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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 inhomogeneity of keratin structure and the curl shape of a fiber. A wool fiber has a strong curl shape and is mainly composed of cuticle and cortex. The cortex 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 there are obvious differences in the geometrical arrangement of the IFs among these cortical cells. The purpose of our study is to analyze the inhomogeneity in the IF distribution of a single bilateral wool fiber in intact condition by measuring SAXS patterns with an X-ray microbeam scanning from the inner to the outer sides of the curved fiber. In the first year, we optimized experimental conditions to improve Signal / Noise (S/N) ratio of measured SAXS patterns, and succeeded in detecting the difference of the intensity profile between orthocortex and paracortex. We have made further optimization of experimental conditions in order to evaluate quantitatively the IF distribution in the cortex by the calculation of the equatorial intensity profiles based on the IF distribution model

Experimental

SAXS patterns from a Merino wool were measured at BL-4A. They were measured with a X-ray microbeam (size : 5μm) scanning with a 5μm step from outer to inner sides of a curved fiber (A single Merino wool fiber has around 30μm diameter).

Results and Discussion

We extracted the equatorial intensity profiles of the cortex from the 2-dimensional SAXS patterns after subtraction of the parasitic scattering and compared these with those calculated based on the IF distribution model proposed by Briki et al.[2]. Then the IF diameter and the mean IF-IF distance, which are included in the model as parameters, are determined by the least square method. Figure 1 shows one example of the results. The experimental data were obtained from the SAXS pattern measured at the inner side of the cortex (the black coloured points were used for fitting). The simulated curve (red line) is found to be in good agreement with the experimental data. Figure 2 shows the results of IF diameters and IF-IF distances calculated from three fibers. It is found that the IF-IF distance increases from c.a. 80Å at the outermost to c.a. 95Å at the innermost of the curved fiber while the IF diameter has an almost constant value (c.a. 75Å). These tendencies are in good accordance with the results of previous work that the ratio of KAP/IFs is higher in the paracortical cells than that in the orthocortical cells [3]. From this study, we could not only evaluate the IF diameter and the IF-IF distance of a wool fiber in intact condition but also show quantatively the differences of them between orthocortex and paracortex at the first time.

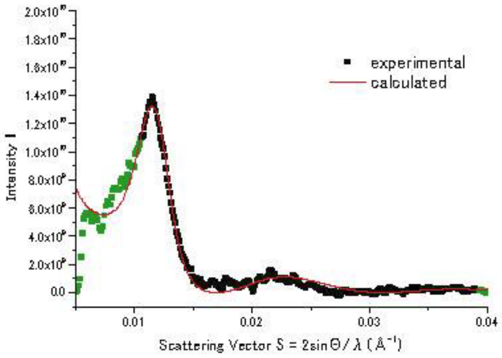

Fig.1 Experimental data and the result of calculation of an equatorial intensity profile of the cortex

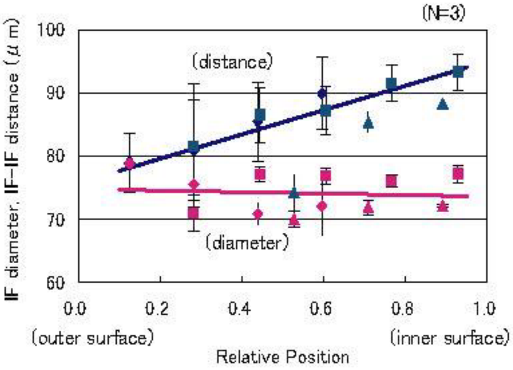

Fig.2 IF diameter and IF-IF distance along a lateral direction of a wool fiber

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