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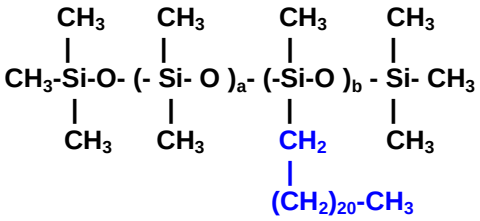
Multi Domain Silicone™ Waxes
A New Class of Ingredients for Personal Care

Background

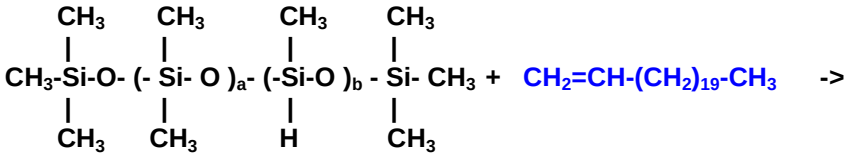
Dimethicone is difficult material to incorporate into many formulations since it in insoluble in both water and oil. Silicones lower surface tensions and provide elegant skin feel to many formulations when added to the oil phase. One of the most important physical attributes of a cosmetic product is skin feel. This attribute is a major consumer perceptible property of virtually all cosmetic products. The ability to alter the cushion and play time in a cosmetic product is a highly prized formulation skill. If one rubs oil on the skin of the hand with the index finger, the Cushion is "the gap" between the finger and hand that the oil occupies. Play time is the length of time cushion exists. Many organic oils cushion and playtime are directly related. Materials with a lot of cushion have a lot of play time. The proper selection of alkyl silicone will allow for the ability to reduce play time without effecting cushion.

Alkyl Silicones Chemistry

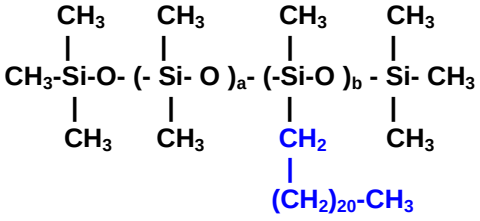
Alkyl dimethicone polymers are a class of amphilic silicones that have both an alkyl and a silicone portion present in the same molecule. Mutually insoluble groups include water, oil, silicone and fluorocarbon.



Alkyl dimethicone compounds are made by the reaction of a silanic hydrogen containing polymer and an alpha olefin.



Silanic Hydrogen polymer C22 alpha olefin



Behenyl dimethicone

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Physical Properties

Solubility

Alkyl silicones are insoluble in water, isopropanol, and dimethicone. They are soluble in mineral oil, triglycerides and fatty esters. Their solubility in oily materials makes these products of interest in personal care applications.

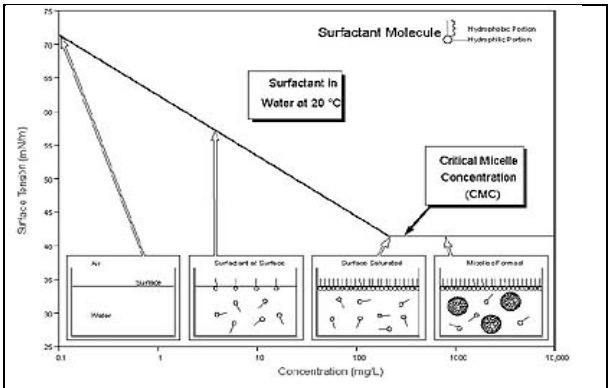
Despite the fact that alkyl silicones are soluble in many oils, they go to the surface, lowering surface tension then as the concentration increases form micelles. It is this property of alkyl silicones that offer the formulator the most advantage. The lowering of surface tension from 30 dynes/cm^2 to 20 dynes/cm^2 makes the oil based product feel more like silicone.

The melt point of an alkyl dimethicone is determined in large part by the length of the alkyl group attached to the silicone. The amount of silicone can also effect the melt point, but to a lesser degree. The amount of silicone present on the molecule alters the hardness of the alkyl dimethicone. As the amount of silicone increases in a molecule, the material becomes softer.

Typical values for alkyl dimethicone products having alkyl chains are: C-22 alkyl 35^{o}C; C-26 alkyl 50^{o}C and C-32 alkyl 60^{o}C.

Surfactant Properties

The graphic below shows the action of amphilic materials in solution. In this case the multi domain silicones in oils. The beneficial effects of surface tension lowering on spreadability and both cushion and playtime are key benefits of this technology. The applicability reaches through all product types for personal care including serums, emulsions, sun products and pigmented products.

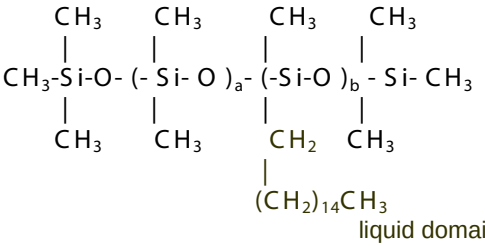


Surfactant properties in solution

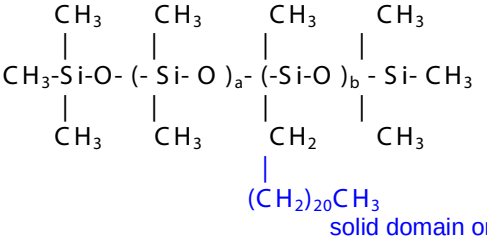
States of Matter

A solid is a state of matter in which the material shows resistance to deformation and changes in volume. Solids have their molecules closely packed together in fixed positions. If the molecules are fixed in repeating groups a crystalline group occurs. A liquid is s state of matter in which molecules are fluid that is they can move easily around, assuming the shape of the container.

Alkyl dimethicone compounds have been around for many years. They are soluble in a variety of oils like mineral oil, and esters. The length of the alkyl chain determines the melt point of the traditional alkyl dimethicone. Consequently, cetyl (C16) dimethicone is liquid and Behenyl dimethicone (C22) is solid.

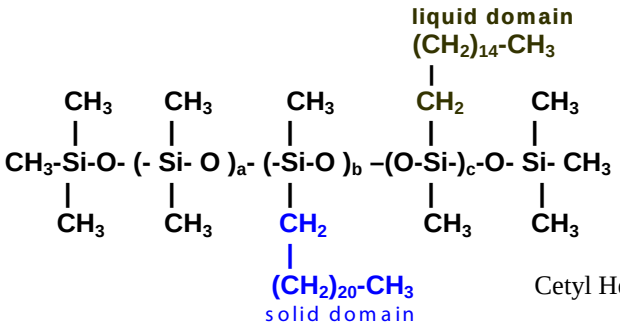


Cetyl dimethicone
(liquid at room temp).



Behenyl dimethicone
(mp 37°C)

Unlike the products shown above, Multi-domain silicone polymers are carefully engineered materials that have segments called domains that have both solid and liquid alkyl groups placed on the same silicone backbone. The result is an inability to form a hard wax. The reason for this is that the molecule takes on the lowest energy confirmation in which there are solid domains and liquid domains within the matrix. The presence of these different domains within the polymer results in unique properties. The liquid and solid domains within the same molecule limit the ability to form hard solids and result in soft cosmetically elegant wax.



Cetyl Hexacosyl Dimethicone

COMPARISON

A comparison of the multi-domain silicone polymer and product made by blending two silicone polymers on which there is one alkyl group each is shown below. The two products have the same average composition, but the multi-domain product is clearly different. This difference is because of the structuring provided by the multi domain design.

Comparison

Multi-Domain alkyl silicone and blend of two different alkyl silicone polymers (having the same ratio of alkyl groups)

Multi domain alkyl silicone Blend of two alkyl silicones

The comparison above clearly demonstrates that the effect of a multi domain alkyl silicone polymer. The product on the left is translucent, and flows slightly. The blended product is hard and opaque. The Multi domain silicone is thixotropic liquefying under pressure feels like petrolatum on the skin but has minimal playtime. It spreads rapidly and has no stickiness. This is attributed to the low surface tension and spreadability provided by the two domains in the one molecule.

Multi Domain Silicone™ Product Line

There are currently four materials in the patent pending Multi Domain Silicone™ product line. The main differences include melt point and skin feel. The products have been described as transient petrolatum, providing the feel and cushion of petrolatum, but has variable playtime, ranging from very little play time to longer play time. Products leave a high level of gloss and no tack, for this reason they have been called "*Vanishing Petrolatum". W*hen added to emulsions, both invert and regular, the effect is dramatic, prviding outstanding skin feel. When added to shampoos as a conditioning agent in coacervate applications, they are oily soluble conditioning agents with outstanding spreadability and dry conditioning. When added to pigmented products, these materials minimize syneresis and improve glide.

TYPICAL PROPERTIES

The products do not differ in their solubility activity or appearance.

Appearance	White Gel
Active Content %	100
Color, Gardner	3 Max
Solubility (1% and 10%): -Water -IPA -Mineral Oil -Cyclopentasiloxane (D5) -350 visc. Silicone Fluid	 -Insoluble -Insoluble -Soluble -Insoluble -Insoluble

INCI: Cetyl/hexacosyl dimethicone

Product	Melt Point Range (°C)	Carbon Number	Play Time	Cushion	Description
Silwax D221M	34-36	21	2	1	Comb silicone
Silwax J221M	30-33	21	3	2	Higher MW Silicone than D-221M
Silwax J218M	29-32	18	4	4	Higher MW Silicone and lower carbon number than D-221M
Silwax Di1021M	35-38	21	1	3	Terminal Functionality
			1 is least	4 is most	

USES AND APPLICATIONS

The **MULTI DOMAIN SILICONE SILWAX®** product line provide gloss, softness, barrier properties and lubrication. The salient differences is found in melt point, play time, gloss and cushion. These materials are useful in sun care products to increase SPF, moisturizers, lotions, antiperspirants and deodorants and pigmented products (lipsticks, mascara, foundations).

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