THE Melliand TEXTILE MONTHLY

VOL. III. SEPTEMBER, 1931 No. 6

The Identification of Fibers

By H. B. GORDON*

It is intended, in this series of short articles, to discuss the means of distinguishing the different fibers used in the textile and allied industries, giving especial attention to the microscopic appearance of fibers, but mentioning also chemical tests which should be used in conjunction with the microscopic examination, either as a check or to give additional information.

The chemical equipment needed in the identification of fibers is very simple, and, except for some of the reagents used, should be found in any chemical laboratory. The microscope need not be of a very expensive type but should be provided with lenses of good quality. Especially when stained fibers are under examination the advantage of lenses carefully corrected for chromatic aberration is very evident. An achromatic objective is satisfactory if of good quality. Care should also be used in the selection of the eye-pieces. The equipment should include 6X and 10X eyepieces, and 4 mm. and 16 mm. objectives. A lower power objective, say one of 32 mm. or 48 mm. focus, is also useful at times. The addition of an oil immersion lens is often recommended, but it adds considerably to the cost of the equipment, and in the experience of the writer, is seldom required. In general, as emphasized by Chamot,[1] it is best to work with low magnifications.

For illumination many prefer daylight. The light from the north sky on a bright day is probably as satisfactory a light as can be found. However, daylight varies so much, both in quality and intensity, on different days and even at different times of the same day, that the writer prefers an artificial light. A great many kinds of lamps for use with the microscope are on the market. One of the small lamps which may be placed directly in front of the microscope mirror or under the stage of the microscope (the mirror having been removed) is quite satisfactory. This lamp, when fitted with a ground glass diffusion disc and a blue glass disc to give "artificial daylight," is excellent for all general work.

* Professor of Chemical Engineering, Alabama Polytechnic Institute, Auburn, Alabama.

An accessory which, in the opinion of the writer, doubles the efficiency of the microscope, is the mechanical stage. This is of so great assistance in the systematic examination of a slide and in making measurements with the microscope that its omission from any outfit intended for serious work seems very unwise. The more expensive mechanical stages carry millimeter scales with verniers, enabling one to use them for measurements to a tenth of a millimeter. While this is sometimes of value the occasions for such measurements are not often met in most laboratories, so the cheaper form, without the millimeter scales, may well be used.

Not infrequently it is found desirable to measure the diameter of a fiber. For this purpose a simple micrometer disc, that may be placed inside of the ocular, serves very well. Of course this must be calibrated for the lenses and tube length used. This is easily done by means of a stage micrometer.

Occasionally polarized light can be used to advantage in the study of fibers. However, polarization equipment is somewhat expensive. It is hardly worth its cost in most laboratories unless it is to be used for some other work to be done in addition to fiber examination.

It is very often found desirable to record the results of microscopic examination for future reference. This may be done by drawing the object as observed with the microscope. For this purpose a camera lucida is helpful, but probably a more satisfactory arrangement is secured by projecting the image upon the drawing paper. By turning the microscope down horizontal, and placing a small mirror, inclined at about 45°, behind the ocular, the image may be reflected down upon the table on which the microscope is standing.

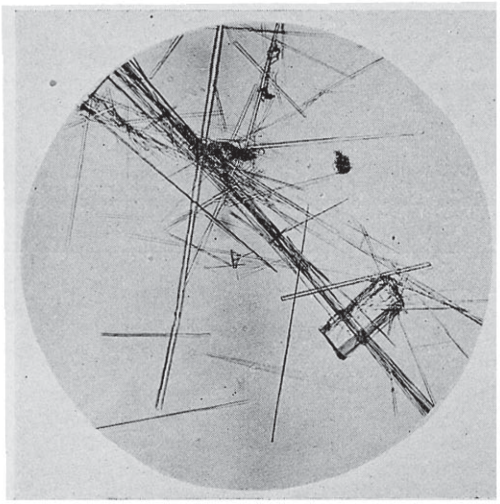

Fig. 1. Asbestos. Magnification 125 X

This requires a rather powerful illuminant and should ordinarily be carried out in a darkened room.

For many purposes a photograph is better than a drawing. The making of such photographs (photomicrographs) is not much more difficult than making ordinary photographs when satisfactory equipment is available. A suitable illuminating device and a camera are required. Of course the microscope serves as the lens of the camera. Suitable cameras may be purchased at prices ranging from $50 to $1,500. The camera with which many of the pictures were made and which are used in the illustration of this series of articles was made from a corrugated board carton and some pieces of pine board. The only money cost was for plate holders. It is supported on a heavy laboratory stand by two large iron rings.

The illuminant for making photomicrographs must be a rather powerful one. A concentrated filament, incandescent lamp with suitable mirror and condensing lens works very well, but many prefer an arc light. If an arc is used an automatic feed is desirable although not a necessity. Owing to the intense heat from the light a cell containing water (a flat bottle will do) should be placed between the arc and the microscope. The addition of enough slightly acid copper sulphate solution to give a blue tinge to the water is said to increase greatly its power to absorb heat.

The use of a green ray filter, placed between the water cell and the microscope, is also to be recommended. This makes the light nearly monochromatic, thus securing a somewhat sharper image than would be possible with white light.

For most purposes the medium in which fibers are mounted for examination is not important. The writer likes a mixture of water and ethyl alcohol in about equal parts. This wets waxy surfaces more easily than water alone and is less volatile than pure alcohol. However, if much time is to elapse during the examination of the sample the use of glycerine and water, or glycerine and alcohol, is advantageous. Glycerine alone is too viscous to wet fibers well, but when mixed with two or three volumes of alcohol a solution is obtained which wets them very well. Upon standing, the alcohol evaporates, leaving the glycerine.

Classification of Fibers

Fibers are usually classed as mineral, animal, vegetable, and artificial. This classification, based on the source or origin of the fiber, is doubtless as good as any and will be followed in the discussion which follows.

Mineral Fibers. There are several fibers in this group but the only one of sufficient importance in textiles to warrant mention is asbestos. This is sometimes used in yarn or fabrics intended to resist heat, chemical ac-

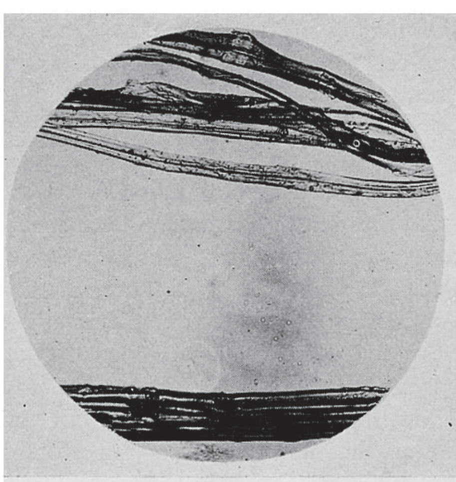

Fig. 2. Gum Silk. Magnification 125 X

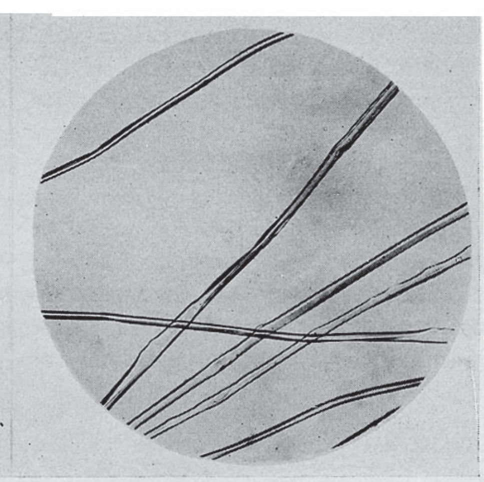

Fig. 3. Silk (degummed). Magnification 125 X

tion, etc. The fibers, Figure 1, are very fine and straight. They could hardly be mistaken for any of the fibers of organic origin. A check test can be made by touching the fibers with the flame of a gas burner. Asbestos fibers will not be changed but fibers of organic origin will be burned.

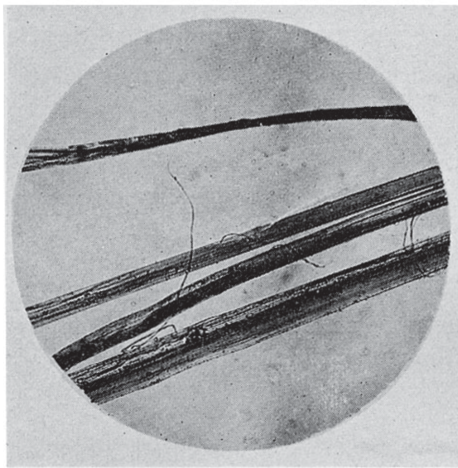

Fig. 4. Tussah Silk (gum). Magnification 125 X

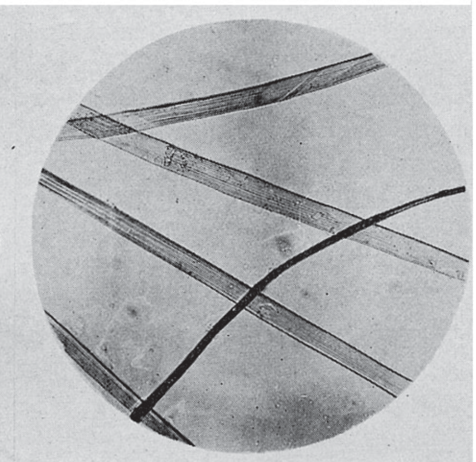

Fig. 5. Tussah Silk (degummed). Magnification 125 X

Animal Fibers. These may be divided into two classes: Fibers produced by the solidification of filaments of liquid expelled by an animal through tiny holes in its surface, and fibers produced by the skins of animals. The former may be referred to as "silks," the latter as "hairs."

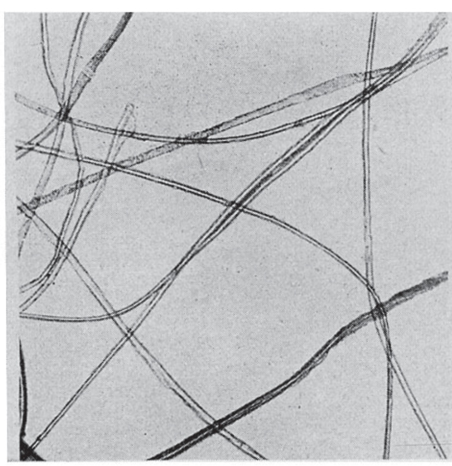

Fig. 6. Spider Silk. Magnification 100 X

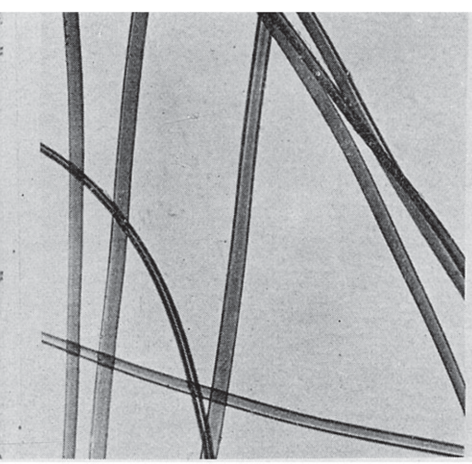

Fig. 7. Byssus Silk. Magnification 100 X

Silks

By far the most important of the silks is that produced by the insect *Bombyx mori,* which has been cultivated in China several thousand years. When the word "silk" is used without modification it should be applied only to this variety of silk. Other silks should be referred to with the use of some distinguishing word, as "tussah silk," the fiber produced by worms which the Chinese call *shan tsan* or mountain silk worms.

The silk fluid is expelled by the worm through two holes or spinnerets in its head. The two filaments solidify and are stuck together by silk gum or silk glue, thus forming a double filament, or bave. Raw silk may be so heavily coated with this silk gum as scarcely to show the presence of the individual filaments. In Figure 2 are shown two threads of raw silk. Each thread contains a number of baves. One thread is shown spread out to show the single filaments and baves.

In order to bring out the luster of the fiber it is necessary to remove the gum by "boiling off" with a solution of soap, to which sodium carbonate is sometimes added. The resulting bright silk fibers, Figure 3, are smooth and transparent. They are usually about 20 microns† in width. A distinctive characteristic is the occasional flattened spots, several of which may be seen in Figure 3. These spots are sometimes of service in distinguishing silk from certain types of fine filament rayon.

Aside from the silk produced by Bombyx mori the chief silk is that which is called *tussah*. Although this variety is now cultivated it has not been cultivated so very long, hence it is still called "wild silk." There are several other types of wild silk, but like tussah, they have a wide, ribbon-like filament, and upon boiling off the glue, they show longitudinal striations. In Figure 4 is shown a wild silk with gum. In Figure 5 the same silk is shown after removal of the gum. Often wild silks come on the market with gum not removed or incompletely removed. In this condition the longitudinal striations may be scarcely discernible. They are easily recognized, however, because of their wide, ribbon-like fiber. It is often 50 or 60 microns in width.

Comparisons of Figures 2 and 4 indicate that less gum is present in a tussah than on a cultivated silk. This is borne out by quantitative chemical analysis. Matthews[2] gives the gum as 8 to 14% for tussah and 18 to 24% on cultivated silk.

A silk of some interest, though of small commercial importance, is that produced by a spider in Madagascar, Figure 6.

† A micron is 0.001 millimeter. One inch equals 25.4 millimeters.

Another silk of small commercial importance is the byssus silk, Figure 7. This is produced by a mollusk, and hence is sometimes called sea silk.

Often silk is weighted with salts of tin or other metals. One might suppose that the weighting would readily be seen by the use of the microscope. This, however, is not the case. Figure 8 shows a heavily weighted silk, but its microscopic characteristics are not essentially different from those of the silk shown in Figure 3. The fibers are somewhat larger and the dark dye renders them opaque, but this might be so without weighting. The presence of weighting may be shown by burning a few threads. The resulting ash has the form of the original thread, while for unweighted silk it assumes the form of dark pellets.

Another form of silk weighting which is only rarely met is illustrated in Figure 9. This is a gum silk which has been coated with some organic material. Although so much of this sample is something else than silk fiber the thread would be called "all silk" because silk is the only fiber present. The writer knows of no satisfactory method for quantitative estimation of weighting of this type. Tin weighting may be estimated as described by Matthews.[3]

Fig. 8. Silk. Tin weighted. Magnification 125 X

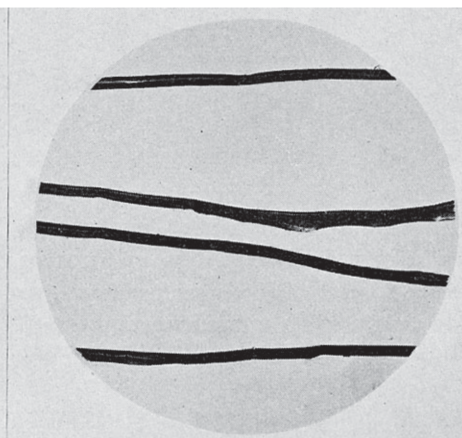

Fig. 9. Gum Silk. Organic Weighting. Magnification 125 X

REFERENCES

(1) Elementary Chemical Microscopy, E. M. Chamot, 2nd ed., p. 18.
(2) Textile Fibers, J. M. Matthews, 4th ed., p. 292.
(3) Textile Fibers, J. M. Matthews, 4th ed., p. 971.