

Mandom Successfully Formulates Oil Gel That Contains Large Amounts of Multiple Oils in Water Phase

~We create a less sticky hair oil that holds hair together while controlling frizz~

Mandom Corporation (Head Office: Osaka City; President Executive Officer & Director: Ken Nishimura; hereinafter referred to as "Mandom") is developing cosmetics (including quasi-pharmaceutical products) in response to consumers' wants when it comes to hair. One of those products is a multi-functional hair oil that the company is currently performing pharmaceutical research for*1.

On this occasion, we strived to develop a hair oil formulation that can hold hair together while controlling frizz and giving it a non-sticky smooth feeling. In doing so, we successfully developed technology for mixing vegetable oil with silicone oil, a feat that has essentially been difficult to achieve, and formulated O/LC²-type (high internal phase liquid crystal) oil gel that incorporates a large amount of mixed oil from vegetable and silicone oil in water phase with moisturizing agents. This technology was applied to "Lucido-L, Oil Treatment, #EX Hair Oil, Frizz Care," which was released in August 2021.

[Background Information on this Research]

In recent years, there has been an increasing number of consumers who use hair oils that give their hair a natural shine and allow them to style their hair in various trendy fashions. Although less sticky hair oils are particularly popular among these products, the biggest problem that hair-oil-product users encounter is frizz³ (wavy hair/cowlicks).

Hair oils generally consist only of oil ingredients that do not contain water and are divided into two categories, namely vegetable-oil-based formulations and silicone-oil-based formulations. Vegetable-oil-based hair oil is suitable for holding hair together while controlling frizz, but it is characterized by its poor ability to be stretched throughout the whole hair, as well as its very sticky feel and glossy look. On the other hand, silicone-oil-based hair oil, which has been trending in recent years, does a good job of achieving a natural look while keeping hair feeling silky as consumers run their fingers through them, but these hair oils tend to do a poor job of controlling frizz while holding hair together. In addition, although there are differences in the types of oil ingredients used, oil ingredients tend to come with the disadvantage of feeling sticky and adhering to the hands and hair.

In response to the issues listed above, we identified the need to develop a hair oil that can control frizz, hold hair together and achieve a less sticky yet more silky feeling than conventional products, and therefore set out to establish the two following technologies:

- (1) Technology that uniformly combines vegetable oil and silicone oil to take advantage of the benefits each of them provide
- (2) Technology that improves the natural coherence of hair while utilizing the advantages of oil ingredients and, at the same time, preventing its distinctive stickiness.

1. Developing technology that uniformly combines two types of oils that do not mix with each other

Vegetable oil does an excellent job of holding hair together while controlling frizz, while silicone oil is great for achieving silky-smooth feeling. However, these two oils do not mix with each other due to differences in their chemical properties. However, we have discovered an oil (hereinafter referred to as "binder oil") that not only is highly compatible with these two oils, but also works to make them get along with one another. By using this binder oil, we were able to dissolve vegetable oil and silicone oil with each other and successfully develop a one-phase mixed oil (hereinafter referred to as "uniformly mixed oil") (Figure 1).



2. Developing high internal phase liquid crystal oil gel that incorporates a moisturizing gel with moisturizing agents as well as large amounts of mixed oil

Although the development of this uniformly mixed oil allows the benefits of both oils (vegetable and silicone) to be utilized, it does not mean that those benefits can be demonstrated sufficiently^{*4}. On the other hand, moisturizing agents are effective at holding hair together without leaving any oil-like stickiness. Therefore, we came to the conclusion that it would be useful to combine moisturizing agents to oil to reduce its stickiness and at the same time improve its ability to naturally hold hair together while controlling frizz. The method of combining water-soluble moisturizing agents with normal, non-aqueous hair oil leads to emulsification, which results in an inability to demonstrate the benefits of the oils used since there is a limit to how much oil can be mixed, and since the appearance becomes white and therefore loses its oil-like appearance. That is why we developed a formulation that can maintain that oil-like appearance while still demonstrating the benefits of oil by successfully formulating O/LC oil gel (high internal phase liquid crystal oil gel) that includes mixed oil containing large amounts of uniformly mixed oil in a moisturizing gel that has been formed using certain surfactants, water and glycerin (Figure 2).

3. Confirming high ability to straighten out frizz and hold hair together while leaving little stickiness

We have evaluated the functionality and usability of this high internal phase liquid crystal oil gel formulation (developed formulation) by applying it to bundles of hair.

<<Functionality & Usability Evaluation Method>>

● Ability to control frizz & hold hair together (Figure 3)

State confirmation after applying fixed amounts of the developed formulation & a comparison product to 30-cm bundles of bleached hair.

● Stickiness (Figure 3)

State confirmation after sprinkling wood chips on 10-cm flat hair bundles to which fixed amounts of developed formulation & a comparison product have been applied.

● Straightened frizz retention (Figure 4)

State confirmation regarding frizz after applying fixed amounts of the developed formulation & a comparison product to 30-cm bundles of curled hair that have received a permanent wave perm, and to the same bundles of hair after they have been straightened using a hair iron heated to 180°C and left for 10 hours in a 35°C environment at 80% humidity (assuming use scenarios that deal with thermal equipment such as hair irons).

<<Evaluation Results>>

The developed formulation was confirmed to be much less sticky and greatly more capable of controlling frizz and holding hair together than when applying vegetable oil, silicone oil or uniformly mixed oil.

In addition, when it comes to evaluating straightened frizz retention, the developed formulation was able to maintain the straightened state of frizzed hair better than uniformly mixed oil when applied to the same types of hair, and the developed formulation also makes it relatively more difficult for curls to return (compared to uniformly mixed oil).

This time, as a result of promoting the development of a hair oil that can control frizz, hold hair together and achieve a less sticky yet more silky feeling than conventional products, it was found that the developed formulation not only realized the functionality and usability that was required of it, but that it was also able to maintain the straightened state of frizzy hair after the use of thermal equipment such as a hair iron. We will continue to promote the product application of high internal phase liquid crystal oil gel forming technologies, including multiple oils, in order to further evolve hair oil formulation technology so that consumers can use our products more comfortably.

*1 The 84th SCCJ Research Debate: "Preparation of liquid crystal oil gel containing high internal phase (O/LC gel) and the way of lowering viscosity of it"

*2 A structure in which oil is retained in liquid crystal (a state that has the fluidity of liquid while still maintaining regular molecular arrangement like solid).

*3 Reference News Release: ""Lucido-L, Oil Treatment, #EX Hair Oil, Frizz Care" (June 14, 2021)
<https://www.mandom.co.jp/release/202106140105.html>

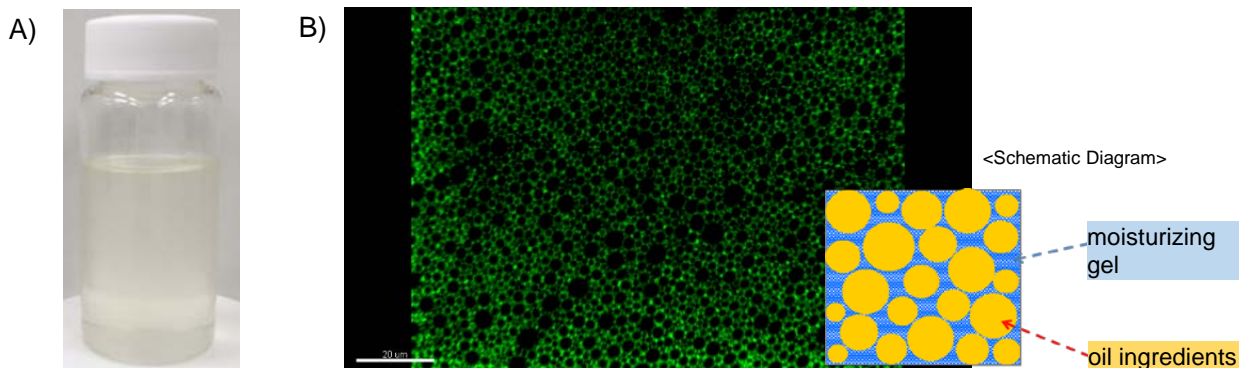
*4 Verified by a portion of the <<Functionality & Usability Evaluation Method>> (see Figure 3. A to D)

[Reference Materials]

Figure 1. (Left) Vegetable oil (crambe abyssinica seed oil) and silicone oil that has been separated in two phases (Right) Binder oil that mixed vegetable oil (crambe abyssinica seed oil) and silicone oil in one phase.



Figure 2. High internal phase liquid crystal oil gel's appearance (A) and microscopic image (B).



Water phase stained using green fluorescent dye (green: moisturizing gel (water phase), black: oil phase)

Measured using a confocal microscope, 100 times magnification, 473 nm excitation wavelength

Figure 3. Ability to control frizz, hold hair together and stickiness.











	A) Unapplied	B) Vegetable oil	C) Silicone oil	D) Uniformly mixed oil	E) Developed formulation
Control frizz & hold hair together	× 	⊙ 	△ 	○ 	⊙ 
Little stickiness	⊙ 	× 	○ 	△ 	○ 

Figure 4. Developed formulation's (high internal phase liquid crystal oil gel's) straightened frizz retention results

