Structured gels with organic oils and alkyl dimethicone

Tony O'Lenick – Siltech LLC, US
David Zhang PhD - Siltech Corporation, Canada

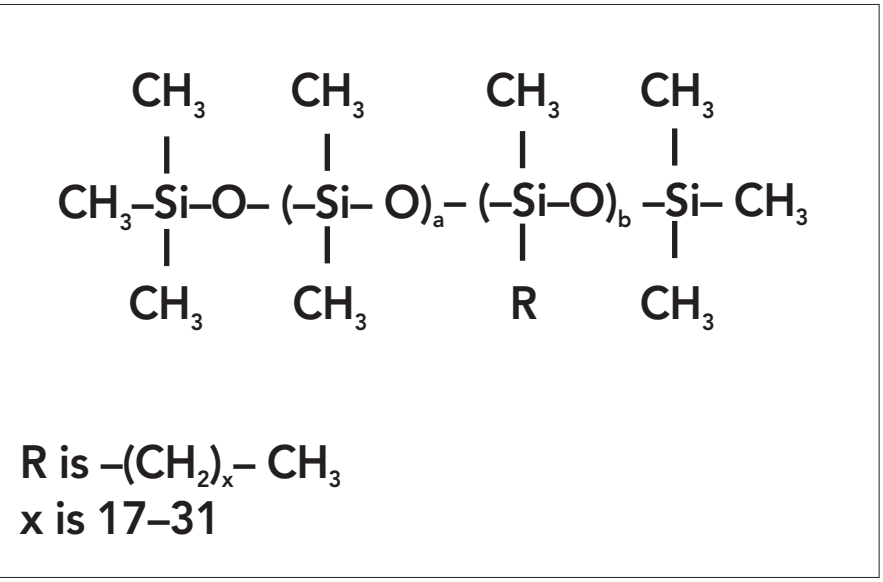
Abstract

Butters are very commonly used in personal care formulations. Butters are divided into two classes, those that exist in nature, including shea butter,[1] cocoa butter[2], mango butter[3], lilpe butter[4] and several others or those that are man-made such as olive butter. Butters are structured gels that provide not only a unique skin-feel but also have a great rheology thinning under pressure.[5] There are only a handful of butters in nature, many of the rest are made by partial hydrogenation of the oil. Another approach to make structured gels that avoid partial hydrogenation is addition of alkyl dimethicone compounds to natural oils and esters. These compositions offer the formulator the ability to make a wide variety of structured oil formulations offering a variety that of formulations that not only have a great initial feel and playtime on the skin, but a variety of tunable final aesthetics after rub in. This article will address the basic technology used to make these materials.[6]

US Patent 7,875,263[7] describes structured gels that are produced by heating the oil together with the proper alkyl silicone to above the melt point of the alkyl silicone and adding the oil to produce a butter with unique skin spreadability properties. This provides combinations of particular value as a carrier in antiperspirants, pigmented products, skin care products, sun care and the like since they spread rapidly and efficiently on the skin from a gel providing emmoliency. Additionally, there are a host of oil soluble additives including sun screen actives, hydroxy acids, antioxidants, flavonoids, tocopherol, vitamins and the like that can be incorporated into the formulation. These gels are very cosmetically appealing having a dry feel on the skin and provide a lubricious property which improve the aesthetics of skin creams, skin care lotions, moisturisers, facial treatments such as acne or wrinkle removers, personal and facial cleansers, liquid soaps, bath oils, perfumes, colognes, sachets, sunscreens, pre-shave and after-shave lotions, shaving soaps, and shaving lathers. It can be used in hair shampoos, hair conditioners, hair sprays, mousses, permanents, depilatories, and cuticle coats, to enhance cosmetic elegance. The oil phases that are of most interest are glyceryl esters (triglycerides including natural oils), trimethylolpropane esters, and pentaerythritol esters.

The two key ingredients in the blend determine the properties of the final gel. The first is the selection of the alkyl dimethicone and the second is the ester to which it is added.

Figure 1: Alkyl Dimethicone Structure



Alkyl silicone

Alkyl dimethicone polymers have the structure shown in Figure 1.

A: Alkyl chain length ('x')

The 'x' value is the most important factor in determination of the melt point of the alkyl dimethicone. Figure 2 shows the melt point data for a series of dimethicone polymers.

Gels made with melt points below 40oC will have a refreshing feel on the skin melting at body temperature.

B: Percentage alkyl by weight

If the percentage of alkyl by weight is above 80 per cent, the resulting gel will crack rather than flow when pressure is applied. The lower the percentage of the alkyl component, the softer the gel will become. Controlling the "a" to "b" ratio is key to the softness of the gel.

US 7,875,263 teaches:

Figure 2

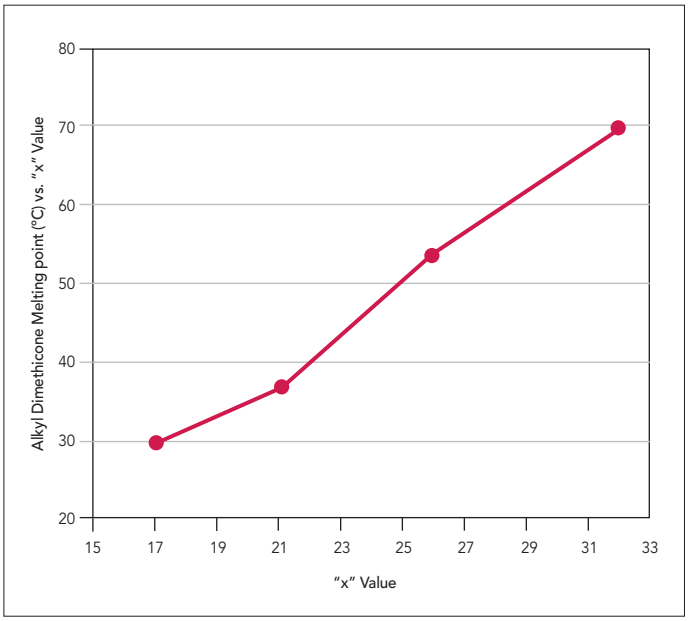


Table 1: Alkyl Dimethicone

	"x" Value	% Alkyl	Melt point
ADM-1	25	79	58°C
ADM-2	25	60	54°C
ADM-3	25	60	51°C

Table 2: Formulation for Strucured Gels

Ingredients	Product A	Product B	Product C
	(5%) ADM-1	(5%) ADM-2	(5%) ADM-3
C8-C10 Triglyceride (95%)	C8-C10 Triglyceride (95%)	C8-C10 Triglyceride (95%)	C8-C10 Triglyceride (95%)
Total (100%)	100%	100%	100%

Table 3: Melting Range of Structured Gels 5% ADM

	"x" Value	% Alkyl	Melt point
M.P. (°C)	53 ~ 60	47 ~ 50	40 ~ 46
* M.P. range was tested by Fisher – Johns melting Point Apparatus			

"…that structured gels made with lower percentages of alkyl dimethicone (1-5% by weight) are soft gels. They liquefy upon the touch and spread rapidly on the skin. At ranges of between 5 and 10% by weight added alkyl dimethicone, the structured gels become increasingly more rigid but still yield under pressure. The cushion of the formulation is increased.

"The intermediate level of between 5 and 10% by weight have short play times, spreading out rapidly. At levels of between 10 and 20% by weight the gel becomes very rigid, and the play time is extended. This allows the formulation of products that have wide cosmetic applications, allowing the formulator wide latitude to develop a product that meets consumer expectations.

"The higher the number of carbon atoms in the alkyl dimethicone, the higher the melting point of the structured gel. At the melt point the structured gel dissolves making a liquid, upon cooling the structured gel reforms, making the technology very flexible". The gel can be warmed and melted as often as desired.

Organic oil

The aesthetics of the organic oil added to the product is a major factor in determining the type of gel that is produced. Very dry, low viscosity esters are recommended for antiperspirants, and sun care products higher viscosity esters are recommended for skin care and pigmented products.

Gel evaluations

The evaluations of structured gels were conducted using a C8-10 triglyceride (a common relatively inexpensive triglyceride) and the alkyl dimethicone polymers shown in Table 1.

Table 2 shows the composition of the structured gels prepared using 5% by weight of the ADM materials and 95% by weight.

The melting range of the structured gels made with the formulations in Table 2 are shown in Table 3. Figure 3 shows the melting range used instead on melting point for the blends. The melting starts at 53oC and was not complete until 60oC.

The percentage of ADM was increased in a subsequent set of experiments to observe the effect upon melt point and structured gel appearance. The finished structured gels have a melting range not a single melt point. Table 4 shows the melt point range at 10% and 20% for each ADM prepared. One can see that increasing the usage level of ADM did not change the melting range.

The texture evaluation of the structured gels is shown in Table 5 and pictures are shown in Figure 4.

The hardness of each structured gel made varies proportionally with the % by weight of the alkyl in the ADM. ADM is substantially harder (more brittle) than the other two, which are very similar in hardness.

Emulsions

It is well understood that one way to increase the stability of an emulsion is to provide structure to the two phases. The effect of adding 5% of the ADM to olive oil before making the emulsion was studied. The simple formulation is shown in Table 6.

Figure 5 shows the results of the emulsion after 24 hours. Clearly, structuring the oil phase improved the stability. In order to make the structured emulsion the emulsification process needs to be run above the melting point of the ADM chosen. The ADM in the oil phase increases slip and provides a less sticky feel to the formulation.

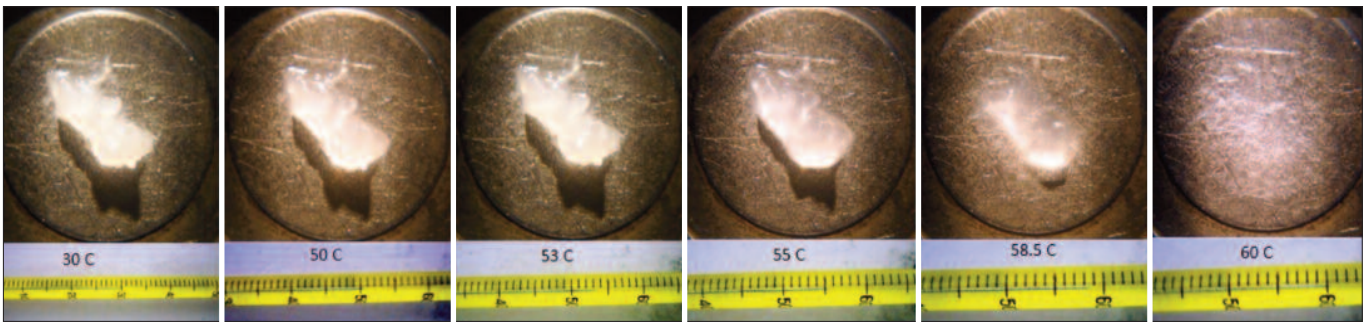


Figure 3: Melting range of Structured Gels 5% ADM.

Conclusion

Properly chosen alkyl dimethicone polymer are soluble in oil including mineral oil, simple esters, complex esters and natural oils allows for the modification of aesthetics of formulations using these oils by simply adding these materials to the oil phase above the melting point of the alkyl dimethicone. This addition improves the spread, lowers the surface tension and minimises stickiness of the oil.

The selection of an alkyl dimethicone having over 18 carbon atoms in the alkyl chain allows for the preparation of cosmetic butters that avoid the partial hydrogenation process and therefore are free of undesirable trans fats and provide the aesthetic boost of a silicone polymer.

The ability to select different oils and different alkyl dimethicone products offers the formulator the possibility of having a range of hardness, spreadability, flow and feel. This will allow a specific formulation to become a 'platform' formulation which can be altered for different consumer needs. PC

References

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Table 5: Melting Range of Structured Gels 5% ADM

	Formula 2 Non-Structured Oil	Formula 1 Non-Structured Oil
Olive Oil	36.0	36.0
Water	55.0	55.0
Lauryl PEG 8 Dimethicone	4.0	4.0
Cetyl Dimethicone	5.0	–
ADM – 2 C26 Dimethicone	–	5.0
Total	100.0	100.0

Table 7: M.P. of structured Gel with 10% and 20% of Alkyl Dimethicone (ADM)

	ADM – 1	ADM – 2	ADM – 3
10% ADM Added	53 ~ 60°C	50 ~ 52°C	44-50°C
20% ADM Added	51-60°C	50 ~ 54°C	47 ~ 52°C

Table 8: Texture of structured Gels

Texture of Butters	ADM – 1	ADM – 2	ADM – 3
5% ADM	Not Good*	Not Good*	Not Good*
20% ADM	Improved	Improved	Improved
20% ADM	Good	Good	Good

* The structured gel when press in the container cracked. Table 9 (below) shows the resulting structured gels

Table 9: Structured Gels of ADM/C8-10 Triglyceride

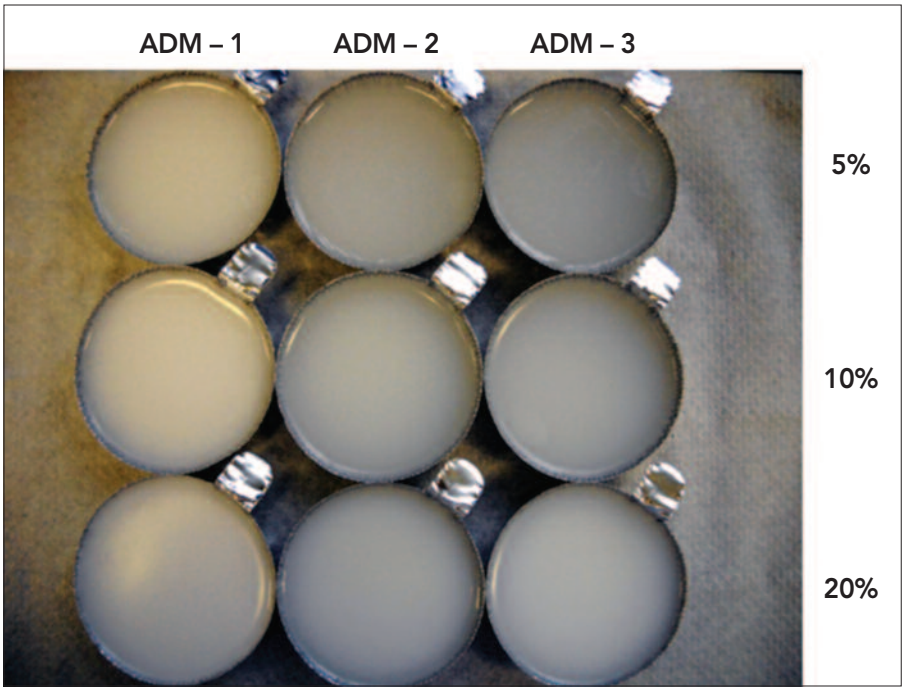
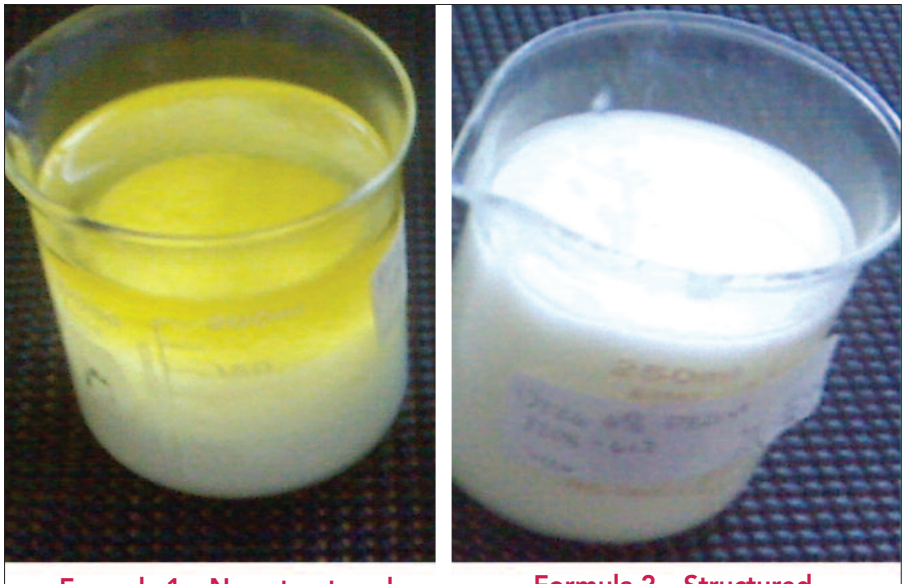


Table 11: Emulsion Structured and Non-structured Oil Phase.[8]



Formula 1 – Non structured

Formula 2 – Structured