Latest findings and measures in hair changes due to aging

Several basic scientific approaches targeting aging are being undertaken by cosmetic companies to meet the demands arising from demographic changes in our country. How Japanese cosmetic companies are addressing trends in our aging society is being observed by cosmetic companies around the globe.

In a survey of beauticians and internal hair evaluators who deal with hair on a daily basis, "fluffy" stood out as words used to describe age-associated changes in hair. Because we hypothesized that the reduced internal density of hair is responsible for these changing perceptions, we measured the internal density (g/cm^3) of hair samples from subjects of various ages at their newly formed (healthy hair) and damaged parts (damaged hair, approximately 30 cm away from the newly formed part). The results showed that newly formed hair grows at a lower density as age advances and that the density in the damaged parts is less than that in the newly formed parts regardless of age (Fig. 1(a)). Furthermore, the density ratio in the newly formed parts to that in the damaged parts decreases with age (Fig. 1(b)). This indicates that the age-associated reduction in hair density is greater in the damaged parts compared with that in the newly formed parts; we call this phenomenon of an age-associated decrease in hair density "Hair-porosis" in an analogy to osteoporosis. Currently, we presume that this phenomenon is a combination of an intrinsic change in hair (i.e., proteins, which account for approximately 80% of hair constituents, are more readily eluted from hair at an advanced age [1]) and changes in the frequency of cosmetic routines such as hair dyeing. Future detailed studies should confirm these presumptions.

To investigate the structural changes that occur within hair due to density changes, we observed cross-sections of hair with TEM and found that the frequency of internal voids in hair increases with aging. Because damage during sample preparation, such as when cutting the cross-sections, could not be eliminated, we employed the non-destructive X-ray CT method using beamline **BL24XU** to observe the internal structure of hair. This method utilizes X-ray microscope optics to achieve a sub-micrometer spatial resolution. Using 7 keV X-rays, we observed an age-associated increase in void frequency, a typical example is shown in Fig. 2. We have yet to identify the damaged portions, but hope to gain further insights by improving the spatial resolution and sensitivity for density [2].

It is generally known that hair proteins are lost due to beauty treatments, such as hair coloring and permanent wave treatments. The keratin protein has been well studied as a repair material for hair damage caused by these treatments. However, conventionally prepared keratin is easily eluted from hair by repeated washing and drying during daily care. To solve this problem, S-carboxymethyl alanyl disulfide keratin (CMADK) has been developed to meet the expectations of a long-lasting form of the keratin protein [3].

We verified whether continued use of CMADK can improve the age-associated decrease in density using hair samples from subjects in their 40s. The samples were treated with a 1% CMADK solution, washed, and dried using a dryer; this process was repeated for a designated number of days. The internal density of the samples was measured daily. The result showed that the continued use of CMADK gradually improved the internal density of hair (Fig. 3(a)). We then incorporated CMADK into a commercial product and demonstrated that the product effectively improved the internal density of hair when used daily as described

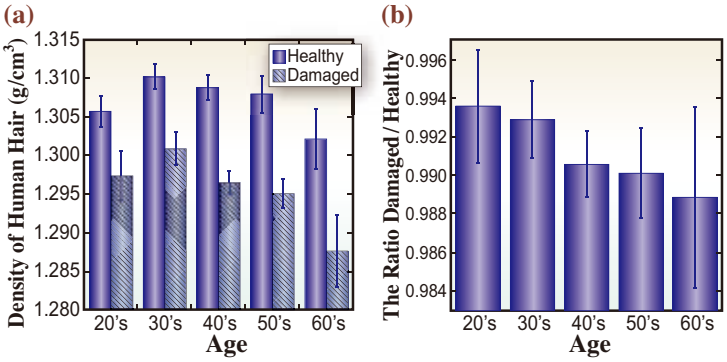

Fig. 1. Density of healthy and damaged hair with age (N = 219). Healthy: hair at the base (P<0.01); Damaged: hair 30 cm from the base (P<0.004).

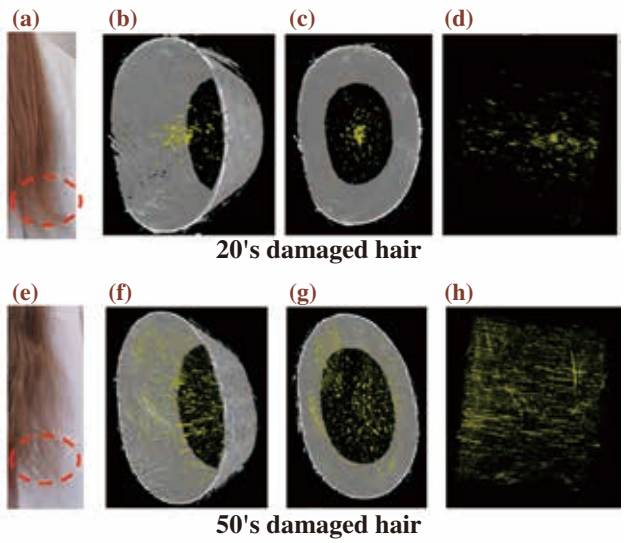

Fig. 2. 3D images of human hair using X-ray CT method at beamline BL24XU.

above (Fig. 3(b)). We have successfully developed a series of products incorporating a haircare system to recover the internal density of hair, which would be otherwise lost with age (Fig. 3(c)). We hope to continue elucidating new phenomena by cutting-edge analysis and measurement technologies, and applying them to product development in order to meet diversified client needs.

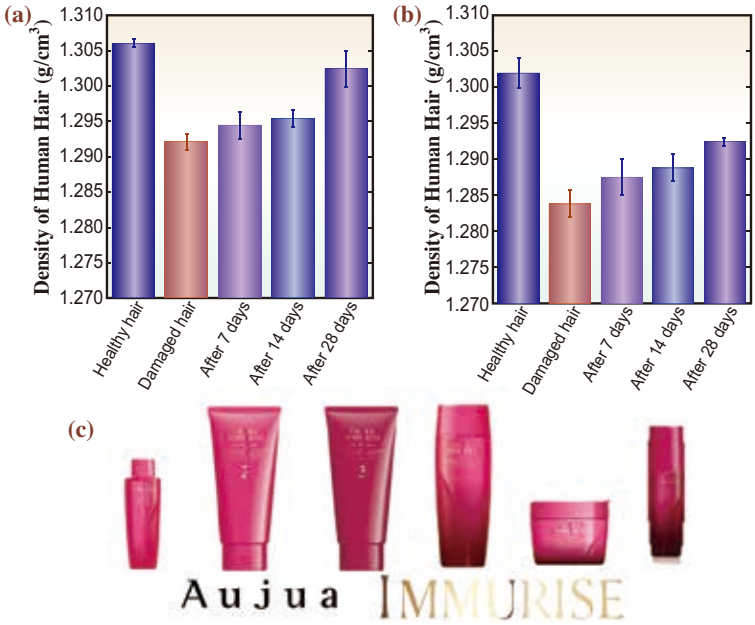

Fig. 3. Verification of the effect and products. **(a)** Changes in the internal density of hair when CMADK as a raw material is continuously used. **(b)** Changes in the internal density of hair when a CMADK-containing shampoo and conditioner are used daily, and **(c)** photograph of the product line.

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