MOLECULAR AND ULTRAFINE STRUCTURE

OF

COTTON FIBRES

A thesis submitted by

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To
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ABSTRACT

Differences among native cottons which have been recognized in the textile industry for many years, and have formed the basis for cotton classification in commerce and ultimate utilization, include factors such as fibre length, fineness and spinnability. Recent, detailed investigations have established that, in addition, cotton types vary in their fundamental mechanical properties. The object of the present work has been to ascertain whether the variation in fibre properties are due to differences which exist at the ultrafine and molecular levels of the structure. Furthermore, with the advent of man-made fibres, modifications of the properties of natural fibres has become a compelling requirement, for their survival in the competitive world markets, and for this reason a detailed study of the structure of the cotton fibre has particular relevance.

The ultrafine and molecular structure of several varieties of cottons have been examined by means of transmission electron microscopy and X-ray and electron diffraction techniques.

It has been possible to establish that there are no significant differences in: (i) the size of the particles (obtained after hydrolysis) whose dimensions may be taken to represent the combined crystalline and para-crystalline regions, and (ii) the crystal structure (cellulose I), between different cotton types. X-ray studies have shown that differences in the orientation of the 'crystallites' have an effect on the mechanical properties of the fibre. Thus, the evidence leads to the conclusion that variation in fibre properties are due to differences at higher (fibrillar) levels of structural organization.

Electron diffraction results have conclusively shown the inadequacies of the widely accepted model for the fundamental structural unit of crystalline cellulose I (unit cell), proposed by Meyer and Misch on the basis of X-ray diffraction studies. A possible unit cell to fit the observed data, from electron (and X-ray) diffraction, has been postulated, even though a detailed elaboration of a unit cell for cellulose I was outside the scope of this work.

The present study has laid the foundations for further investigations into the structure of cotton fibres at the fibrillar level and a more rigorous study of the unit cell of native cellulose by means of electron diffraction.

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