

## Artificial oxidation treatment induces Ca accumulation in the peripheral part of human hair as determined by X-ray imaging

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### Introduction

Possible correlation between Ca content in human hair and the incidence of human breast cancer has been proposed as one of the important applications of X-ray elemental analysis [1]. However, Ca content was also demonstrated to increase with the treatment of an oxidative colorant [2]. Therefore, the contribution of oxidative damage to the increase of Ca content in human hair should be evaluated in more detail. We have measured the distribution of a cysteic acid, a major component of oxidation product of cystine in normal human hair, with a submicron resolution by using soft X-ray contact spectromicroscopy at the S-K absorption edge [3]. Further we demonstrated a correlation between oxidative damage and Ca content by comparing the distributions of Ca and cysteic acid in human untreated hair and routinely bleached hair at a beauty parlor [4].

In the present study, we further confirmed that the oxidative damage induces Ca accumulation in human hair by the treatment with a controlled bleaching condition in the laboratory.

### Materials and Methods

For the mapping of cysteic acid and Ca, X-ray contact microscopy with an electronic zooming tube with a resolution of about 0.5  $\mu\text{m}$  was employed at the S-K edge for cysteic acid and at the Ca-K edge for Ca at BL-11B. Another analysis of Ca distribution has been carried out by X-ray fluorescence imaging at BL-4A with higher sensitivity than X-ray contact microscopy with an absorption contrast.

Hair specimens were prepared from normal women. For the artificial bleaching in the laboratory, they were soaked twice in a bleach solution containing 1.2% ammonia and 3.5% hydrogen peroxide for 30 min. Ca soaking was performed with 10 mM  $\text{CaCl}_2$  for 2 days with a change of the solution. At the position of around 1 cm from hair roots, they were cut at the thickness of ca. 20  $\mu\text{m}$ , and then placed on a SiN membrane with 100 nm thickness. The opposite side of the membrane was coated with Au as a photocathode of the zooming tube.

### Results and Discussion

Fig. 1 shows X-ray absorption images of cystine, cysteic acid and Ca. Images in the upper row (a) and the lower row (b) are for untreated hair and for bleached hair,

respectively. As expected, cysteic acid was increased by the bleach treatment. In accordance with the increase of cysteic acid, Ca content was also found to increase as shown in Fig. 1 and 2. It should be noted that the accumulation was evident particularly in the peripheral area of the hair, which indicates that the bleach treatment damages mainly the cuticle part followed by Ca accumulation. The present results confirmed that Ca accumulation is significantly induced by oxidative damage such as bleach treatment.

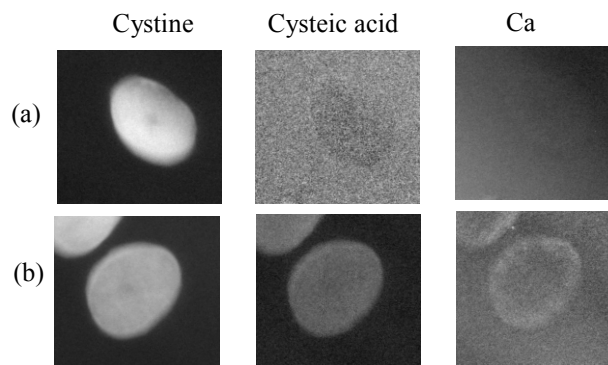


Fig. 1. Cystine, cysteic acid and Ca distributions in human hair. (a) untreated hair with Ca soaking; (b) artificial bleached hair with Ca soaking.

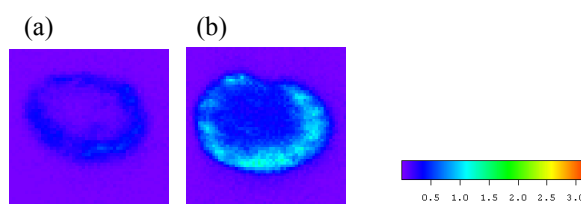


Fig. 2. Ca distribution in Ca-soaked human hair. (a): untreated hair; (b): artificial bleached hair.

### References

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