

Shiseido Develops World's First Measurement System for Three-Dimensional Shape and Subsurface Scattering Light in Facial Skin

- Discovery of key factors involved in age-induced decrease in skin translucency -

Shiseido Company, Limited (“Shiseido”), in collaboration with the Norwegian University of Science and Technology, has developed an innovative measurement system that realizes a comprehensive non-invasive approach to visually and numerically measuring and analyzing the three-dimensional facial shape as well as optical properties of facial skin, such as subsurface scattering light, which has been difficult to analyze until now (Figure 1). With this system, we measured the facial skin of more than 1,000 people, analyzing subsurface scattering light, which is an important factor for skin translucency, and as a result, it was revealed that the subsurface scattering light decreases with age and is associated with five factors, including melanin level and the condition of the stratum corneum. Among these research results, the research paper titled “Development of a System to Measure the Optical Properties of Facial Skin” was published in the Journal of Imaging Science and Technology and received the Charles E. Ives Journal Award*¹. In addition, some of these results were presented at the Optics & Photonics Japan 2022 held from November 13 to 16, 2022.

This research is being conducted under the Science/Creativity approach of Shiseido’s R&D philosophy “DYNAMIC HARMONY”. While the skin appearance, which strongly influences our impression of the skin, tends to be judged subjectively, we will further pursue research to elucidate the visual quality of the skin objectively and quantitatively through cutting-edge science to help realize the ideal skin for each individual.

*¹ Shiseido MIRAI Technology Institute’s Researcher, Kumiko Kikuchi, Ph.D., Received the Charles E. Ives Journal Award of Journal of Imaging Science and Technology (2022)

<https://corp.shiseido.com/en/news/detail.html?n=00000000003471>

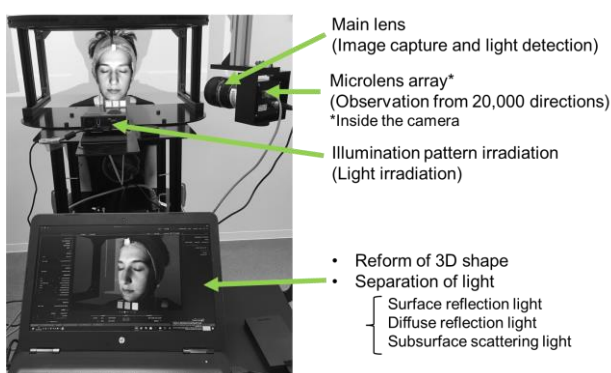


Figure 1. A new system to measure optical properties of facial skin.

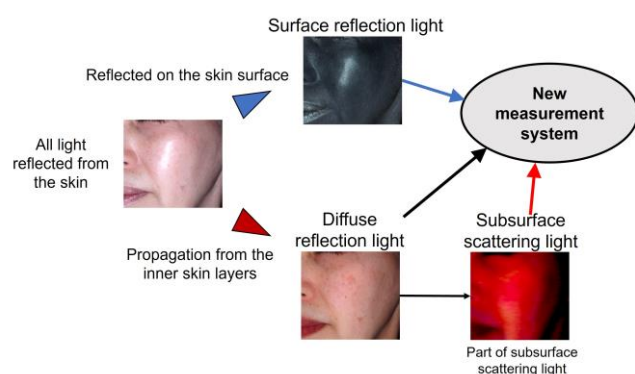


Figure 2. Subsurface scattering light influences the skin appearance.

Research background

Shiseido was one of the first to focus on skin appearance, such as perception of the skin’s radiance and translucency, which strongly influence the facial impression given, and has been conducting research using optical*² and psychophysical*³ methods. However, since it was technically difficult to divide the light that follows various paths inside and outside of human skin and non-invasively measure optical properties and three-dimensional facial shape simultaneously, research was unsuccessful. In order to understand the

changes in skin appearance and the factors involved, the development of a system that can measure optical information inside and outside of the skin in detail has long been desired.

*2 Shiseido Develops Optical Simulation System that Accurately Reproduces Skin Appearance

<https://corp.shiseido.com/jp/news/detail.html?n=0000000003040> (Japanese only)

*3 Shiseido Scientifically Verifies that Facial Skin Radiance Makes a Good Impression

<https://corp.shiseido.com/en/news/detail.html?n=0000000003111>

Discovery of age-induced reduction of subsurface scattering light

When light from an external source hits the skin, part of the light is reflected by the skin's surface (surface reflection light), and the remainder penetrates the skin (diffuse reflection light). Because the skin is translucent, light spreads inside the skin, and then the light exits the skin from other points than the initial point of contact (subsurface scattering light) (Figure 2). The surface reflection light, diffuse reflection light and subsurface scattering light play an important role in skin appearance, and our previous research has shown that subsurface scattering light is particularly important for "translucent skin" *4.

In our joint research with the Norwegian University of Science and Technology, a world leader in the field of imaging science, we successfully developed the world's first optical analysis system that both measures surface reflection light and diffuse reflection light along with the three-dimensional facial shape and separates the light penetrating into the skin: subsurface scattering light in greater detail (Figure 3).

In this study, we expanded the measurement area from a limited area to the entire face, which we tested in our previous study, and measured the facial skin of more than 1,000 women ranging from their 20s to 70s. As a result, we found that the subsurface scattering light decreases with age (Figure 4), suggesting that subsurface scattering light is involved in age-induced changes in skin appearance, especially in skin translucency.

*4 Shiseido Succeeded in Developing a High-Precision Device to Measure Skin Translucency

https://corp.shiseido.com/jp/newsimg/archive/0000000001063/1063_p3u01_jp.pdf (Japanese only)

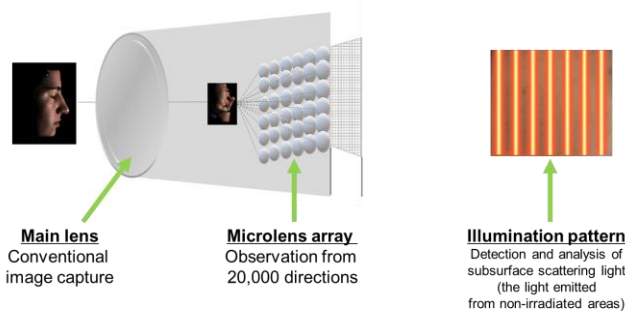


Figure 3. World's first optical measurement system

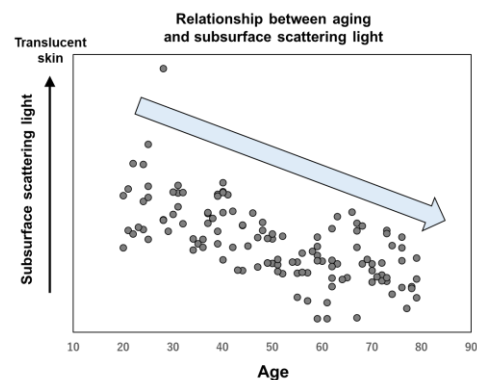


Figure 4. Trend of surface scattering light decreasing with aging.

Five factors affecting subsurface scattering light

Along with subsurface scattering light, we measured various components of the skin. After analyzing their relationships, we found that there are five factors that affect subsurface scattering light, namely melanin level, stratum corneum status, skin moisture level, collagen status, and skin texture (Figure 5, 6, 7).

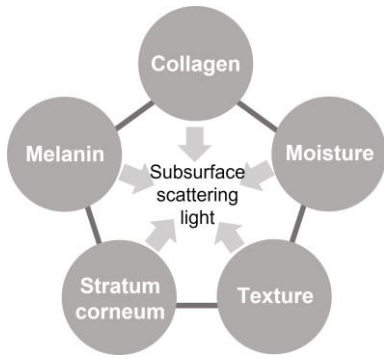


Figure 5. Five factors affecting subsurface scattering light.

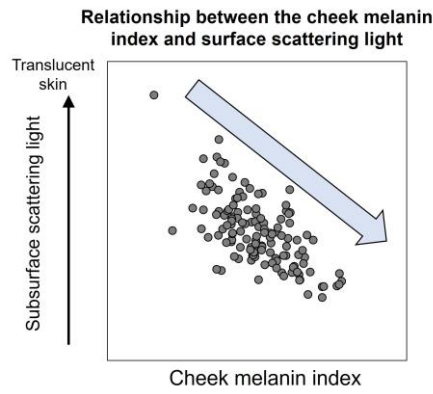


Figure 6. Trend of higher melanin index inducing lower surface scattering light.

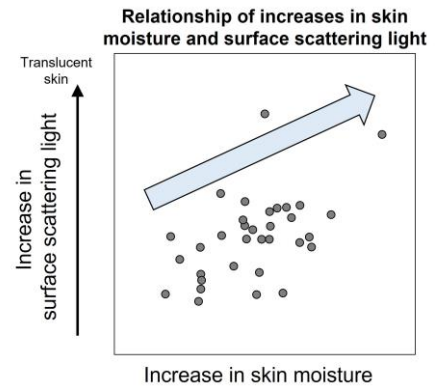


Figure 7. Trend of volume increase in surface scattering light following increase in skin moisture.

Aiming to realize the “ideal skin” for each individual

In this study, we developed an optical measurement system that non-invasively separates light that follows various paths inside and outside of human skin. We will continue to vigorously pursue the development of cutting-edge technologies so that each and every person can achieve their ideal skin, feeling confident and happy in their lives.

Shiseido's R&D philosophy "DYNAMIC HARMONY"

Shiseido Formulates its Unique R&D Philosophy "DYNAMIC HARMONY" (2021)

<https://corp.shiseido.com/en/news/detail.html?n=0000000003252>

The DYNAMIC HARMONY special website:

<https://corp.shiseido.com/en/rd/dynamicharmony/>

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Researchers' challenges

- Joint research with Norwegian University of Science and Technology, a world leader in image engineering

Shiseido researcher, Kumiko Kikuchi studied at the Norwegian University of Science and Technology, a world leader in the field of imaging science, for a year to pursue this research. The university has outstanding expertise in technologies related to object texture perception, optics, and image measurement. Through the fusion of these strengths with our knowledge of dermatology and skin measurement technology, we were able to deliver the research results.



Researcher, Kumiko Kikuchi, Ph.D.

- A desire to objectively clarify the subjective perception of skin appearance through science

To date, we have been challenging ourselves to objectively elucidate the subjective perception of one's own skin and facial appearance, as well as of the texture and fragrance of cosmetics they use, in the field of sensitivity research, which is one of our stronger research areas. We have seen the skin of countless people through face-to-face communication including in-store skin analysis, and made advances in skin measurement over the years. This time, we performed non-invasive procedures to measure the conditions of the skin surface to deeper skin layers, and verified which factors affect the skin appearance by applying the latest optical research and image-processing technologies. Going forward, we will continue to take on the challenge of grasping skin appearance more objectively by utilizing and evolving technologies such as color science and optics, which have recently been attracting attention in the digital field, as we did in this research.