Mandom Succeeds in First Elemental Analysis of Ultrafine Structure of Hair

- Permeation/Repair Effect of Hair-Care Components on Damaged Hair -

Mandom Corporation (headquarters: Osaka; CEO: Motonobu Nishimura; hereinafter, “Mandom”) has been striving to develop technology to analyze the ultrafine structure inside the hair in order to create a product that maintains the beauty of hair.

As part of that effort, Mandom, in cooperation with Toray Research Center, Inc. (headquarters: Chuo-ku, Tokyo; CEO, Takuji Sato), has created a technology for elemental analysis of the ultrafine structure of hair using scanning transmission electron microscopy (STEM) and electron energy-loss spectroscopy (EELS; together, STEM-EELS) to analyze biological samples, and we succeeded in quantitatively evaluating perm/bleach-related changes in the hair microstructure as well as the permeation of hair-care ingredients.

Mandom used this technology to confirm that the hair-care ingredient di(phytosteryl/octyldodecyl) lauroyl glutamate (POLG) permeated the cell membrane complex layer and endocuticle.

Mandom applied this novel hair-analysis technology to the Lucid L. hair-styling series that went on sale in 2011.

The results are intended to be announced at the 27th Japan Analytical & Scientific Instruments Show (9/6 to 9/7/2011, Chiba) and the 69th SCCJ Research Symposium (11/30, Tokyo).

1. New effort to develop the structural analysis of a finer microstructure inside the hair

Perming and bleaching have become commonplace, and with the additive effect of daily shampooing and the heat from hair drying and ironing, the hair becomes damaged. Therefore, many people have hair concerns, such as the hair “not staying together,” “lacking firmness/resilience,” and “being dry and brittle.” In order to develop a product that maintains hair beauty in all kinds of people, it is important to understand the changes in the microstructure of the hair that are caused by damage and to clearly evaluate the repair sites and functions of hair-care ingredients.

In conventional studies, microstructural analysis of the hair is performed using ultra-thin slices of stained hair, so it is difficult to ascertain the original hair microstructure. In addition, there were problems with spatial resolution when evaluating the permeability of hair-care ingredients into the hair, and there was no technology that quantitatively evaluated permeation into the microstructure of the hair.

Therefore, we used STEM-EELS, which has higher spatial resolution and is suited to the goal of precisely and thoroughly analyzing each submicroscopic point, and developed a technology for performing an atomic-level evaluation of the permeation of hair-care ingredients into damaged hair structures.

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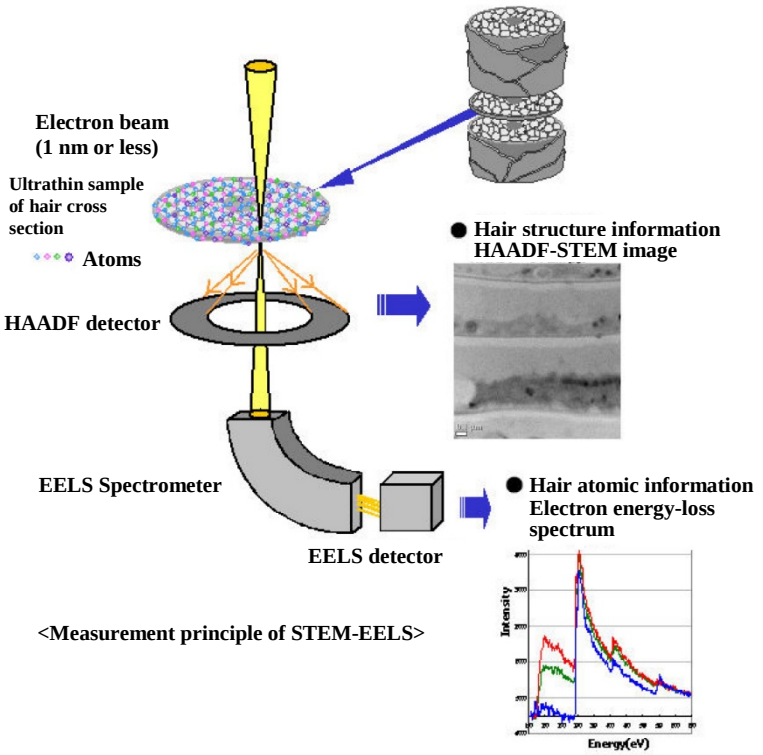
2. Mandom is the First in the World to Successfully Perform Elemental Analysis of the Ultrafine Structure of Hair

To analyze the ultrafine structure of hair, an electron beam of 1 nanometer or less (1 nanometer is 1/1,000,000th of a millimeter) was focused onto the surface of a very thinly sliced cross section of hair. A high-angle annular dark-field (HAADF) detector and EELS detector were used to detect electrons passing through the surface of the hair. As a result, a HAADF-STEM image of the ultrafine structure of the hair reflecting the atomic density was able to be obtained with the HAADF detector, and atomic information about the structure of the hair was able to be obtained with the EELS detector. This study allowed the relative quantity of atoms in each structure of the original hair to be evaluated without using processing techniques, such as staining. The atomic composition of the cuticle layers, specifically, the A layer, exocuticle (EX-C), endocuticle (EN-C), and cell membrane complex (CMC) layer, were revealed for the first time (Figures 1, 2).



<Measurement principle of STEM-EELS>

3. Identifying the hair microstructures that change as

a result of damage from perming and bleaching Untreated hair and hair damaged by perming and bleaching were measured by STEM-EELS, and the analyzed results were compared. When hair is damaged by the compound procedures of perming and bleaching, the relative abundance of atoms in the cell membrane complex (CMC) layer and the endocuticle (EN-C) was found to decrease. It was believed that the structure of the CMC and EN-C changed and their components, mainly carbon atoms, were believed to have effused out (figure 1,3).

4. Confirmation of the repair effect of POLG on damaged hair

POLG was used on damaged hair, and hair cross sections were measured and analyzed by STEM-EELS. The results showed that, of the 4 cuticle layer structures, the relative abundance of atoms in the CMC and EN-C increased compared with that of damaged hair. This shows that POLG penetrated the hair in a site-specific manner (Figures 1, 3).

Furthermore, untreated hair damaged by perming and bleaching became hard, but damaged hair treated with POLG tended to have higher flexibility (Figure 4), suggesting that the softness of the hair was restored to a level similar to that of hair that was not permed or bleached because the POLG permeated the CMC and EN-C.

5. New POLG-formulated product on sale from Fall 2011

Based on the analytical results for this technology, Mandom used POLG to formulate its Lucid L. hair styling series, which went on sale in 2011.

We will continue to strive to develop technology to create products that maintain the beauty of the hair.

<References>

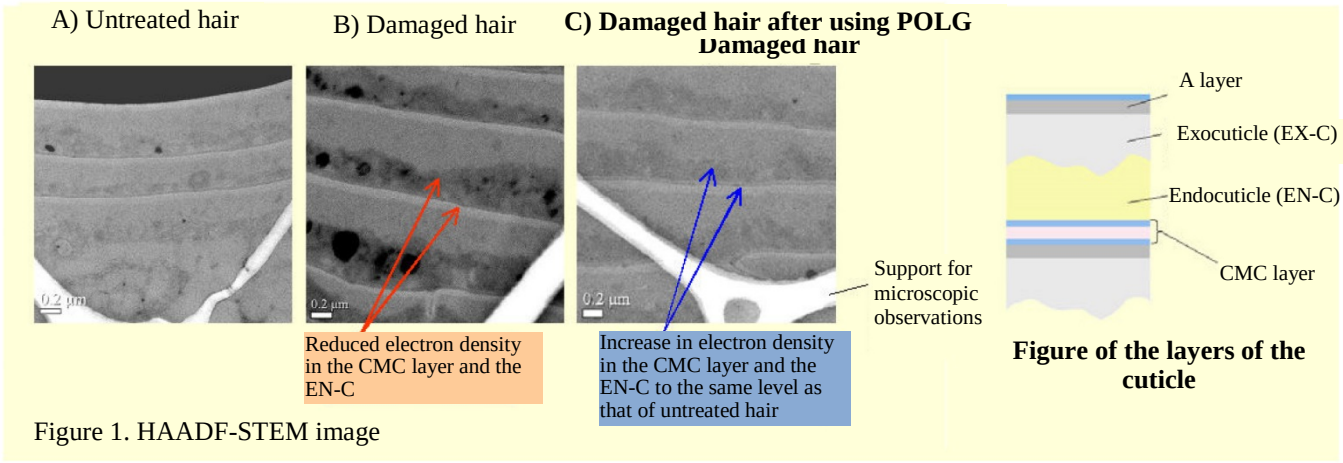


Figure 1. HAADF-STEM image

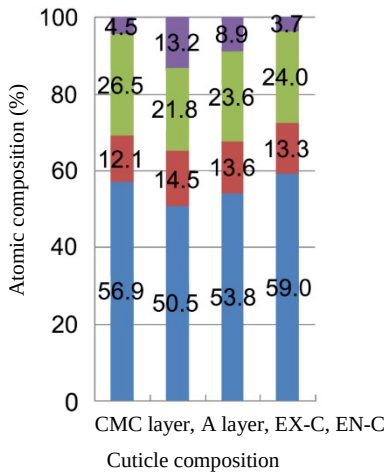


Figure 2. A) Atomic composition of the cuticle structure of A)

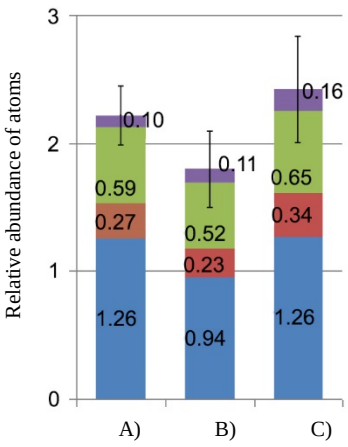


Figure 3. EELS analysis results for the CMC layer

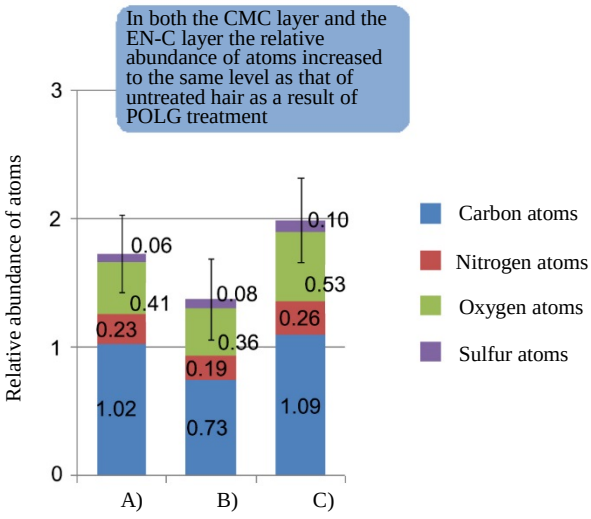


Figure 4. EELS analysis results for the EN-C

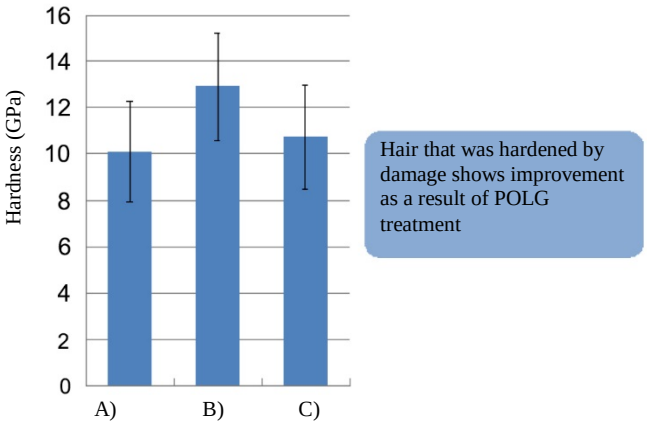


Figure 5. Improvement effect of POLG on hardness