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Structural Analysis of Chemically Treated Human Hair Single Fibers by Scanning Microbeam SAXS

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Introduction

We have studied the nano-structure of curly human hair to understand the dependence of typical hair shapes on the ethnic origins and it is concluded that the curliness of human hair has a strong correlation with the inhomogeneity of the intermediate filaments (IFs) arrangement in the cortex [1, 2].

In this study, scanning microbeam SAXS is applied for evaluation of the structural change of hair after reduction and oxidization, so-called perm treatment.

Experimental

Chemically untreated curly human hair fibers of African-American were used in this study. Permed hair samples were prepared as follows. First, hair samples were immersed in the aqueous solution containing 7% thioglycolic acid and then, immersed in the aqueous solution containing 2% hydrogen peroxide.

Two dimensional SAXS patterns of single hair fibers were measured with an X-ray microbeam (size: 5 μm). A hair fiber was moved in the transverse direction with a 5 to 10 μm step from outer (P=0) to inner (P=1) sides of the fiber curvature, where P represents the relative measuring position.

The center-to-center distance of IFs and the radius of IF were determined from the equatorial intensity profiles and full-width at half maximum (FWHM) of the intensity profile in the azimuthal direction was also evaluated [2].

Results and Discussion

Figures 1 and 2 show the values of FWHM obtained from untreated and permed hair fibers, respectively. It is found that the values of FWHM for permed hair are larger than those for untreated hair, which indicates that the IF tilt angle against the fiber axis increases by perm treatment. Figure 3 shows the ratios of FWHM averaged in the outer side (P=0.2 to 0.4) and in the inner side (P=0.6 to 0.8) for permed hair to those for untreated hair, respectively. From Fig. 3, it is suggested that the outer part of curly hair is more reactive to perm treatment than the inner part. Such different reactivity might be associated with the different structures or chemical compositions of both parts of curly hair.

References

[1] Y. Kajiura et al., PF Activity Report 2005 #23 part B (2006) 216.
[2] Y. Kajiura et al., J. Struct. Biol. 155, (2006) 438-444.

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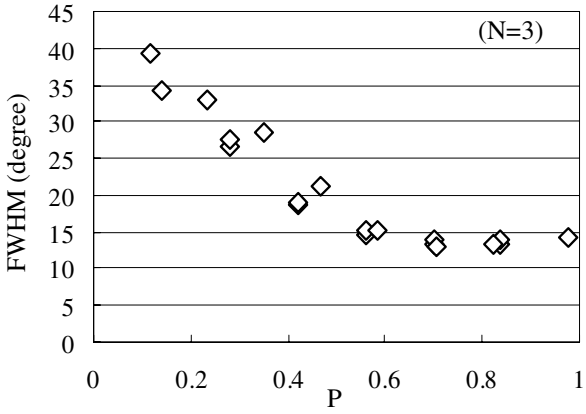

Fig. 1: FWHM (IF tilt angle) vs. normalized lateral position for untreated hair fibers.

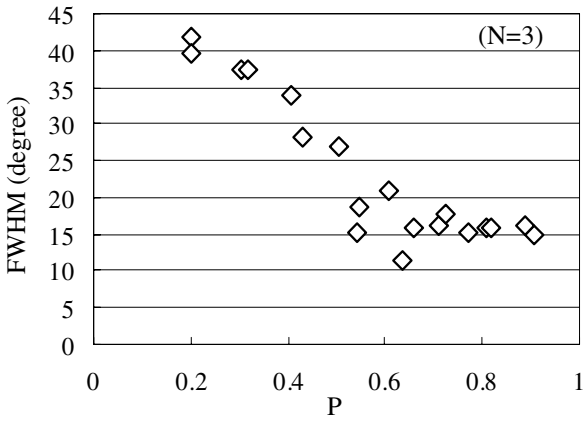

Fig. 2: FWHM (IF tilt angle) vs. normalized lateral position for permed hair fibers.

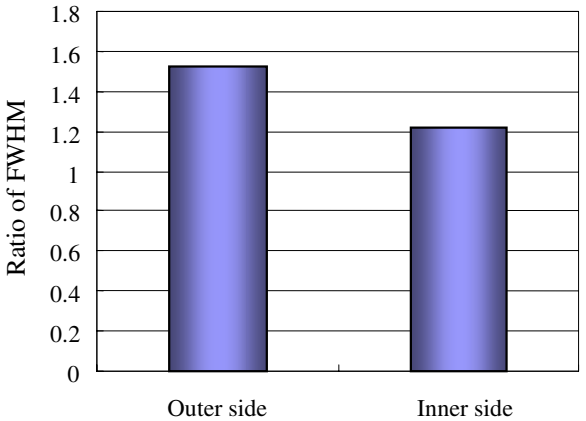

Fig. 3: Ratio of FWHM for permed hair fibers to that for untreated hair fibers.