

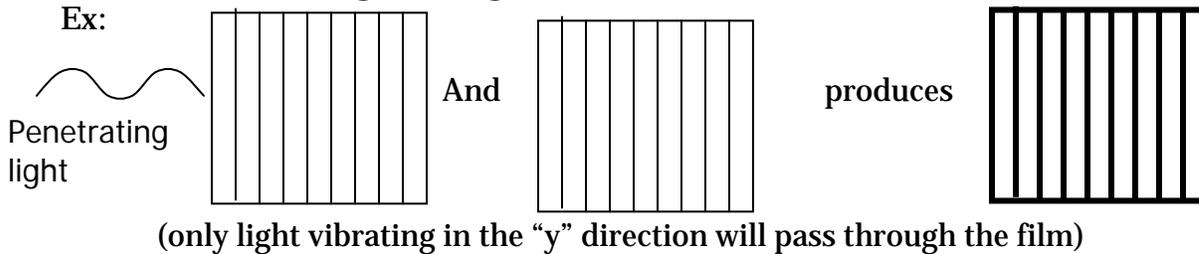
## Teacher Guide to Fiber and Hair Lessons

These activities are designed to be used in a forensics elective course, but some of the activities on fiber solubility and polarity may be useful in a Chemistry class as well.

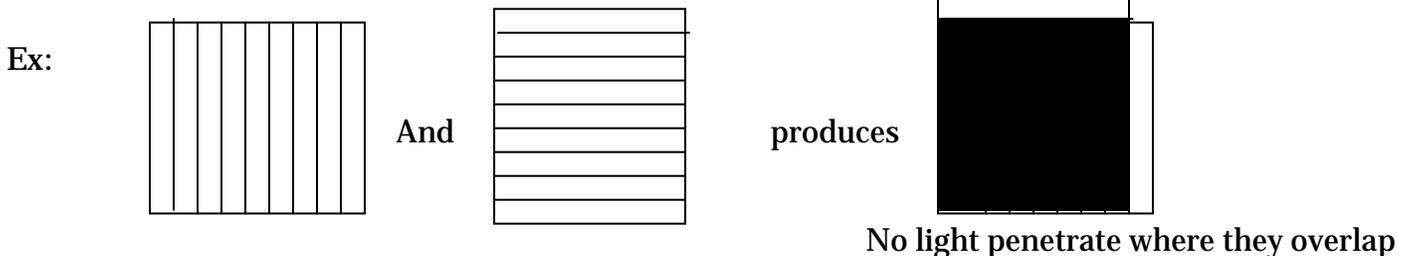
### **Demonstration:**

Materials in this kit are provided to do a demonstration to explain polarizing light and use with a microscope. An overhead will be needed as well as the polarizing film in the matte board, the polarizing film mounted to the wood platform and the tygon tubing.

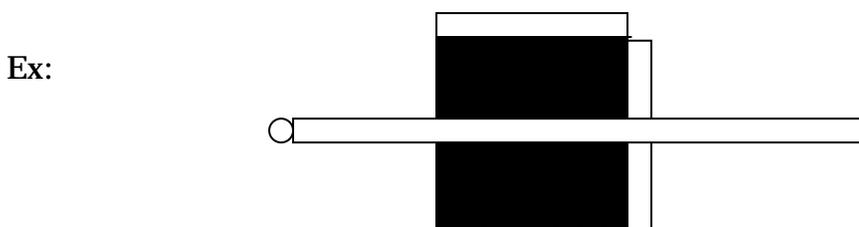
Place the matte board polarizing film on the overhead. Explain that the film has polarized the light – only the light vibrating in the same direction as the “slits” or coating on the film can pass through. Then place the mounted film over it so that the film is aligned. Most of the light will go through since the slits that let the light through are in the same direction.



When you twist the mounted film 90° the light cannot pass the slits and the space where they overlap becomes dark.



When you add the tygon tubing in between the two polarizing filters, light goes through both layers and creates a rainbow pattern as you bend and stretch the plastic. The explanation is that the tubing is bending the light. The polymers form a regular, repeating pattern similar to a crystal and will bend (diffract) the light. When the polarized light enters the tubing it's direction is changed and some of the light can pass through the second polarizer.



This is the idea behind the polarizing microscopes. Different fibers will bend the light differently, creating identifiable patterns. (these patterns are also quantifiable and used to determine the birefringence – not a topic discussed in this lesson) Students should see changes in the fiber as they

rotate the second polarizing film on the eyepiece for each sample. They should be able to see some differences among the fibers but unfortunately it will not be a solo identifier, you will need the other activities to determine your unknown

**Fiber Lesson:**

1. Activity one – be sure the threads from the fabric are pulled apart to the smallest fiber obtainable - untwisting the thread and pulling apart with tweezers works well.
2. Activity two – the bottom polarizer should be placed on top of the microscope light source (illuminated from the bottom) and the film canister should go over the eyepiece as shown.

Looking through the eyepiece, if the field is dark, then rotate the bottom polarizer 90° .



View of set up (on low power to focus) First polarizer

Second polarizer

3. Activity three – usual lab safety and precautions with flame. Reference book on flame results below:

**Table III—Reaction to Flame**

	<i>Melts Near Flame</i>	<i>Shrinks From Flame</i>	<i>Burns in Flame</i>	<i>Continues to Burn</i>	<i>Appearance of Ash</i>
<b>Natural Fibers</b>					
⇒ silk	yes	yes	yes	slowly	soft black bead
⇒ wool	yes	yes	yes	slowly	irregular black
⇒ cellulose	no	no	yes	yes	light greyish
⇒ asbestos	no	no	no	no	may blacken
<b>Man-Made Fibers</b>					
⇒ acrylic	yes	yes	yes	yes	hard black
⇒ acetate					irregular
⇒ azlon					shaped
⇒ nylril					bead
⇒ polyester	yes	yes	yes	yes	hard black
⇒ nylon	yes	yes	yes	yes	round bead
olefin	yes	yes	yes	yes	hard grey
vinal	yes	yes	yes	yes	round bead
modacrylic	yes	yes	yes	no	hard tan bead
saran					hard black
vinyon					irregular bead
metallic	yes	yes	no	no	metal bead
glass	yes	slowly	no	no	hard clear
					bead
rubber	yes	yes	yes	no	irregular mass
spandex	yes	no	yes	yes	fluffy black
					or grey
anidex	yes	no	yes	yes	brittle black
					irregular bead
⇒ rayon	no	no	yes	yes	none
aramid	no	yes	yes	no	hard black
					bead
novoloid	no	no	brief	no	carbon

4. Activity Four – no special considerations
5. Activity Five – Caution – very dangerous chemicals being used! Students should have googles, apron and gloves when working with these materials. You may wish to assign each group of students to only one solution to limit exposure and decrease the time needed to complete the lab.
  - a. To prepare 5% bleach: Household bleach is already 5 -6 % sodium hypochlorite and can be used undiluted.
  - b. To prepare 500 ml of 20% hydrochloric acid, add 270 ml of concentrated HCl to 230 ml of distilled water.
  - c. To prepare 500 ml of 59.5% sulfuric acid, add 309 ml of concentrated sulfuric acid to 191 ml of distilled water.
  - d. To prepare 500 ml of 70% sulfuric acid, add 365 ml of concentrated sulfuric acid to 136ml of distilled water
  - e. The results are shown below:

**Remember to always add acid to the water, never the reverse!**

Fiber Type	5% Bleach	20% Hydrochloric acid	59.5% Sulfuric acid	70% Sulfuric acid
Cotton	no	no	no	yes
Nylon	no	yes	yes	n/a
Polyester	no	no	no	no
Worsted wool	yes	no	no	no
Silk	yes	no	yes	n/a
Rayon	no	no	yes	n/a

n/a - Instructed to not perform the solubility in 70% sulfuric acid if the fiber dissolves in 59.5%

### **Hair Lesson:**

If you would like to extend the hair lesson, the polarized films can be added with the hair as well.

1. Activity One – using the nail polish to make a cast of the hair cuticle takes a little practice. Sometimes the cuticle is visible when you focus above the hair before the medulla is visible.
2. Activities two through four – no difficulties in performing these steps, just encourage the students to be careful and thorough. For unknowns you can just re-label the given hairs to see if they can be identified. Students will most likely not be able to determine which individual the hair has come from – it is a class property. This means that many people have similar hair, like a blood type group where many individuals are type O.
3. If you would like to discuss hair cross section, it makes a nice tie in with fibers. Cross sectional shape in hair is race dependent and goes along with the straight v. curly. Asian ancestry with straight hair tends to be perfectly rounded, Caucasian hair is more oval and African ancestry with curly hair will be flattened.
4. Rubbing your finger and thumb up and down the length of the hair will always cause the root to move away from your hand because the scales of the cuticle point to the tip, and the ridges on you finger causes the hair to move to the tip.

**Fabric swatches from Testfabrics.com, sample type and style number below:**

Bleached cotton - #400

Polyamide (nylon 6,6) - #361

Polyester (Dacron 54) - #769

Wool - #537

Silk - #615

Rayon (viscose) - #266

**References:**

1. Dr. Margaret Frey, Professor of Fiber Science and Apparel Design, Cornell University, Ithaca, NY 14853.
2. AATCC Technical Manual on Fibers (1994) p. 48 -65
3. Forensic Science - An Introduction. Richard Saferstein , Prentice Hall, 2008
4. Hair and Fiber Analysis Lab Activity, Wards Natural Science Establishment, 2006
5. BioDetectives: Investigations in Forensics. "Using Polarized Light to Identify Fibers" Prentice Hall, 2002.