Development of Base Makeup Series "ASTALIFT LIGHTING PERFECTION"

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Abstract

In recent years, market trends have shown increased demand for base makeup that offers a sheer-looking, flawless finish and does not look overdone. Conventional powders have a technical limitation: the more sheer-looking the finish is, the less likely it is that the pores, irregular skin tone, and dark spots will be concealed; the more intensive the powder coverage, the less sheer-looking the finish is. To address this, we developed "SAKURA AURA powder." With this powder, we have launched the base makeup series "ASTALIFT LIGHTING PERFECTION," which offers rich, sheer-looking, and cherry blossom-like skin without losing the coverage effect. This is achieved by the soft-focus effect of the powder, which allows more red light, making the skin look beautiful, to penetrate through and reflect on skin, and to shine back from inside of the skin.

1. Introduction

We have released the ASTALIFT cosmetics series by advancing our expertise as a photo film manufacturer in collagen research, antioxidation technology, nano technology, photoreaction analysis and control technology. In September, 2011, we launched onto the market Light Analyzing Moisture Foundation that would make the skin look clear under a variety of light sources in daily life and have established a good reputation with its outstandingly high concealing effect on pores, irregular skin tones and pigmented spots.[1)]

However, in recent years, market trends have shown increased demand for a sheerer, fine finish without skin looking overly made-up. We therefore developed SAKURA AURA powder to resolve a technical issue of conventional powder: the more sheer-looking the powder, the less effective is the concealing of pores, irregular skin tones and pigmented spots, and vice versa. Consequently, we launched onto the market the base makeup series, ASTALIFT LIGHTING PERFECTION, blending SAKURA AURA powder. The series realizes cherry blossom-like transparency in the skin, while maintaining perceivably high concealing performance, by utilizing the soft-focus effect that allows more red light, which makes the skin finer, to be transmitted and reflected and thereby to illuminate the skin from inside (Figs. 1 and 2).[2), 3), 4)]

2. Characteristics of SAKURA AURA powder - Common features between cherry blossoms and beautiful skin

In the course of studying beautiful skin ideal for women, we were inspired by sakura (cherry blossoms) that most people feel beautiful as a subject of photographs. Believing that reproducing their petals' fresh and clear tones and beauty in skin could lead to the expression of fine skin, we analyzed their optical characteristics and sought features common between the petals and beautiful skin. Consequently, we found out that light is the key for fine texture and discovered the following three properties in common: reflecting light homoge-

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Fig. 1 Makeup cosmetic "ASTALIFT LIGHTING PERFECTION" from the left, "pressed powder" for base makeup finish, the powder foundation "long keep pact UV," and the liquid foundation "moist pure liquid UV"

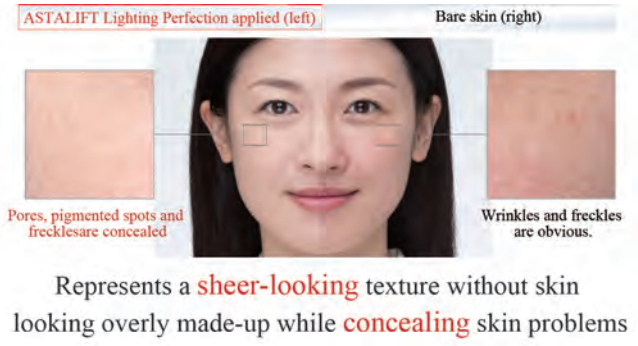

Fig. 2 Makeup effect after makeup (left) and before makeup (right)

neously in all directions from the surface; absorbing yellow light; and transmitting a large amount of light and reflecting it from beneath the surface. To reproduce those optical characteristics in skin, we developed our original powder, SAKURA AURA powder (Fig. 3).

The details of the above three shared properties are described in paragraphs 2.1, 2.2 and 2.3 respectively.

SAKURA AURA powder is optical powder that incorporates both red powder with a special property of absorbing yellow light that darkens the skin and white powder that reflects light homogeneously in all directions from the skin surface. Instead of those used in conventional ordinary foundation, we employed clear red colorants that were able to introduce red light effectively into the skin. However, they were very unstable and difficult to blend into foundation as they were. To respond to that problem, we then transformed those red colorants into a stable form by fixing them onto powder using our own technology (Fig. 4).

Fig. 3 "SAKURA AURA powder"

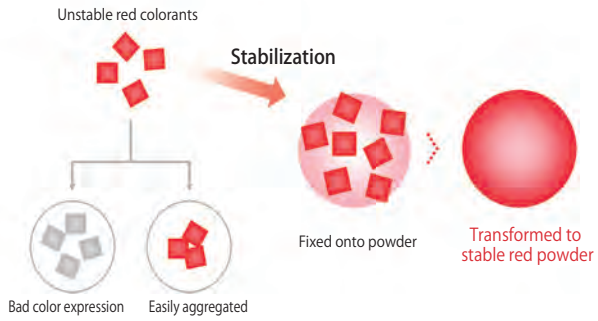

Fig. 4 Modification of an unstable red colorant form stable red powder

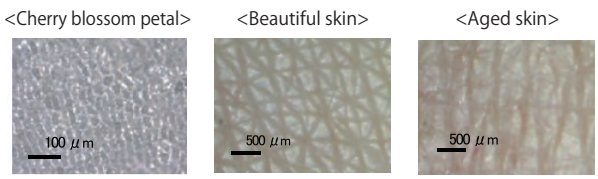

Fig. 5 Optical photomicrographs of the surface of a cherry blossom (left), beautiful skin (middle), and aged skin (right)

2.1 Superficial bumpy structure allowing homogeneous reflection of light in all directions from the surface

We observed the superficial bumpy structures of cherry blossom petals, beautiful skin and aged skin with an optical microscope and measured the intensity and angle distribution of light reflected from their surfaces using a goniometer.

The observation results revealed that cherry blossom petals and beautiful skin had a uniform size of asperities on the surface while aged skin had various sizes of asperities (Fig. 5).

The goniometer expresses the intensity of reflected light

as the size of a circle and its angle distribution as the shape of the circle (the closer to a perfect circle, the more homogeneously in all directions the light is reflected). The measurement results indicated that, although cherry blossom petals and beautiful skin reflected much light homogeneously in all directions, aged skin reflected a little light in only some specific directions (Fig. 6).

From the aforementioned results, we found that asperities of a uniform size on the surface allowed cherry blossom petals and beautiful skin to reflect light evenly in all directions, while aged skin with asperities of various sizes reflected light in irregular directions (Fig. 7).

Therefore, to ideally improve light reflection, we blended white powder that had homogeneously light-reflecting properties in all directions into SAKURA AURA powder (Fig. 8).

2.2 Absorption of yellow light that causes dullness in skin

Skin naturally looks dull under yellow light with a wavelength between 570 and 600 nm used in our daily-life illumination.

We measured the reflectance spectrum of cherry blossom petals, beautiful skin and aged skin. Fig. 9 shows the quantitative differences in their yellow light absorption rates.

For cherry blossom petals and beautiful skin, the extent of decrease in the reflection rates of yellow light was significant. In contrast, that for aged skin was small.

In conclusion, the former two can express a darkening-free fine skin tone by absorbing yellow light that causes dullness in skin and the latter looks dull because of yellow light.

We then blended red powder to absorb yellow light that causes the problem into SAKURA AURA powder.

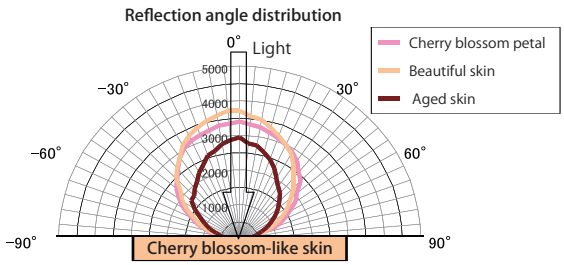

Fig. 6 Angle distribution of reflected light intensity (goniometer)

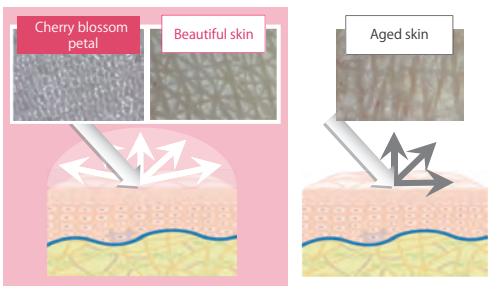

Fig. 7 Direction of the reflected light cherry blossom and beautiful skin (left) and aged skin (right).

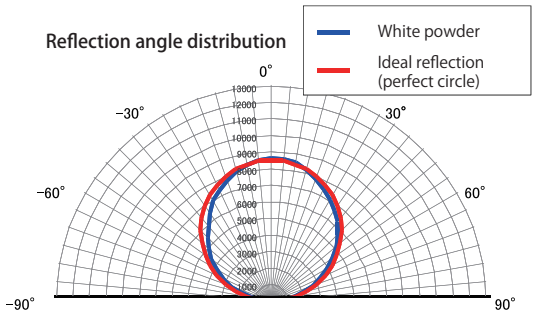

Fig. 8 Angular distribution of the reflected light intensity from white powder (goniometer)

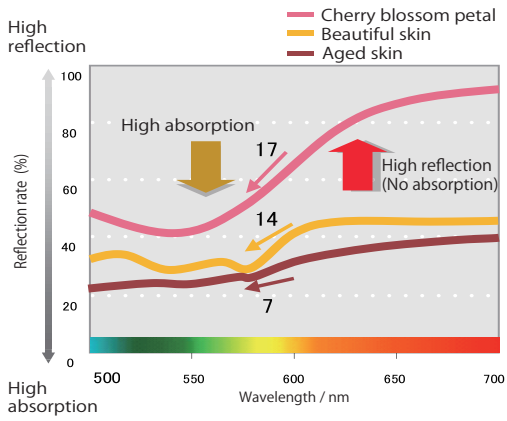

Fig. 9 Reflectance spectrum and decreased reflection ratio of yellow light

2.3 Photoanalysis using a one-shot visible spectrometer SD-OCT - Transmission of light and its reflection from beneath the skin surface

We performed an analysis on cherry blossom petals, beautiful skin and aged skin to determine the depth from which light passing through their surfaces is reflected and the amount of light reflected.

Optical coherence tomography (OCT) systems used in the medical field are available for noninvasive biological tissue tomography. However, they take time to obtain high-precision data at a micrometer-level resolution and thus they are not suitable for the tomography of human skin that is difficult to hold steady for a long time. In addition, the equipment uses a near infrared light source, which is not compatible with the optical (visible light) information of human skin. Therefore, we developed a one-shot visible spectrometer for spectral-domain (SD) OCT, using a visible light source and allowing the instant acquisition of tomographic images of the target.

The optical system of the new equipment is the SD type that uses a fixed-wavelength light source and spectroscope for optical coherence. The system incorporates a cylindrical lens (CL) that collects light linearly and emphasizes signal images by making the light returned from inside the skin (measurement light) interfere with reference light, which has enabled instant imaging in a mere few tens of microseconds (Fig. 10).[5)]

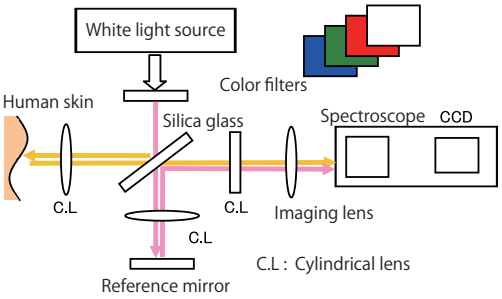

Fig. 10 Optical system of one-shot visible spectrometer SD-OCT

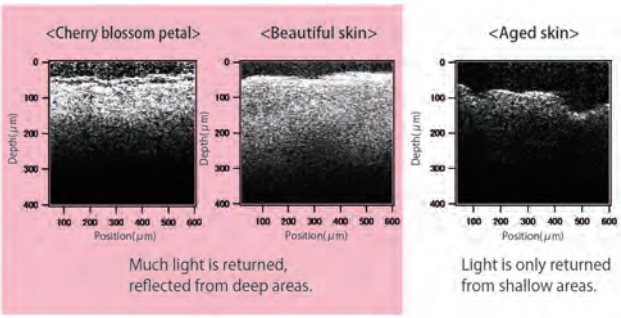

Fig. 11 Tomographic images of light reflected from under the skin cherry blossom (left), beautiful skin (middle), and aged skin (right).

The equipment is designed so white light is passed through colored filters, allowing skin tomography with visible light having an arbitrarily selected wavelength. In addition, by simultaneously radiating red, green and blue light using the incorporated multi-wavelength simultaneous transmission filter, it can capture RGB spectroscopic tomographic images of a region all at once.

Fig. 11 shows the tomographic images of a cherry blossom petal, beautiful skin and aged skin captured with the one-shot visible spectrometer SD-OCT. White areas indicate depths from which a large amount of light was returned, whereas black areas show where less light was returned.

The figure indicates that aged skin reflects a little light from only shallow areas of the skin, while cherry blossom petals and beautiful skin reflect a substantial amount of light from far deeper areas.

As a result, it was confirmed that, like cherry blossom petals, beautiful skin looks transparent because it is bright, illuminated by much reflected light, and aged skin looks dull and dark with little light reflection.

3. Discovery of the mechanism of red light making skin look beautiful

The appearance of skin, such as transparency and the visibility of open pores, irregular tones and pigmented spots, is greatly affected by the wavelength of light irradiating the skin. It is generally known that blue light with a short wavelength emphasizes pores, irregular skin tones and pigmented spots, whereas red light with a long wavelength has the opposite effect. However, the mechanism was not explained yet.

To discover that mechanism, we captured human skin tomographic images using the one-shot visible spectrometer SD-OCT with visible light of a variety of wavelengths applied and analyzed the relationship between the visibility of skin problems (e.g., open pores, irregular skin tones and pigmented spots) and the color of light (Fig. 12).

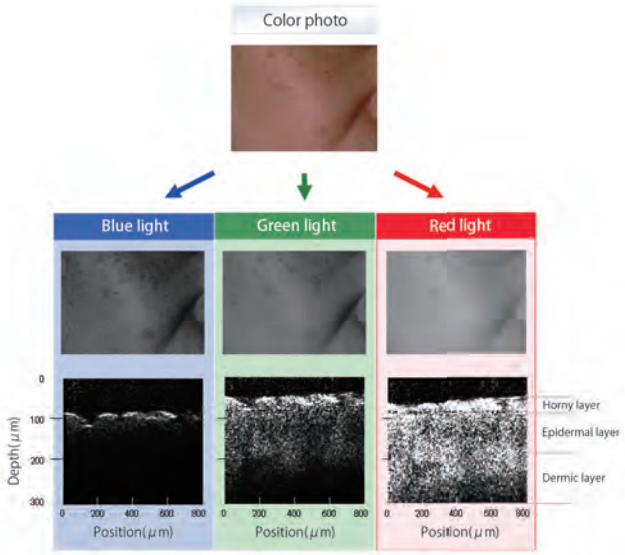

Fig. 12 Tomographic images of human skin with visible light of varying wavelength blue light (left), green light (middle), and red light (right).

The detailed results are as follows. Blue light only reaches shallow areas in the horny layer and epidermal layer. The skin region that reflects the light is thin and the amount reflected is small. On the other hand, a large amount of red light reaches the upper dermic layer located deep in the skin. The skin region that reflects the light is wide and the amount reflected is large, illuminating the skin from inside.

In conclusion, the depth of light transmission and the amount of light reflected are the factors that produce clear texture in skin. The above described skin problems can be made less conspicuous by passing a large amount of light deep into the skin and allowing much of it to reflect there. In that way, transparency can be given to the skin.

Next, employing the slit evaluation method, we radiated red light vertically through a long slit and measured the distance that the light traveled horizontally inside the skin from that radiation position. (Figs. 13 and 14).

The results revealed that foundation blended with SAKURA AURA powder allows red light to reach further and the travel distance is approximately three times longer than foundation without SAKURA AURA powder.

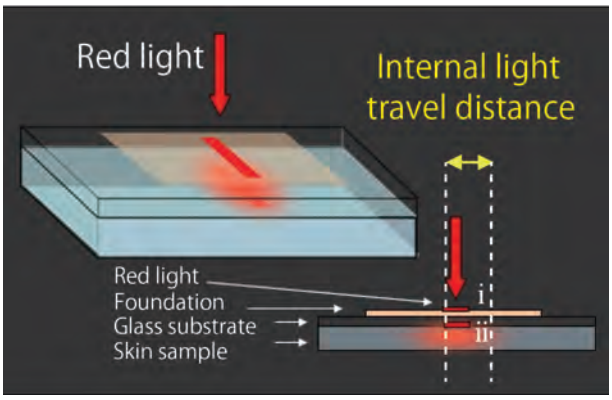

Fig. 13 Slit evaluation method (measurement of light traveling distance inside skin)

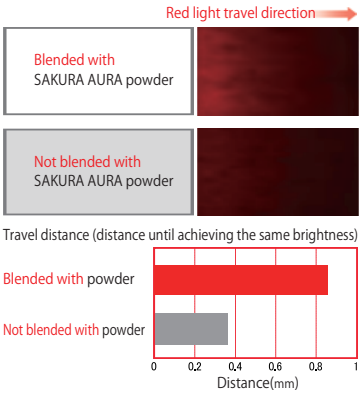

Fig. 14 Distance travelled by red light under the skin after SAKURA AURA powder application

4. Effects of makeup - Transparency compatible with concealing performance

4.1 Transparency

We radiated light from the back of a silicone skin replica with imitated open pores to which foundation was applied and measured the amount of transmitted light (Fig. 15). The smaller the amount transmitted, the more transparency was lost, which made the skin look overly made-up. Conversely, the larger the amount transmitted, the clearer the skin looked.

Compared with bare skin, the skin to which ordinary foundation was applied halved the transmission of light. However, the measurement results confirmed that the Lighting Perfection foundation blended with SAKURA-AURA powder transmitted an amount of light nearly equal to bare skin.

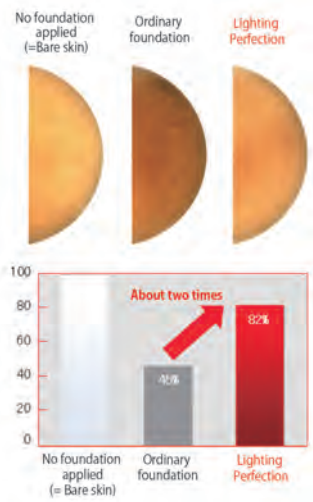

Fig. 15 Light transmission effect in a skin replica

4.2 Concealing performance

We captured images of skin regions with problems such as open pores, irregular skin tones and pigmented spots, before and after the application of foundation blended with SAKURA AURA powder and measured the luminosity (brightness) of those images (Fig. 16). We defined small regions where a specified amount of luminosity decreased compared with the whole face as open pores and larger such regions as irregular skin tones. Pigmented spots were confirmed visually. We calculated the percentages of the whole image area that were occupied by those skin problems both before and after the application of the foundation and compared their change rates.

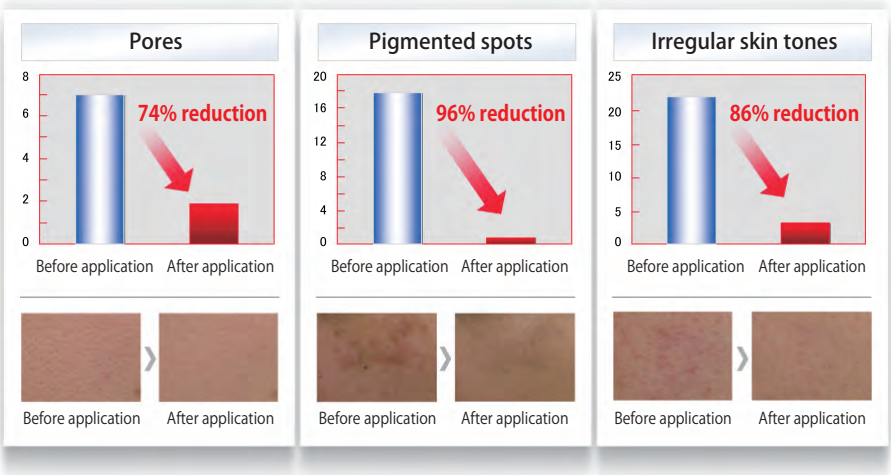

Fig. 16 Areas recognized as “pores,” “irregular skin tone,” and “pigmented spots” greatly decreased after applying the "ASTALIFT LIGHTING PERFECTION" foundation.

Consequently, we confirmed that the areas with open pores, irregular skin tones and pigmented spots were all significantly reduced by the application of the foundation blended with SAKURA AURA powder.

4.3 Durability

The characteristic of the Long Keep Pact UV powder foundation is its durability. The foundation retains the same texture and tone as it achieved when it was applied in the morning by preventing sweat and sebum from deteriorating makeup and causing dullness in skin. It finishes the skin with a soft and resilient impression and smooth texture.

Fig. 17 shows the analytical results for the clumping and deterioration of makeup 6 hours after the powder foundation was applied. Although slight changes were observed beside the nose and in the surrounding area, they didn't affect the overall impression.

4.4 Skin moisture

The characteristic of the Moist Pure Liquid UV liquid foundation is its high skincare effect. The foundation contains skincare ingredients, such as astaxanthin, lycopene and three kinds of collagen, to maintain fresh skin. It finishes the skin with a fresh and radiant impression and moist texture.

Fig. 18 shows the changes of skin moisture over time observed in the measurement of the skincare effect of the foundation. The results confirmed that, compared with bare skin, the skin to which Moist Pure Liquid UV was applied retained moisture for a long period of time.

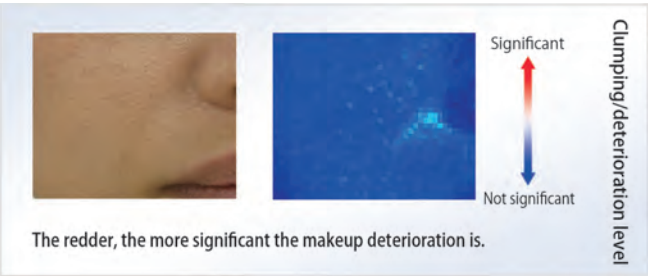

Fig. 17 Makeup endurance of the powder foundation "long keep pact UV" measured 6 hours after application

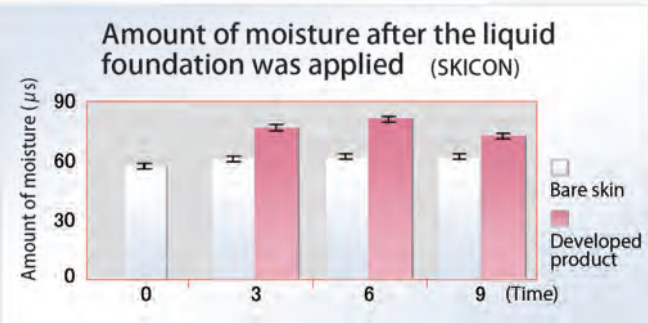

Fig. 18 Moisturizing effect of the liquid foundation "moist pure liquid UV"; changes in skin moisture over time

5. Conclusion

We optically analyzed cherry blossom petals that everybody feels beautiful as a subject of photographs using the one-shot visible spectrometer SD-OCT. We then developed the optical powder, SAKURA AURA powder, by reproducing the optical properties of cherry blossom petals in it and blended it into foundation. The foundation achieves high transparency in skin, while exhibiting excellent concealing performance. Specifically, the foundation has light transmittance of the same level as bare skin together with a high makeup effect as a base makeup item to conceal common skin troubles, such as open pores, irregular skin tones and pigmented spots, and to realize beautiful skin ideal for women.

In the future, we will keep utilizing our expertise accumulated in photography for the realization of ideal beautiful skin and, via product development activities based on the novel perspective and scientific attitude characteristic to FUJIFILM, we are going to contribute to the improvement of women's beauty.

References

1) Nakamura, K; et al. Development of Concept behind "ASTALIFT Light Analyzing Moisture Foundation." FUJIFILM Research & Development. 2012, no. 57, p. 11-14.
2) FUJIFILM News Releases. Jun. 19, 2014. http://www.fujifilm.co.jp/corporate/news/articleffnr_0884.html.
3) FUJIFILM News Releases. Jun. 23, 2014. http://www.fujifilm.co.jp/corporate/news/articleffnr_0885.html.
4) FUJIFILM News Releases. Jun. 30, 2014. http://www.fujifilm.co.jp/corporate/news/articleffnr_0888.html.
5) Yoshida, N.; Tani, T.; Ishibashi, H.; Naya, M. Optical analysis of dullness and translucence of the skin using optical coherence tomography (OCT) and polarized light imaging. Fragrance Journal. 2013, 41 (3), p. 29-35.

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