News Release

June 14, 2019

Success in Highly Precise Observation of Component Protein of Hair using HiSOR Synchrotron Radiation

~Discovery of the Denaturation Process of Component Protein of Hair due to Alkali Damage and the Ingredients Capable of Suppressing the Damage~

The Milbon Co., Ltd. (President and CEO: Ryuji Sato), collaborating with Associate Professor Koichi Matsuo and his team (Hiroshima Synchrotron Radiation Center, Hiroshima University: HiSOR)[*1], have successfully acquired the details of the denaturation process of component protein of hair by alkali using HiSOR synchrotron radiation.

When beauty treatments such as hair coloring or bleaching cause hair damage, it is known that an unfavorable change in structure (protein denaturation) occurs in the hair. In the past, we have used technology making use of near-ultraviolet rays[*2] to acquire information on the structural changes of protein inside hair due to the damage (June 29, 2017 “Development of New Technology for Analyzing the Structural Changes of Protein inside Human Hair due to Damage”).

For this new research, we have investigated the structural changes of the component protein of hair in more detail using vacuum-ultraviolet rays[*3] obtained from the synchrotron radiation light source and have made more precise screening of effective ingredients possible, allowing us to discover the ingredients capable of suppressing the damage.

This knowledge will be applied to haircare products that we currently intend to release nation-wide in Japan. The external release of the results of this research are planned to be reported as follows.

[External Release]

Released At: Joint Annual Meeting of 71st Japan Society for Cell Biology & 19th Protein Science Society of Japan

Release Title: Analysis of structural change of hair protein using synchrotron radiation vacuum ultraviolet circular dichroism

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[Research Background]

Preparations such as hair color, bleach, and perm, which are the beauty treatments necessary to fully enjoy a hair design, contain alkali. This alkali is known to cause a change (protein denaturation) of the structure of proteins in hair, and as hair is comprised of more than 80% protein, it is believed that hair is extremely damaged by alkali. Proteins have various secondary structures, including α-helix structures[*4] and β-sheet structures[*5], and up until now these structures were measured using CD spectroscopy in the long wavelength range of the near-ultraviolet region.

However, those methods had some limitations in regard to precise estimation of the present volume of secondary structures.

In this research, we attempted to resolve these issues at HiSOR, where synchrotron radiation in the vacuum-ultraviolet rays can be used.

[Research Results]

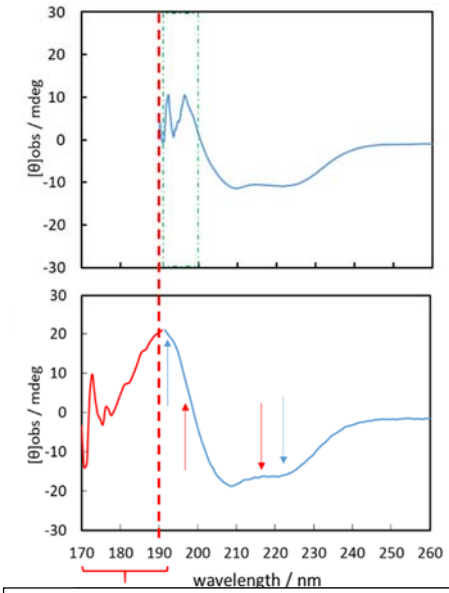
In the past, measurements were taken in the 200 – 190 nm wavelength range, but the usage of synchrotron radiation at HiSOR allowed us to expand the measurement range into the short wavelengths than before. This has made it possible not only to accurately acquire the peak forms of the secondary structures, but also to provide several peak positons originated from the structures. These strength and shape of peaks allowed for a more accurate analysis, allowing us to precisely calculate the present volume of α-helix and β-sheet structures (Fig. 1).

Using the measurement and analysis methods, and considering the experimental conditions such as the protein concentration, alkali volume, and exposure factors of synchrotron radiation, it became clear that the α-helix structures within the component protein of hair decreased, while the β-sheet structures increased as time passes (Fig. 2).

Based in these results, a search for ingredients that can suppress the structural change led us to the discovery of three ingredients (polyethylene glycol (mean molecular weight 1000), glycine, and taurine) that are particularly effective, regardless of value of pH. When the preservation ratio of the secondary structures in the component protein of hair was calculated under the presence of these ingredients, it became clear that the decrease in α-helix structures and increase in β-sheet structures were suppressed (Fig. 3).

Milbon will use this new knowledge and technology to further explain the fundamental phenomena of damage being caused to hair, and to develop preventative and care technologies.

[Reference Materials]



Data measured using existing technology

Data measured using newly established technology

The 170 nm – 190 nm vacuum-ultraviolet rays region can now also be measured

Fig. 1 CD Spectroscopy of Proteins Comprising Hair

(Top: using existing measurement methods, bottom: newly established measurement method)

The 190 – 200 nm range spectroscopy data in the top graph (the area inside the green dotted lines) can now be acquired more accurately, as shown in the bottom graph.

The shoulder at around 222 nm (indicated by the downward blue arrow) and the peak at around 190 nm (indicated by the upward blue arrow) are originated from α-helix structures.

The point around 217 nm (indicated by the downward red arrow) and around 197 nm (indicated by the upward red arrow) means the presence of β-sheet structures.

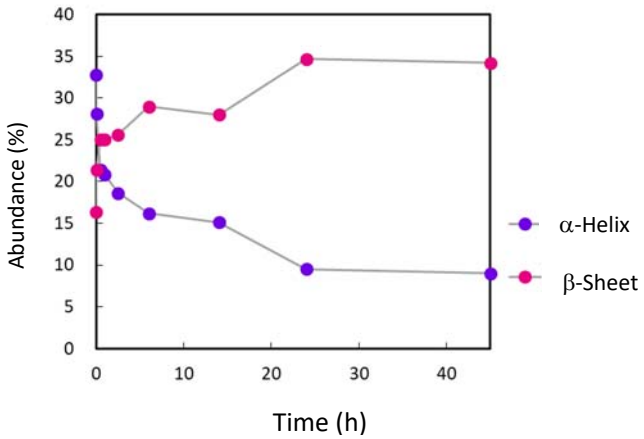


Fig. 2 Change Over Time of Secondary Structure Contents in Component Protein of Hair due to the Exposure to Alkali Ingredients

The α-helix structures decrease as time passes while the β-sheet structures increase.

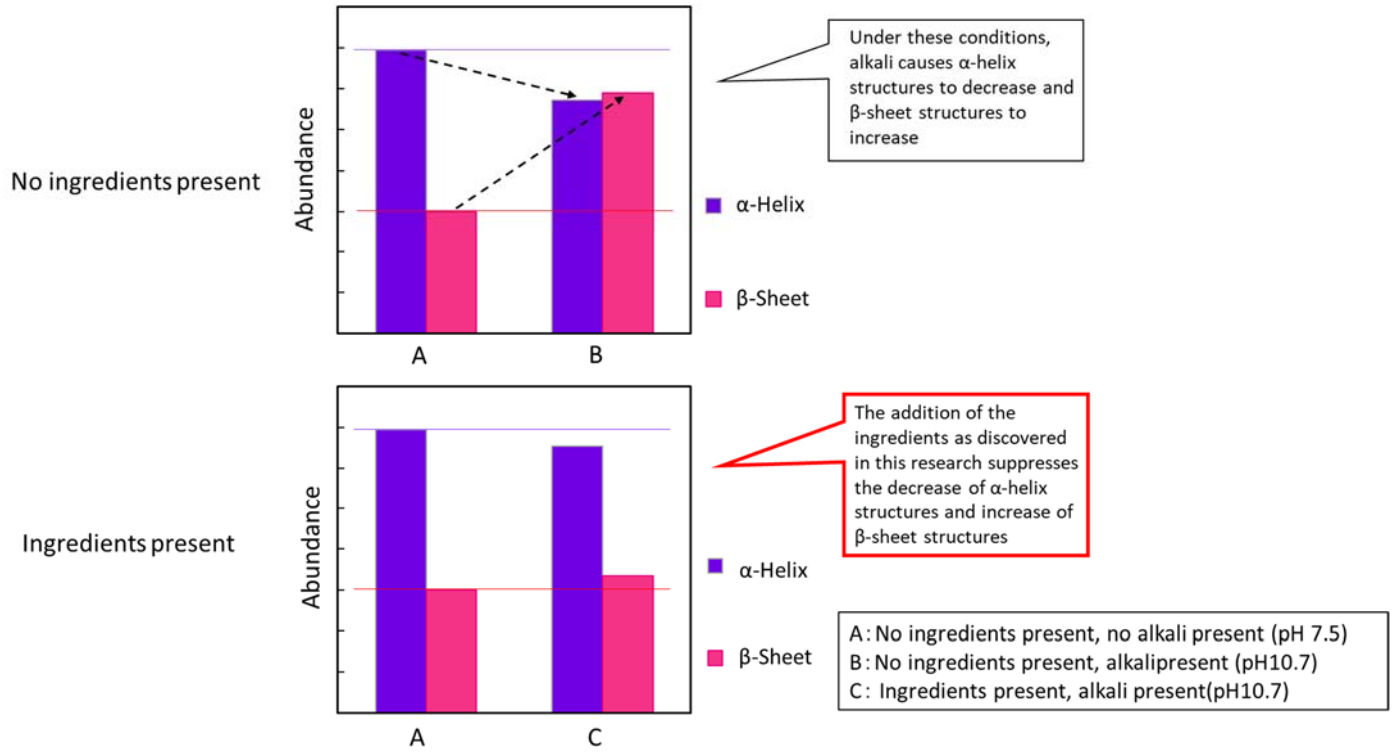


Fig. 3 Changes of Structure in the Component Protein of Hair due to Alkaline Denaturation, and Suppression of Denaturation Using Ingredients

Alkaline denaturation causes the secondary structures of the component protein of hair to break own, leading to a reduction in α-helix structures and an increase in β-sheet structures (A -> B), but when polyethylene glycol, glycine, taurine are applied from the beginning, they effectively suppress the denaturation (A -> C).

[Terminology]

*1 Hiroshima Synchrotron Radiation Center, Hiroshima University (HiSOR http://www.hsrc.hiroshima-u.ac.jp/)

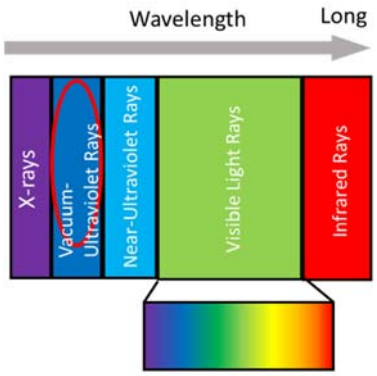
A synchrotron radiation test facility located at Hiroshima University (Higashi-Hiroshima City, Hiroshima Prefecture). Synchrotron radiation is the name given to the powerful electromagnetic waves generated when electrons are accelerated to almost the speed of light and then their direction of travel is altered using magnets. HiSOR specializes in experiments using synchrotron radiation in the vacuum-ultraviolet rays and the soft X-ray regions, and performs research into such areas as methods for analyzing the structure of biological matter.

*2 Near-Ultraviolet Rays

Light comprised of ultraviolet electromagnetic waves that are outside the visual range but have a shorter wavelength, which is comparatively close to that of the visual range.

*3 Vacuum-Ultraviolet Rays

Light that covers a short wavelength region in ultraviolet, which is easily absorbed by oxygen and nitrogen in air, and which cannot pass long distances without a vacuum environment.



The range of light humans can see

*4 α-helix Structure

One of the representative patterns in the three-dimensional structure of proteins known as “secondary structures”. Proteins are created by chains of amino acids linked by peptide bonds. The region of peptide chain called α-helix structure forms a spiral conformation.

*5 β-sheet Structure

One of the representative patterns in the three-dimensional structure of proteins known as “secondary structures”. The region of peptide chain called β-sheet structure are extended straightly in parallel or antiparallel rows, forming a flat sheet.

*6 CD Spectroscopy

A method for acquiring information relating to the structure of biomolecules such as protein by using a variety of different wavelengths of light.

■**For inquiries relating to this press release**

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