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COMMUNICATIONS

A RAPID METHOD FOR CUTTING MICROSCOPE SECTIONS OF COTTON YARNS AND FABRICS

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In the course of some investigations on the physical properties of cotton fabrics, it became necessary to cut a large number of sections of loose fibres, yarns, and fabrics, for microscopic examination. This proved to be more difficult than was at first anticipated. Inquiry among other workers showed that they too had met with difficulties similar to our own, but had overcome them more or less successfully. Their methods were, however, too elaborate and lengthy for our purpose. Eventually, a method was worked out which can easily be used by those unskilled in such work and which meets our own requirements so satisfactorily that it is hoped a description of it may be interesting to other workers on textiles.

The difficulties to be overcome are:—

- (1) The cotton fibres are readily pushed through the mountant by the razor, and as cotton is stated to be nearly as hard as cast-iron this is not surprising.
- (2) It is necessary for our purpose that fibres should retain their relative positions in the yarns. This makes it difficult to secure proper penetration of tightly twisted yarns by the mountant, as untwisting is not allowable.
- (3) The treatment should be such as not to alter the shape of the fibres. For this reason we excluded any method in which the mountant is admitted to the cotton under reduced pressure, since from other work it appears probable that the relative position of the fibres may be altered and their shape may be flattened when the pressure comes on again.

The work was begun during the war when the usual mountant celloidin was both scarce and costly; preliminary experiments with paraffin were unsuccessful; finally, aeroplane dope was found to be quite satisfactory for our purpose.

SOLUTIONS USED: Both cellulose nitrate and acetate have been used. The former¹ gives much better penetration and does not require protection from water vapour while it is drying, as does the latter; but it is now difficult to obtain, at least in a standard quality—hence, this note is concerned only with the acetate.

The acetate is bought in the solid form² and is dissolved in acetone before being used. Two solutions are made: one contains 5 to 6 grams of acetate per 100 ccs. of acetone, and the other is stronger and is a thick viscous syrup. Considerable shaking is necessary to bring about solution.

PRELIMINARY PREPARATION OF THE SPECIMENS: Except when tightly twisted yarns are used, little preliminary preparation of the samples is required.

All that is necessary is to immerse them for an hour in the weaker of the two solutions mentioned above, and then to place them, in the wet condition, on a previously prepared slide (see next par). Where the twist of the yarn is tighter, an hour's immersion in absolute alcohol is necessary before putting them in the thin dope.

MOUNTING THE SPECIMENS: A microscope slide is cleaned under the tap, dried, and a layer of the weaker solution is painted on it with a camel hair brush. When this is nearly dry, a layer of the thicker solution is added, and, after a suitable interval, when some evaporation has taken place, a second or more layers, the number depending on the thickness of the fabric to be cut. While the last layer is still wet the sample of material is transferred from the thin solution and is laid flat on the slide. More layers of dope are added as before. Several different samples can be mounted on the same slide if required. If the nitrate be used, the drying can take place in the ordinary air of the laboratory, but the acetate, if dried under such conditions, is liable to combine with moisture and form an opaque white film. This is easily prevented by drying the slide in a desiccator containing calcium chloride, with the lid half off. A film as clear as glass is then obtained. The drying could, of course, be accelerated by pulling dry air over the slide by means of a water pump. When dry, film and enclosed specimen can be stripped of the glass and stored if necessary.

EMBEDDING THE SPECIMENS: As stripped from the slide, the dope is too hard and brittle to cut satisfactorily. A strip of it, $1\frac{1}{2}'' \times \frac{1}{4}''$, is hung in acetone vapour in a bottle until it is soft enough to be bent easily but does not bend under its own weight. Experience soon tells the proper degree of softness. It is then mounted in paraffin wax. The wax must have a low melting point— 40°C. to 45°C. —and must not be heated more than a few degrees above that temperature, otherwise too much solvent is driven off from the dope which then becomes too brittle. A most convenient method of embedding is to use a copper or brass mould of the shape shown in Fig. 1, of a size suitable for the microtome block; about $0.75'' \times 0.6''$ suits our machine.

This is smeared on the inside with glycerine.

The small piece of dope is supported between the two arms of a piece of thin wire which is bent double and is laid across the top of the mould while the paraffin is poured in. The mould is then placed in cold water to a depth of $\frac{1}{2}''$ so that solidification starts at the bottom, and it is an advantage to keep the upper layers liquid by means of a hot wire until the lower portions have hardened. When the wax has set, the top part of the mould can be lifted from its base and the wax containing the dope pushed out of the cylinder. It is then mounted in a Jung microtome so that the threads of the fabric are cut *in succession*, thereby obtaining the

greatest stiffness of the dope. The razor is set obliquely. Samples whose preparation has begun on one day can be cut on the next, and could possibly be cut on the same day if more rapid drying were used.

When working on sections, we have, on many occasions, seen what are apparently Balls' daily growth rings in sections. As we do not know the age of the fibres we are using, we cannot verify this by counting the rings and comparing with the age as Balls did³. A fairly coarse yarn is taken—20's count is very suitable—the section is washed well with xylol to remove the paraffin, then in absolute alcohol. It is stuck to the slide with a thin smear of albumen, without heat (White of egg 25ccs., glycerine 25ccs., sodium salicylate 1 gm.) The slide is inverted over a bottle of acetone for a few minutes until the dope softens and curls back on to the glass. It is then covered with acetone in a suitable vessel for about 2 hours to remove the dope. Each single cotton hair then stands freely on end on the slide. If the section is mercerised by allowing some caustic soda of strength 45°Tw. to pass under the cover slip the growth rings will usually be seen on some of the single fibre sections. An attempt to photograph such a section was not very successful owing to the lack of contrast between the different portions, so the soda was washed out, the section lightly stained with safranin, re-mercerised, and photographed while in the soda. Mercerisation multiplied the diameter by two at most, and, as a $\frac{1}{4}$ " lens was used, giving a magnification of 500 in the camera, the total magnification of the original fibre is less than 1,000. This is much less than the 20,000 magnification used by Dr. W. L. Balls to show the growth rings in longitudinal section, but it is quite possible that the viscose method he used would bring out a larger number of rings. (See Fig. 2.)

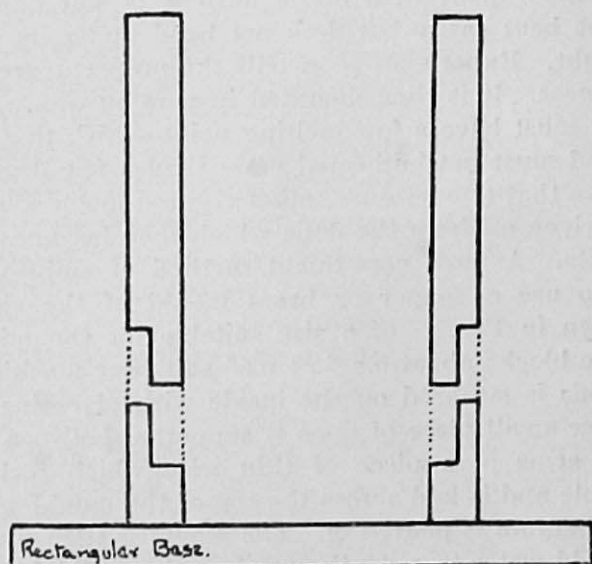


FIG. 1.

The photograph (Fig. 3) is a section of mercerised voile fabric showing the bent threads of the weft

and the cut ends of the single hairs in the warp yarns. A section cut in this way is an excellent means of testing whether the lye has penetrated the fabric.

For most purposes albumen is quite satisfactory as an adhesive but, under certain conditions, especially with alkali solutions, the sections are apt to float away. Dr. S. B. Schryver, of the Imperial College of Science and Technology, suggested to

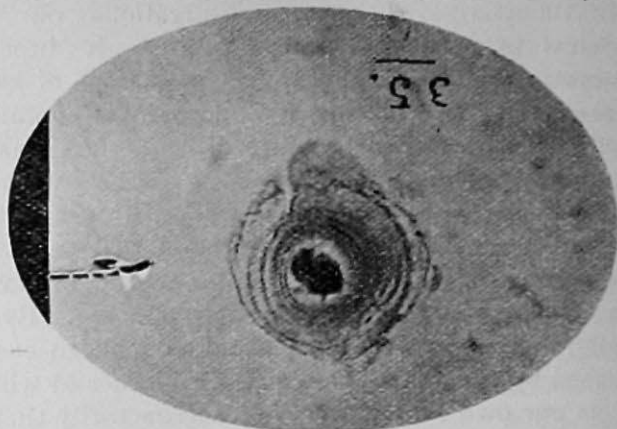


FIG. 2.

me that agar-agar jelly made at 120° would possibly be more useful. This has been fully supported by experiment; sections mounted in agar-agar will stand repeated applications of the various alkaline swelling reagents without falling over.

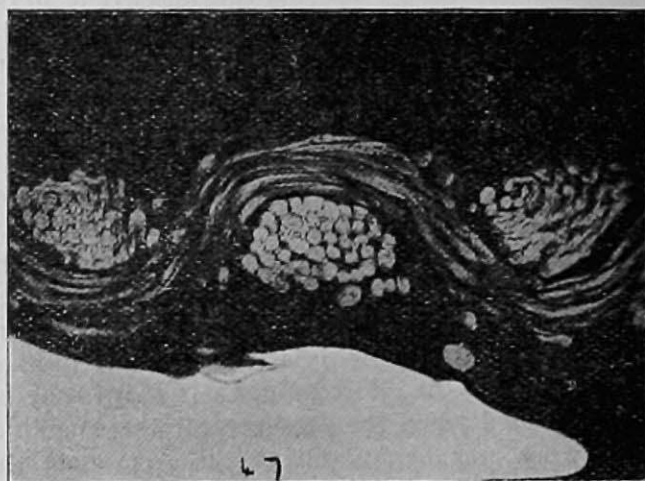


FIG. 3.

Since writing the above my attention has been drawn to a paper in the "Journal of the Chemical Society," vol. 16, by W. Crum, F.R.S., in Plate 7 of which are drawings which may well be the daily growth rings, although the author ascribes them to optical effects. If they were merely diffraction effects, there should be faint fringes outside the fibre, but these are absent from the drawings.

Research Department,
Messrs. Tootal Broadhurst, Lee, Co., Ltd.,
Manchester, March, 1921.

¹ The sample we used was labelled "Emaillite."

² From British Cellulose Company, Spondon, Derby.

³ Proc. Roy. Soc. 90, 542 (1919).