

GEOMETRICAL, OPTICAL AND ELECTRON  
MICROSCOPIC STUDIES ON FIBRES

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| ARABIC ABSTRACT                             |             |

A B S T R A C T  
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Optical diffraction, electron diffraction, and spectrophotometric methods were applied to study the parameters and structure of fibres.

A new method has been devised for measuring the number of threads per unit length in woven fabrics. The woven fabrics were used as a crossed grating. Results have been obtained with Nylon samples using monochromatic light. The applicability of the method has been tested for fabrics of 30 - 60 threads/cm. A development of the previous described method using a source of coherent radiation was applied for woven fabrics of 48-162 threads/cm. The success of the method depends on being able to obtain diffraction bands with good definition.

Also experimental aspects of a nondestructive method to measure the noncircularity of single fibre are presented. The technique made use of the variation of the spacings of maxima or minima in the forward scattered light as a function of fibre orientation when it was rotated about its axis. The method has been applied to fibres and ellipticities as small as 0.99. The results are in agreement with photomicroscopy. Analysis of the back-scattered-light pattern was utilised for determining the average refractive index and the diameters

of Nylon 6 and Nylon 66 fibres. A scanning electron microscope, with high resolution was used to study the surface structure of fibre. This enabled determination of fine morphological detail of the cuticle; namely average height, number of scales per unit length and average length of scales. Relation between the twisted bilateral structure of the cortex of wool fibre and its external shape, has been investigated.

Sections of Nylon 6 fibre were examined, with combined electron diffraction and electron microscope techniques. It was found that Nylon 6 forms monomer in addition to polymer crystals. Various types of electron diffraction patterns were obtained. The array of reflections on all of them corresponds to monoclinic symmetry of  $\alpha$ -forms. Transmission electron microscopical investigations indicate a continuation of fibrous morphology down to smaller size. Texture patterns of Nylon 6 was obtained, for the first time, by the electron diffraction technique and fitted well with the X-ray diffraction pattern of  $\alpha$ -phase of Nylon 6.

Spectrophotometric and colorimetric methods were applied for studying the ash contents and colour measurements. Ashing process for ten natural wool samples was done. Experimental relation between dominant wave-length and mineral contents was evaluated.

## GENERAL INTRODUCTION

Fibre physics is the study of the structural and physical properties of fibres. By means of optical, X-ray, electron microscopic, spectrophotometric, and colorimetric techniques, the textile physicist reveals many aspects of the properties, sources, processing and utilization of the examined fibres. (1,2)

In this work, geometrical, optical and electron microscopic studies on fibres are presented.

Interference gratings, parallel lined or tapered are used for examination of fabric for threads space variation. The principle underlying the use of these gratings is that, interference bands are formed when the spacing of the lines on the grating is comparable with that of the threads in fabric over which the grating is placed. (3,4)

Chapter I deals with determining the number of threads per unit length in woven fabrics, utilising a new method using conventional and coherent radiation, The woven fabric acts as a crossed grating.

Also diffraction patterns which are produced when a beam of He-Ne laser falls on a fibre are obviously a

function of fibre diameter, cross section, packing of configuration, and wavelength of light. (5,6)

Chapter II deals with the use of light scattering non-destructive technique to measure the fibre diameter, to study the relationship between geometry of the cross section and light-scattering profiles of single fibres, and for determination of refractive indices at back scattering for Nylon fibre.

X-ray technique is used to obtain fine structure on the atomic scale. By interpretation of X-ray fibre photographs, a knowledge of the texture of fibre structure, the size, and the dispersion of the orientation, of the crystalline regions can be obtained. Difficulties arise in investigation of the structure of approximately one tenth of a micron ( $0.1 \mu$ ) or less. Electron microscope is suited to these needs. Thus optical diffraction, X-ray diffraction, electron microscopy and electron diffraction are the techniques to be used in the field of investigation of fibre structure. The essential difference between them arises from the wavelengths used. (7,8)

Chapter III deals with the determination of the geometrical parameters of fibre using scanning electron microscope,

measurements of length scale dimension, average number per unit length and average height of the scales were carried out. The crystal structure of Nylon 6, using electron microscopy and electron diffraction technique, in close association with X-ray diffraction has been investigated in Chapter IV.

As a small amount of mineral matter appears to be an essential constituent of the natural fibres e.g. cotton and wool.<sup>(9)</sup> Ashing process method is suited to estimate the small quantity of these mineral content. The relation between these mineral matter in wool fibres and some of its physical properties has been investigated in Chapter V.

DETERMINATION OF NUMBER OF  
THREADS PER UNIT LENGTH IN WOVEN FABRICS

CHAPTER I

### I.1. Introduction And Previous Work :

Woven fabrics are those fabrics made by passing one set of yarns above and below another set of yarns at right angles. They are the important group of fabrics. The number of threads per unit length in woven fabrics has a great influence on their behaviour during processing from grey materials to final products. Determination of the number of threads per unit length can be made in several ways. There are three general methods of determining fabric count.<sup>(10)</sup> The following is a short account on each of the three methods commonly used:

- (1) Unraveling the cloth.
- (2) Methods utilising microscopy.
- (3) Other methods for determining the number of threads in woven fabric based directly on microscopy.

#### (1) The method of unraveling the cloth :

This method is used principally to deal with dense fabrics with a felted surface where the separate yarns are hard to distinguish. It is also sometimes used where, in addition to yarn count, the relative weights of warp and filling are being determined.