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Structural Analysis of a Single Keratin Fiber by Scanning Microbeam SAXS

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Introduction

The nano structure of a single wool fiber has been studied by scanning microbeam SAXS to reveal the relationship between the lateral heterogeneity of keratin structure and the curl shape of a fiber. A Merino wool fiber is about 10~50µm in diameter and has a strong curl shape. It is mainly composed of cuticle and cortex. The cortex constitutes the major part of the fiber mass and consists mainly of the crystalline α-keratin filaments (Intermediate Filaments:IFs) embedded in the amorphous matrix protein (Keratin Associated Protein:KAP). Most wool fibers contain two (sometimes three) types of cortical cells, so called orthocortex and paracortex (and mesocortex), and the bilateral arrangement of them (usually orthocortex and paracortex) is associated with the crimped structure of wool fibers [1]. It has been found that the orthocortical cells tend to be located at the outer side of the fiber curve and also there are obvious differences of the geometrical arrangement of the IFs among these cortical cells. TEM observation of wool's cross sections shows that the IFs within the paracortical cells are almost parallel each other along the fiber direction, whereas those within the orthocortical cells are supposed to be twisted. The purpose of our study is to analyze the inhomogeneity in IF microstructure of a single bilateral wool fiber in intact condition by measuring SAXS patterns with an X-ray microbeam scanning along the lateral direction of the fiber.

Experimental

SAXS patterns from a Merino wool fiber were measured at BL-15A and 4A. At BL-4A, they were measured with a scanning X-ray microbeam (size : 5µm) at 5µm steps from outer to inner sides of a fiber curve (A single Merino wool fiber has around 30µm diameter).

Results and Discussion

Figure 1 shows a typical SAXS pattern from a single fiber around the center of the fiber curve and three intensive peaks along the equator were observed. The d-spacings for these peaks are roughly 8.0, 4.6 and 2.8nm. These peaks were also observed at 7.0, 4.2 and 2.4nm or 8.2, 4.2 and 2.7nm in the previous conventional X-ray studies [2], and were considered to arise from the dense lateral packing of the IFs embedded in the matrix. From the 1st peak, we found that the IF-IF distance increased from the outer to inner sides of the fiber curve. The results for sevral fibers are shown in Fig.2 (The origin of these samples is the same). This result is consistent with the previous study that the ratio of KAP/IFs is higher in the paracortical cells than that in the orthocortical cells [3]. The technique of scanning microbeam SAXS has the possibility of quantitative evaluation of the IF arrangement in the cortical cells. In the next beamtime, we are going to further improve the signal-to-noise ratio of SAXS patterns.

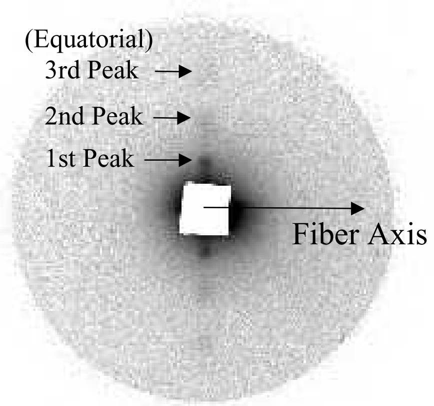

Fig.1 Typical SAXS pattern from the cortex cells of a Merino wool fiber

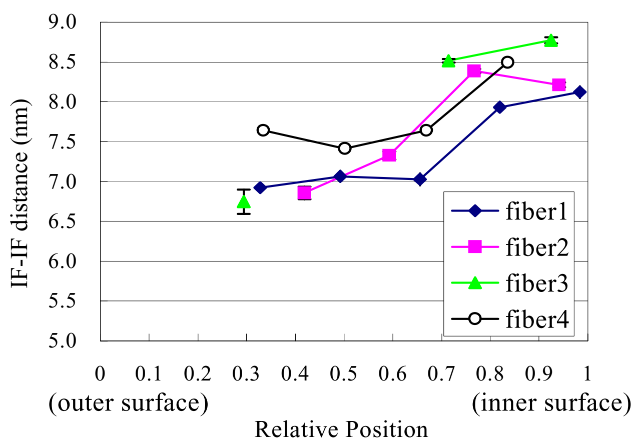

Fig.2 Change of the IF-IF distance in a cross section of a wool fiber

References

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