1. Fiber Identification - DRAFT - Debora Mayer 1994

(see also AIC/BPG/PCC 4. Support Problems 4.4.1)

Fiber identification generally involves taking samples from the artifact and viewing them at 100 times or greater magnification to study the fiber morphology. Stains are often employed to accentuate features and to determine pulping processes. Fiber identification, especially in the case of samples from paper, is not necessarily straightforward. Consultation and study using reference material and known fiber samples is essential.

1.1 Purpose

Identification of the fiber content of the artifact may aid in dating the artifact determining the provenance of the artifact understanding the artist's technique, and, finally, in the selection of conservation treatment procedures and techniques.

The introduction and usage of some fibers and manufacturing process are known. Therefore, it is possible, at times, to date (post) the manufacture of the artifact. Specific fibers and types of paper are sometimes more commonly utilized in certain countries or regions assisting in establishing the provenance of the artifact. Sensitivity to an artist's work and understanding visual qualities of the work can often be enhanced by knowledge of the fiber content and manufacturing process. Different fibers have different chemical and physical properties, including, but not limited to: lignin content, color, absorbency and dimension. Knowledge of the properties may help in predicting how a paper will react to specific treatments (for example: wetting, bleaching, deacidification).

1.2 Factors to Consider

1.2.1 History of Fiber Usage

1.2.2 Fiber Qualities

1.2.3 Sampling Guidelines (see AIC/BPG/PCC Spot Tests 10.2)

1.2.4 Representative Sampling

1.2.5 Fiber Classifications (see Cote 1980 for Fiber Nomenclature)

A. Plant Fibers

1. Wood Fibers

a. Gymnosperm (non flowering)
conifers most important group, they are generally evergreen and called "softwood" by tradespeople
[examples: pine, spruce, hemlock]

cell types: **longitudinal tracheids(fibers), parenchyma**
architecture: **bordered pits and ray crossfield pitting on tracheids**

b. Angiosperm (flowering)
both monocotyledon and dicotyledon trees can be evergreen or deciduous, called "hardwood" by tradespeople
[examples: oak, maple, poplar, red and black gum]

cell types: **tracheids, vessels, parenchyma, vasi-centric tracheids**

cell type: fiber

architecture: shape of medulla, cross sectional shape, scale pattern, all can vary from root to tip within same animal

2. Secretions
protein
[examples: silk, Bombyx Mori (cultivated), Tussah silk (wild)]

cell type: fiber
architecture: smooth or slightly striated fibers, no skin or outer covering, triangular or wedge- shaped cross-sectional shape

C. Man Made Fibers

These fibers are not generally found in paper except in small percentages on modern specialty papers. Synthetic fibers however, are used extensively in conservation treatment and storage materials.

1. Cellulose-based
[examples: viscose rayon, acetates]
2. Synthetic fiber
[examples: nylon, polyester, acrylic]

architecture: long fibers, smooth profile without scales or convolutions, may have striations, generally identified by stains, interference colors and cross sectional shape

D. Mineral Fibers

Rarely found in paper. Strathmore made a watercolor paper in the 1970s with a small percentage of fiberglass. [examples: asbestos, glass]

1.2.6 Optic Properties of Fibers

1.2.7 Wood Fiber Pulping Processes

A. Mechanical

B. Semi Chemical And Semi Mechanical

C. Soda

D. Sulfite

E. Sulfate (Kraft)

1.3 Materials and Equipment

1.3.1 Materials

A. Microscope Slides and Coverslips; Microscope Slide Boxes

B. Teasing Tools

C. Water

D. Stains

coverslip over the sample, lowering it at an angle to avoid creating air bubbles. Allow the slide to stand 1-2 minutes then drain off excess liquid, preferably by tilting the long edge of the slide into contact with a blotter or paper towel.

C. **Slide Labelling**

D. **Permanent Mounts**

E. **Reference Collection**

F. **Disintegration of Difficult Fiber Samples**

G. **Cross Sectioning**

Cross sectioning can provide useful information for the identification of many fibers. Often it is not a conclusive test but cross sectional shape can provide confirmatory evidence. These techniques are primarily designed for textile and ethnographic materials.

1. Plate Method
   This is the quickest and least expensive way to section a sample.

   Materials:

   1) a plate 1" x 3" (25 x 75mm) the same size as a microscope slide but .010-.020" thick (about 0-.5mm) with holes drilled in it. The holes are .035-0.40" in diameter (about 0.75 mm) made with a No. 65 or No. 60 drill respectively.
   2) needle threader or thread
   3) new single edge razor blades

   Note: the plate can be made of smooth shim brass or plastic. Thinner plates have difficulty in holding the fiber plug and thicker plates interfere with the transmission of light. With regard to hole size, small holes are difficult to thread and large holes tend to lose the fiber slice.

   Procedure: Pull a tuft of fibers through the hole in the plate with either a loop of thread (of known identity such as wire filaments, sewing thread, polyester thread, etc.) or with a needle threader. The tuft of fibers must be tightly jammed in the hole to insure that it remains after the top and bottom have been sliced off. If the tuft can be easily pulled through the hole than the finished slice will fall out easily. If the plug is too large the thread or needle threader will break.

   The tufts on each side of the plate are cut as flush as possible with a new single edge razor blade. It works well to cut the side with the needle threader first.

   Contrast of the fiber cross sectional shape can be enhanced by use of fluids between the sample and the coverslip. The background of light, bright fibers can be darkened by using a drop of liquid with a low refractive index such as n-decane (1.41) or dibutylphtalate (1.49). Dark, dull fibers will appear black against a light background if a liquid of high refractive index, such as bromonaphthalene (1.66) is used.

2. Thin Cross Sections

Institute of Science and Technology, 500 10th Street., NW
Atlanta, GA 30318-5794

Specific stain to confirm unbleached sulfite fibers. Unbleached sulfite fibers stain red or pink while all other fibers stain clear or colorless.

F. **17.5% NaOH**

Used to distinguish between mitsumata and gampi fibers.
(see AIC/BPG/PCC 10. p. 17)

G. **Dupont Fiber Stain #4**

Pylam Products Co., Inc., 1001 Stewart Avenue, Garden City, NY 11530

This stain is specifically intended to be used for the identification of synthetic fibers. It is most useful for the identification of nylon, rayon and cellulose acetate.

Boil large sample in a beaker or in a test tube on a hot plate for a few minutes. Withdraw sample and rinse with water. Observe color reaction with reflected light. This procedure is designed for large sample size but the technique can be adjusted, with experience, to use on a micro scale. Place sample on microscope slide. Drop stain onto a sample forming a puddle around the fiber. A ratio of twenty parts stain to fiber is recommended. Heat the slide (and sample) on a hot plate. Rinse sample with water using a pipette to clear stain. Although the stain is intended to be observed with reflected light, the stain can sometimes be observed with transmitted light.

The stain has a long shelf life. Shake stain prior to use to thoroughly re-mix settled out portion.

Color reactions:

nylon—red
rayon—blue
cellulose acetate—orange
polyester—pale yellow/yellow tan/beige
acrylic—beige
olefin—light tan
wood/cotton—green
glass—doesn't stain

H. **Shirlastains A,C,D and E**

Crosrol, Inc., P.O. Box 6488, Tower Drive, Greenville, SC 29606

Designed to be used directly on textile threads. Color reaction is viewed in normal reflected light without the aid of a microscope. May be able to adjust technique to use on micro sample.

Shirlastain A - for the identification of non-thermoplastic fibers, i.e. cotton, wool and other natural fibers; viscose rayon and other regenerated fibers.

Shirlastain C - for better distinction between natural cellulosic fibers such as cotton, flax, hemp and jute.

1.5 Bibliography

1.5.1 Paper History

1.5.2 Fiber Microscopy

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1.5.3 General Microscopy

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