are composed of cellulose. Wool fibers have many *dye sites*—groups of molecules that have positive or negative charges and thus attract the charged dye molecules. Dye sites may be ionic, that is, fully charged, or polar, that is, partially charged. In general, dyes have a greater affinity for natural fibers like wool and cotton than for most synthetic fabrics. Many synthetic fabrics such as acrylic and polyester are non-polar and have fewer dye sites, making them more difficult to dye. One exception is nylon, the first completely synthetic fiber developed in the 1930s from petrochemicals. Nylon dyes more easily than many other synthetic fabrics because it has polar dye sites. Acetate, another synthetic fiber, is chemically similar to cotton, but has fewer dye sites.

Safety Precautions

Congo red will stain skin and clothing. Wear chemical splash goggles, chemical-resistant gloves, and a chemical-resistant apron. Wash hands thoroughly with soap and water before leaving the laboratory. Please follow all laboratory safety guidelines. Please review current Safety Data Sheets for additional safety, handling and disposal procedures.

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Pre-Lab Preparation

Congo Red Solution

1. Dilute 150 mL of 0.1% congo red solution with 300 mL of distilled or deionized water in a 1-L beaker.
2. Add 4.5 g of sodium sulfate decahydrate ($Na_2SO_4 \cdot 10H_2O$) and 3.3 g of anhydrous sodium carbonate (Na_2CO_3) and stir to dissolve.
3. Place a boiling stone in the dye solution and heat to near boiling on a hot plate.
4. Carefully pour the resulting solution into three 250-mL beakers to ease congestion for student use. Wear heat-resistant gloves or use a hot vessel gripping device. The dye must be hot when students test their fabric.

Procedure

Note: The multifiber test fabric consists of six different fibers in the following order starting at the cream colored end: wool, acrylic, polyester, nylon, cotton and acetate.

1. Obtain a test fabric strip and mark one end of the strip with pencil so that the wool side is differentiated from the acetate side.
2. Using forceps or tongs, immerse the test strip into the congo red dye bath. *Caution:* The dye bath is very hot. Exercise caution to avoid burns.
3. After 5–10 minutes, remove the dyed test strip from the bath using forceps. Hold the fabric above the dye bath for approximately one minute to allow excess dye to drain back into the dye bath.
4. Pat the test strip with paper towels and rinse the dyed test strip under running water from the faucet or use a wash bottle. Continue rinsing the test strip until all of the excess dye has been removed and the rinse water is colorless.
5. Place the test fabric on a small piece of aluminum foil or weighing dish and allow it to dry overnight.
6. Record observations concerning the differences in color.

Disposal

Please consult your current *Flinn Scientific Catalog/Reference Manual* for general guidelines and specific procedures, and review all federal, state and local regulations that may apply, before proceeding. The congo red solution may be rinsed down the drain with an excess of water according to Flinn Suggested Disposal Method #26b.

Lab Hints

- This activity was adapted from Forensics of Fibers Student Laboratory Kit (Flinn Catalog No. FB2022).
- Other multifiber test fabrics containing 8 or 13 different fabrics are available from Testfabrics, Inc. See their website at www.testfabrics.com.
- A stereoscope (MS1161) or magnifier (AB1135) may be used to make detailed observations of the fabric sample before and after dying.

References

Collins, David. *Investigating Chemistry in the Laboratory;* W. H. Freeman & Company: New York, NY; 2006; p. 131.

Kubic, T., Petraco, N. *Forensic Science—Laboratory Experiment Manual and Workbook;* CRC Press: Boca Raton, FL; 2003; p. 93.

The materials for *Fiber Findings* are available from Flinn Scientific, Inc.

Catalog No.	Description
FB2022	Forensics of Fibers—Student Laboratory Kit
C0128	Congo Red Indicator Solution, 0.1%, 500 mL
AP6135	Multi-Fiber Test Fabric, 1 Yard

Consult your *Flinn Scientific Catalog/Reference Manual* for current prices.