

Identifying Fibres and Fabrics

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Identifying Fibres and Fabrics

Dress and Textile Specialists

Back to Basics workshop:
Identifying and Understanding Textiles

16 March 2012

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DATS Back to Basics Identifying Fibres and Fabrics Workshop March 2011

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Identifying Fibres and Fabrics

Contents

1. Introduction and Learning Outcomes
2. Timetable
3. Fibres in Public (small group work)
4. Looking at Fibres
 - a. Natural fibres
 - b. Man-made fibres
5. Introduction to Fabric Structures
 - a. Woven fabric structures
 - b. Non-woven fabric structures
6. Introduction to Microscopy
7. Glossary
8. Further Reading
9. Web Resources
10. Acknowledgements

1. Introduction and Learning Outcomes

This workshop aims to introduce participants to basic approaches in identifying fibres and fabrics using simple microscopy. By the completion of the workshop participants should be able to:

- Distinguish common fibre types
- Understand processes used in forming simple yarns and fabrics from fibres
- Identify some common simple yarn and fabric construction techniques
- Understand how different fibres degrade and how textile construction affects degradation
- Undertake simple fibre microscopy
- Undertake simple documentation of yarns and fabric structures

2. Timetable

10:30 – 10:30	Welcome and outline of the day
10:30 – 11:30	Introduction to fibres and fabrics Why do we care? Why does it matter?
11:30 – 12:30	Fibres in public (small group work) Identification of fibres and fabrics in the galleries; feedback and discussion
12:30 – 13:30	Lunch
13:30 – 14:15	Introduction to fibre identification and simple microscopy
14:15 – 14:45	Identifying fibres using microscopy (small group work) Using microscopes to identify main fibre types
14.45 – 15.00	Break
15.00 – 15.30	Understanding yarns and simple weave structures
15:30 – 16:00	Round up and evaluation

3. Fibres in Public (small group work)

Participants will spend some time in a small group in different parts of the collection looking at the textiles & dress on display prior to feedback and discussion to the full group. The aim is to:

- Identify different fibres and fabrics if these are not stated on the label
- Consider how you made these identifications
- Reflect on the different characteristics of the fibres and fabrics on display
- Reflect on possible display and storage issues with the different fibres & fabrics
- Consider how much the visitors understand about fibres and fabrics and how this understanding can be enhanced

Fibres in Public – record sheet

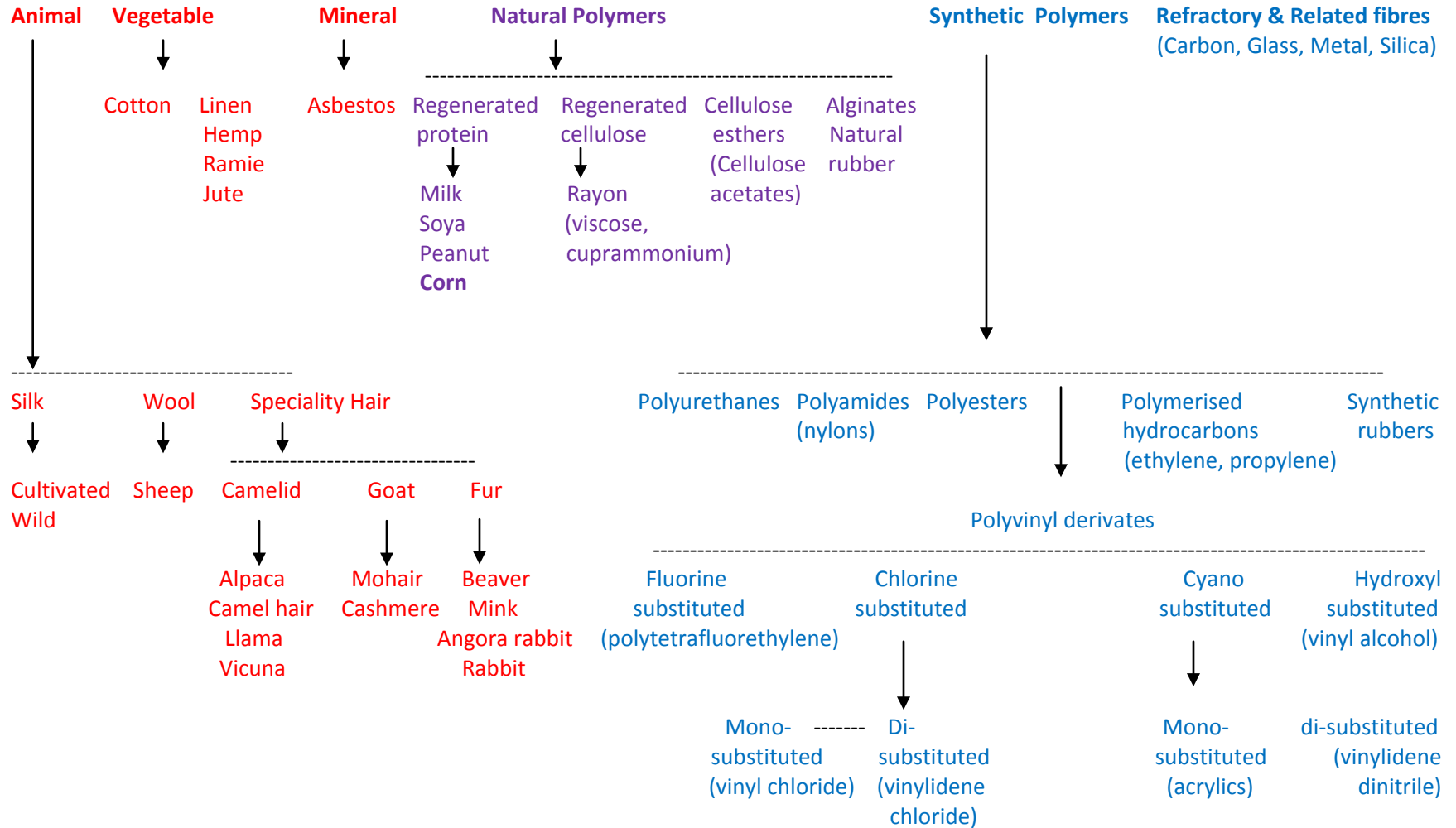
Object	Possible fibre/s	Possible weave	Possible interpretation/ display/storage issues

Object	Possible fibre/s	Possible weave	Possible interpretation/ display/storage issues

CLASSIFICATION OF NATURAL & MAN-MADE FIBRES

NATURAL

MAN-MADE



4. Looking at Fibres

Definition of a fibre: 'Any substance composed of a thread-like tissue whether animal vegetable or mineral, especially when it is capable of being spun or woven'.

Dorothy Burnham *A Textile Terminology Warp & Weft*.

Thread structure:

Fibres are formed into threads by twisting in either an S or Z direction. Yarns are usually made up of two or more single strands twisted or plied together either clockwise (S-twist) or anti-clockwise (Z-twist).

It is possible to make some initial judgements about the identity of a fibre by eye and hand.

- Appearance – shiny, dull, matt, lustrous?
- 'Hand' – how does it feel when you touch it? Is it smooth, rough, stiff, light, fluid?

The context of the fibre can also help in making in narrowing down possible fibre types.

However, fibres are so various and can be processed in very different ways, are made into fabrics using different construction processes and finished in so many different ways that identification by eye and hand is not enough to be certain. For example, linen and cotton may be hard to distinguish from each other and man-made fibres can be confused with the natural fibre they are imitating, such as rayon for silk. Using simple microscope can enable you to identify many natural fibres.

Other approaches – ranging from low to high tech - may be necessary to identifying more unusual natural fibres as well as man-made and synthetic fibres including:

- Fibre cross sections
- Stains; Shirlastain Fibre Identification Stains;
see: <http://www.sdlatlas.com/product/61/Shirlastain-Fiber-Identification-Stains>
- Burn tests; see: <http://www.chymist.com/FIBER%20ANALYSIS.pdf>
- Chemical analysis / solubility tests
- NIR spectrometer; see: Emma Richardson, Graham Martin, Paul Wyeth, and Xiaomei Zhang, "State of the Art: Non-invasive Interrogation of Textiles in Museum Collections," *Microchimica Acta* 162, 3–4 (2008): 303–12.
<http://www.springerlink.com/content/k1400x30l2013163/>

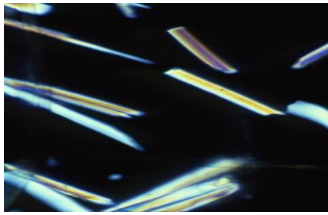
4a. Natural Fibres

Animal – protein fibres

Silk



Silk in good condition



Degraded silk

Continuous filament drawn from the cocoon of a variety of moths, both cultivated (*bombyx mori*) and wild moths.

Consists of two strands of fibroin cemented together with sericin in linear structure.

Fine, strong, lustrous fibre, takes dye very well. Little elasticity and a slight feeling of resistance when rubbed.

Wool – Sheep

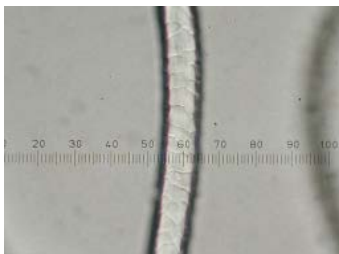


© Whitehall Farm



X 100 ©Alpine Meadows Weavers and Spinners Fiber Microscopy

Fibres from the fleece of a Gotland sheep with some lanolin present.



X 400 ©Alpine Meadows Weavers and Spinners Fiber Microscopy

Over 40 different sheep breeds producing over 200 types of wool of different grades.

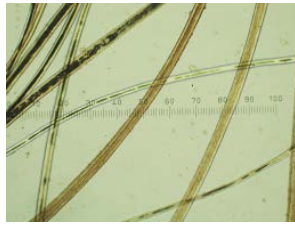
Folded protein called *keratin*. Has a water proof coating known as lanolin.

Soft warm fibre, takes dye well. Will felt under heat, moisture and pressure due to the presence of scales.

Vulnerable to damage by moth.

Note the scales on the fibre.

Alpaca

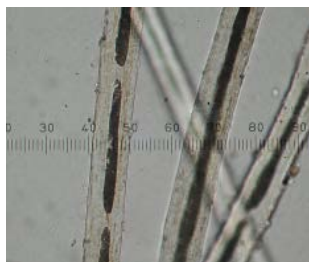


X 100 ©Alpine Meadows
Weavers and Spinners
Fiber Microscopy

Folded protein called *keratin*.

Often blended with wool or cotton to make it easier to manufacture.

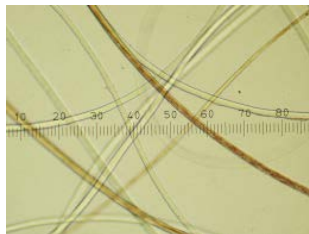
Soft, glossy, durable fibre, more springy than wool and with long 'hairs'. May be light or heavy weight depending on how it is spun. Similar to sheep's wool but is warmer and less prickly. Has no lanolin which makes it hyperallergenic.



X 400 ©Alpine Meadows
Weavers and Spinners Fiber
Microscopy

Note the large medulla (inner canal) in the fibre.

Cashmere



X 100 ©Alpine Meadows
Weavers and Spinners Fiber
Microscopy

Folded protein called *keratin*.

Note the finer size of the fibres and the finer scales.

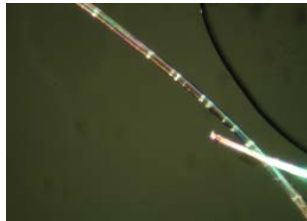


X 400 ©Alpine Meadows
Weavers and Spinners Fiber
Microscopy

Vegetable – cellulose fibres – linearly linked biglucose units

Bast (stem) fibre

Linen



X 100 ©Alpine Meadows
Weavers and Spinners Fiber
Microscopy

Note the bamboo-like cross markings.

Long, straight fibre. Feels smooth and cool. Hard to dye in strong colours.

Seed fibre

Cotton



X 100 ©Alpine Meadows
Weavers and Spinners Fiber
Microscopy

Note the flattened appearance and the ribbon-like effect where it twists.

Shorter, less smooth fibre than linen although the same chemically. Warmer to touch than linen.



X 400 ©Alpine Meadows
Weavers and Spinners Fiber
Microscopy

Detail of the ribbon-like twist.



4b. Man-made Fibres

Regenerated fibres – made from a natural source

Regenerated cellulose

Rayons



First UK production 1905 Courtaulds; Cross, Bevan & Beadle's process. First USA commercial production 1910 American Viscose Company.

Wood pulp or cotton linters dissolved with caustic soda and carbon disulphide and extruded through a spinneret.

Viscose rayon: dissolved in caustic soda giving a viscose, honey-like solution – hence the name.

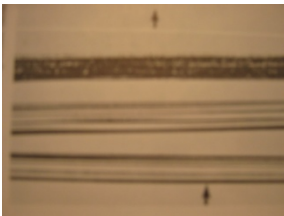
Cuprammonium rayon: treated with ammonia and cupric oxide, hence the name.

Soft fibre, feels like silk, drapes and dyes well but creases easily, loses strength when wet and breaks easily, poor elasticity. Damaged easily by weak acids.

Contemporary version *Tencel* Courtaulds 1994; lyocell process which is more environmentally friendly process. Fibre has better wet-strength and crease resistance.

Acetates

(Cellulose ester fibres)



First UK commercial production 1921 Dreyfus as *Celanese*.

First USA commercial production 1924 Celanese Corporation.

Not made from wood pulp itself but from a chemical derivative, cellulose acetate (process previously used to produce 'dope' for aircraft production).

Soft fibre, good drape, dyes well, dries rapidly, good stability when wet, softens on heating (may deform when ironed).

Peanut fibre.

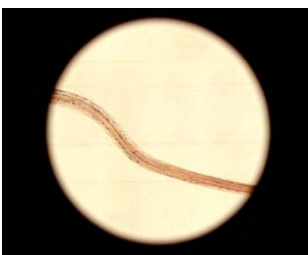
Produced commercially in the UK by ICI 1935-1957 as *Ardil*.

Courtauld's version called *Fibrolane C*. USA version called *Sarelon*.

Made by dissolving protein from peanuts and extruded through a spinneret.

Soft, warm, wool-like fibre but poor wet strength.

Regenerated protein –
made from milk, peanut,
soyabean, corn etc.



Synthetic

Nylon

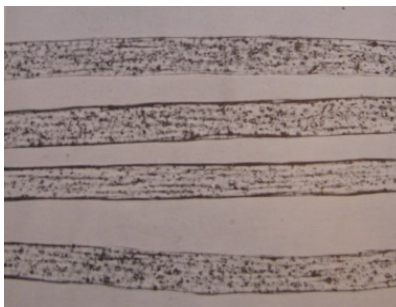


First commercial USA production 1939 E I du Pont de Nemours; developed by Wallace Caruthers.

Polyamide.

Long, smooth, strong, silky featureless fibre. Strong and hard-wearing, resistant to moths.

Acrylic



First commercial USA production 1950 E I du Pont de Nemours.

Polyacrylonitrile.

Light soft and warm with a wool-like feel but less warm to wear. Does not dye well. Wrinkles easily and pills. Less warm to wear. Resistant to moths.

Polyester



First commercial USA production 1953 E I du Pont de Nemours.

Polyethylene terephthalate.

Strong fibre, resistant to insect attack and abrasion, hard-wearing.

Varieties include:

Terylene (UK) / *Dacron* (USA)

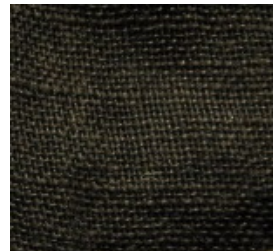
Crimplene Made by ICI 1950s – 1970

5. Introduction to Fabric Structure

5a. Woven fabric structures

Plain weave, also known as *tabby weave*.

The simplest weave, consisting of alternate under and over warps and wefts. When the warp and weft are the same in number and size, a balanced weave results. Variations with different numbers of warps and wefts results in fabrics with crossways ribs or basket effects.

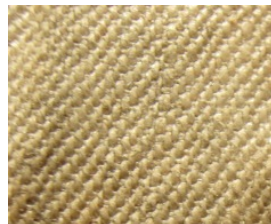
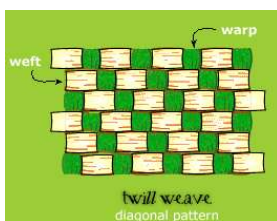


©<http://www.handsoncrafts.org/003-02.htm>

Tapestry weave is a plain variant in which the wefts are packed down to cover the warps to create pictorial effects.

Twill weave.

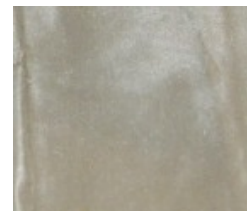
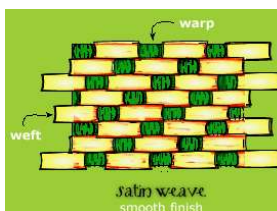
Twill weaves can be recognised by the diagonal effect in the weave created by the weft passing over two warps, then under one; this is then repeated but stepped to one side. The angle of the twill can vary. Twill weaves may have either warps or wefts floating on the front of the fabric.



©<http://www.handsoncrafts.org/003-02.htm>

Satin weave

Satin weaves are similar to twill weaves but do not have the regular sideways step and so do not have a strong diagonal effect but have a smooth unbroken surface with long float. A classic satin has at least five warps and wefts in each weave repeat.



©<http://www.handsoncrafts.org/003-02.htm>

Satin variants include:

Damask in which the pattern is created by alternating warp- faced and weft-faced areas.

Sateen is a weft faced satin.

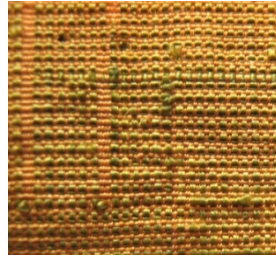
Complex weaves include:

Multiple plain weave woven in two layers which may be interlocked giving a double cloth.

Pile weaves have an additional set of yarns woven into the ground weave. These may be loops (as in terry towels and corduroy) or cut loops (as in velvet).



Front face

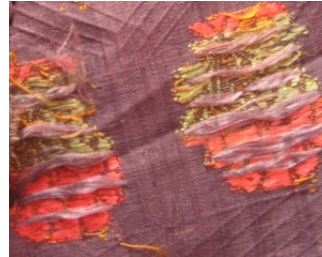


Reverse face

Inlaid weaves such as *brocades* where an additional contrasting thread is inserted into the ground weave.



Front face
(motifs rubbed revealing
The ground fabric below)



Reverse face
(showing different coloured
supplementary wefts)

5b. Non- woven Fabric Structures

Felt



Knitting



Kay Cosserat, Knitted Sample,
University of London.
Constance Howard Resource
and Research Centre in Textiles.

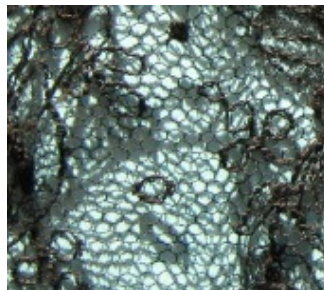
Crochet



19th century Irish crochet lace
imitating 17thC Flemish lace.

© <http://hh-designs.com/crochethistory.aspx>

Lace



Sprang



© <http://www.stringpage.com/sprang/sprangi.html>

Netting

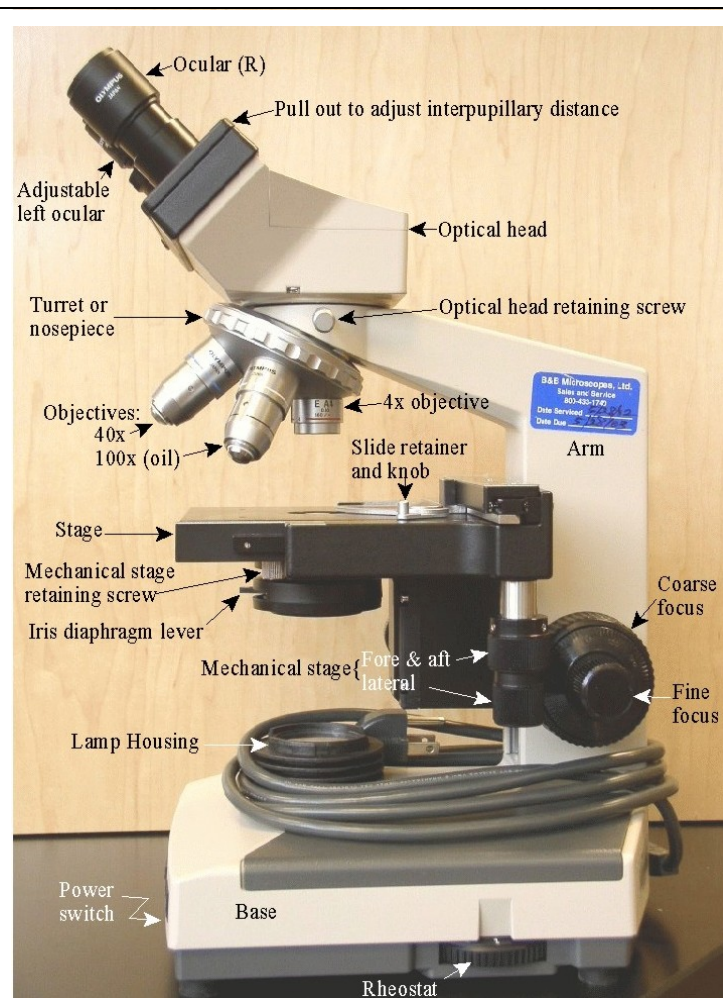


6. Introduction to Microscopy

Think about what you are looking for

It is a lot more difficult to identify a fibre when you have no idea what you are looking for and what it might look like. So make an educated guess first as to the type of fibre and make sure you have relevant images of magnified fibres for comparison.

Understanding the light microscope



Eyeieces (ocular) which can be adjusted to suit your face.

Adjustable left eyepiece.

The nose piece holds different objective lenses. This can be rotated to give different levels of magnification.

The *stage* holds the slide and can be moved up and down using the focus button in two stages for coarse focus and fine focus Iris diaphragm which can be adjusted to enable you to control the amount of light reaching the slide.

The condenser (beneath the stage) contains two sets of lenses which concentrate the light. Light source to illuminate the slide from below, passing through the diaphragm and condenser before illuminating the slide through a hole in the stage viewed.

On/off switch and scrolling switch to adjust intensity of light.

From Fankhauser, D B BINOCULAR MICROSCOPE: ITS FEATURES AND CARE ©David B. Fankhauser
http://biology.clc.uc.edu/fankhauser/labs/microscope/microscope_features&care.htm

Setting up the microscope

If there is a manual for the specific microscope you are using, follow those instructions. If there is no manual, these general points will help you use a microscope successfully.

Plug in and switch on

With the microscope on a stable flat worktop, plug it in. Turn the nose piece so the shortest (lowest power) objective is over the stage. Switch on the internal microscope light; the switch is normally on the base of the microscope at the side.

Adjust the eyepieces

Adjust the two eyepieces just as you would a pair of binoculars so they fit the distance between your eyes comfortably. If you wear glasses, you may find it easier to take them off.

One or both of the eyepieces may be a telescoping eyepiece so you can focus it. As few of us have eyes which are identical, you can focus through this to even up the image. Look into the fixed eyepiece and focus using the microscope focus knob. Then look into the adjustable eyepiece using your other eye and adjust the eyepiece - not the microscope.

Put your slide on the stage

With the shortest objective lens still in the down position and the stage in the lowest position, place the slide on the stage. This will avoid the lens being accidentally scratched by the slide. Make sure the slide is over the light opening and secure it with the clips.

Adjusting the lighting

Slowly raise the stage up using the coarse focus knob. Look through microscope and adjust the position of the stage until you can see an image of the fibre on the slide. You may need to move the slide so you have a good section of the fibre in view.

Bring the light level up gradually. Adjust the condenser (usually to the side of the stage) so that the light is sharply focused on the specimen. Then adjust the iris diaphragm (using the knob below the stage) to control the brightness of the light. You will need to adjust the iris diaphragm when you change to a different magnification.

Focusing

Turn the nosepiece so you have the next powerful (next longest) objective lens in place over the slide. Check you still have the fibre in view. Adjust the focus smoothly using the fine focusing knob. Adjust the condenser and iris diaphragm as necessary.

Always start with lowest magnification (shortest) objective lens and move up in steps, each time refocusing and re-centering the slide. Be very careful not to hit the objective lens with the slide.

If you are finding it difficult to get a good image of the fibre, try focusing on the edge of the cover slip on the slide or on a bubble. Get this into focus and then move the slide so you can see the fibre.

Switching off the microscope

Always switch the light off gradually using the rheostat before you switch off the power switch.

Caring for the microscope

- Always make sure the stage and lenses are clean.
- Only clean it with lens tissue and a suitable lens clean.
- Cover it with a dust jacket when not in use.

Making a temporary wet slide using water

Place a small drop of water in the centre of the slide. Add the fibre sample and put another small drop of water on top. Very gently, pick up a cover slip with a pair of tweezers and slowly ease it on top of the fibre at an angle; this helps prevent the formation of bubbles. The cover slip should be held in place by surface tension. If it floats, you have too much water and need to start again.

7. GLOSSARY

Chiffon

The softest and most flimsy of cloths in a plain weave structure. Both the warp and the weft threads are heavily twisted (crepe). The difference between a crepe de chine and chiffon is that the weft yarn is either a Z or S twist. The characteristic wrinkles are caused by the weft being pulled in one direction. The name is derived from 'chiffen', the French word for rag or flimsy cloth. [MERC]

Crepe

A general term used for all cloths made of a textured, crinkled, wrinkled or grained matt-surface effects. The cloth can be made from a combination of many yarns. Predominantly used in the 19th century for mourning dress. Special hard-twisted yarns are used which shrink when washed to create its puckered and crinkled surface. [MERC]

Crepe-de-Chine

A soft, thin, opaque and lightweight fabric with a crinkled effect. Woven with alternate S and Z highly twisted weft threads and untwisted warp threads. Alternate picks are of opposite twists resulting in a crimp appearance on the fabric. A lustre is always visible owing to the fine silk warp. [MERC & Weavers]

Dimity

Lightweight, plain weave cotton cloth with raised (relief) stripes or cords running lengthwise through the cloth. [MERC]

Georgette

A fine sheer crepe weave fabric which can be made of silk, cotton, rayon or a mixture of these fibres. The cloth is more grainy than crepe, and this is a result of highly twisted warp and weft threads. [SK]

Lawn

Very fine plain cloth. The original lawn was a fine linen cloth used for dress purposes, but is now known as linen lawn. The cloth is crisper than voile but not as crisp as organza. [MERC & SK]

Sateen

A smooth cloth, woven with a weft-faced weave. The cloth exposes more of the weft than the warp. It is mostly used for linings. [MERC& SK]

Taffeta

A plain weave, characterized by its closely woven surface created by an even number of weft and warp threads per inch. It has a slightly stiff crisp papery feel. [MERC]

Velvet

A textured pile fabric used for dress and furnishing, the distinguishing features of which are successive rows of short cut tufts of fibres standing so close together as to present a uniform surface and a dense luxurious feel. The tufts are created by the warp threads which are looped over a wire during weaving and later cut to release the wire and form the pile. [MERC]

Velveteen

A solely cotton fabric with a short full pile made by weft tufts, and frequently referred to as cotton velvet. A better definition of velveteen would be weft pile velvet to distinguish the fabric from warp pile velvet. [MERC]

Worsted

Wool yarns of superior quality and appearance which are spun from good quality wools. The process uses a more elaborate preparation for spinning than other woollen yarns receive. The spinning process assembles the fibres of the yarns to be as parallel as possible, and to remove by combing all the short fibres that would otherwise spoil the regularity, smoothness and lustre which is characteristic of worsted yarns. The cloth requires highly specialised finishing to create the soft crease resistance which marks the quality of the cloth. [MERC]

Sources: MERC: *The Mercury Dictionary of Textile Terms*, Textile Mercury Ltd. Manchester ca.1947;
SK: Sue Kerry, 2007.

Selected definitions taken from Sue Kerry *Identifying Textile Types and Weaves 1750-1950*.
DATS 2007.

8. Further Reading

- BURNHAM, D. K.** 1995. *Warp & Weft: A Textile Terminology*. (2nd ed.) London: Routledge.
- CATLING, D. & GRAYSON, J.** 1982. *Identification of Vegetable Fibres*. London: Chapman-Hall.
- COOK, J. G.** 1993. *Handbook of Textile Fibers: Natural Fibers*. Durham: Merrow Publishing.
- CENTRE INTERNATIONAL D'ETUDE TEXTILES ANCIENS.** 1964 CIETA. *Vocabulary of Technical Terms*. Lyon: CIETA
- EMERY, I.** 1966. *The Primary Structure of Fabrics*. Washington D.C.: Textile Museum.
- FLORIAN, M-L. E., KRONKRIGHT, D. P. & NORTON, R. E.** 1990. *The Conservation of Artifacts made from Plant Materials*. Los Angeles: The Getty Conservation Institute.
- FORD, B.** 1992. Monitoring colour change in textiles on display. *Studies in Conservation*, 37, 1-11.
- HEARLE, J. W. S., LOMAS, B., COOKE, W. D.** 1998. *Atlas of Fibre Failure and Damage to Textiles*. Cambridge: Woodhead & The Textile Institute.
- OELSNER, G. H.** 1952. *A Handbook of Weaves*. New York: Dover Publications.
- SEILTER-BALDINGER, A.** 1994. *Textiles: A Classification of Techniques*. Bathurst, Australia: Crawford House Press.
- TEXTILE INSTITUTE.** 1975. *Textile Terms and Definitions* (7th edition). Manchester: Textile Institute.
- TIMAR-BALAZSY, A. & EASTOP, D.** 1998 (reprinted 1999). *Chemical Principles of Textile Conservation*. Oxford: Butterworth-Heinemann.
- TORTORA, P. G. & MERKEL, R. S.** 1996. *Fairchild's Dictionary of Textiles*. (7th ed.) London: Berg.
- WATSON, W.** 1996 (1937). *Textile Design & Colour: Elementary Weaves and Figured Fabrics*. London: Longmans Green & Co.

9. Web Resources

Alpine Meadows Weavers and Spinners Fiber Microscopy

http://www.alpinemeadowsguild.org/fiber_microscopy.html

Constance Howard Resource and Research Centre in Textiles: Material Collection

<http://www.vads.ac.uk/collections/CHM>

Digital Archive of Documents Related to Embroidery

http://www.cs.arizona.edu/patterns/weaving/topic_embroidery.html

Worshipful Company of Weavers: Glossary of Textile Terms <http://www.weavers.org.uk/glossary>

Historical Needlework Resources (pre 16th century) <http://medieval.webcon.net.au/index.html>

Textile Library <http://textilelibrary.wordpress.com/2011/04/11/lecture-notes-of-textile-fibre-microscopy/>

10. Acknowledgments

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Colleagues in DATs, especially Natalie Raw and Caroline Whitehead

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