

X-ray imaging of oxidative damage of human hair exposed to solar ultraviolet radiation

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Oxidative damage in human hair induced by the exposure of external oxidants and its protection is one of the important issues in the health care against ageing of hair. Although many studies on the UV damage to hair have been reported including structural changes of the outermost part of hair, cuticle area, there are few studies to detect the area of oxidation from cuticle to the inside areas called cortex and medulla, depending on the kinds of solar UV radiation.

We have developed an imaging method of oxidative damage in human hair by X-ray spectromicroscopy with submicron resolution at the K absorption edge of sulfur. The method enabled us to obtain the distribution of cysteic acid, one of the oxidation products of cystine, a major amino acid in human hair. In addition, such X-ray imaging method has an advantage in the detection of oxidative damage deep inside the hair with a thickness of about 0.1 mm. The X-ray spectromicroscopy system was installed at the synchrotron radiation facilities, Photon Factory at Tsukuba.

The oxidative damage by the black light UVA lamp with an emission peak around 365nm was observed at only the surface of the hair at a short exposure, but with prolonged exposure, the damage was extended over the whole area of the hair. Since the UVA exposure of the short exposure case by the UVA lamp corresponds to about 2 hr exposure of solar UV at noon on the clear day of May at the location of Tokai university Shonan campus, our data strongly suggest that even one day exposure to solar-UV induces significant oxidative damage to hair. In contrast to UVA, UVB damage by the UVB lamp with an emission peak around 315nm seems to be limited in the cuticle region, probably because of its low permeability.