

# Ca Accumulation in Human Hair and Micro-XANES at the Ca-K Absorption Edge to Compare Ca Chemical Forms in Different Regions of Hair

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## 1 Introduction

Human hair is known to maintain time-dependent information about blood contents from a hair root to a hair tip, because it grows about 1cm per month by gaining nutrition through the contact with blood only at the root site. Measurement of position-dependent Ca content in human hair was proposed for the very early detection of breast cancer [1]. Although many factors affect Ca content in hair, we reported that Ca accumulation in cuticle, surface of hair, is mainly caused by external oxidative damage, while Ca content in medulla, a central part of hair, would reflect Ca content in blood [2]. To confirm this finding, measurement of XANES at the Ca edge for the discrimination of Ca compounds would be useful. In the present study, we measured local XANES at the Ca-K absorption edge in human hair from a breast cancer patient to compare the profiles measured at cuticle and medulla.

## 2 Materials and Methods

Hair specimen, kindly supplied from a woman suffered from breast cancer based on informed consent at Tokai University Hospital, was cut in a thickness of about 20  $\mu$  m, and attached on SiN membrane as described previously [2]. XANES of local areas of a hair cross-sectional sample at the Ca-K absorption edge was measured at BL-15A1 by using focused microbeam with a diameter of about 15  $\mu$  m, which covered the whole area of a medulla. Prior to the measurements at BL-15A1, the distributions of Ca and oxidative damage were checked by X-ray fluorescence (XRF) mapping at BL-4A and by X-ray spectromicroscopy to obtain cysteine distribution at BL-11B, respectively.

## 3 Results and Discussion

Figure 1 summarizes a map of cystine, a main amino acid in human hair, to show the morphology of the cross-section of the specimen (a), a cysteine acid map to show the distribution of oxidative damage (b), Ca map by XRF mapping (c), and micro-XANES profiles of cortex, cuticle and medulla (d). The significant accumulation of Ca in medulla as revealed by (c) does not result from oxidative damage, because panel (b) indicates little oxidative damage in medulla. On the other hand Ca in cuticle may reflect the accumulation of oxidative damage as seen from (b). In the panel (d), profiles of micro-XANES at cuticle (red), cortex (blue) and medulla (green) were rescaled for easy comparison among these spectra. Nearly identical

profiles were obtained, although the peak ratio between a peak around 4040 eV and that around 4050 eV seemed to be a little smaller for the spectrum of medulla. This observation should be reconfirmed by repeated measurements. In addition, XANES of CaCO<sub>3</sub> was shown for reference (e). The profile was largely different from that of human hair. Further accumulation of reference XANES of Ca compounds are required for the identification of Ca compound in human hair.

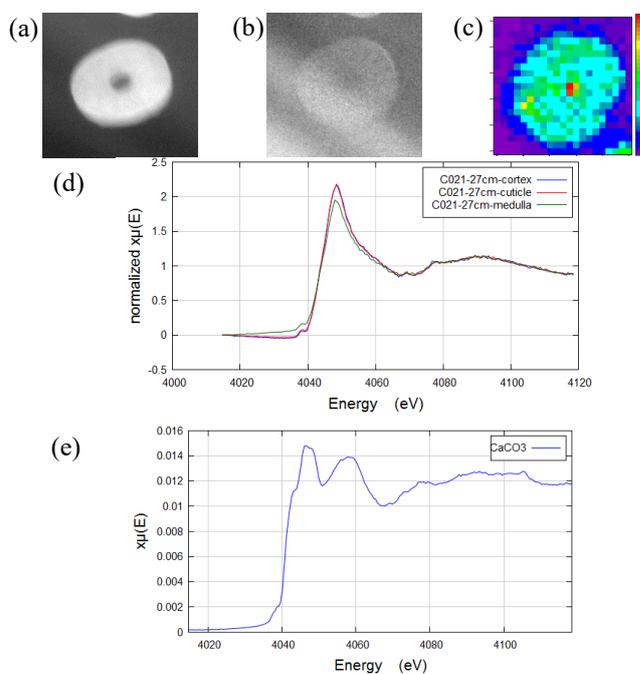


Fig. 1: Distributions of oxidative damage and Ca, and micro-XANES profiles of the cross-section of human hair at the Ca-K absorption edge. (a) cystine map, (b) cysteine acid map, (c) Ca map, (d) XANES of three regions of hair, (e) XANES of CaCO<sub>3</sub>

## Acknowledgement

This work was partly supported by the Japan Society for the Promotion of Science (JSPS) KAKENHI, Grant-in-Aid for Scientific Research (C) (16K05021).

## References

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