Silicones and alternatives 2017
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The use of silicones in cosmetics has gone full circle! In 1983 Dow Corning published an article by Alfred J. DiSapio entitled Silicones as Alternatives to Hydrocarbons in Personal Care Formulations. DiSapio wrote that the flexible functional and sensory capabilities of silicones make them an interesting candidate for the reduction of organic materials in cosmetic and toiletry formulations. The trend was driven by a demand for improved functional performance, interest in the enhanced therapeutic value offered by protective and non-comedogenic products and regulatory issues affecting use of volatile organic compounds.

Thirty-three years later the trend is to replace silicones and hydrocarbons are a popular alternative. This reversal follows concerns over the use of cyclotetrasiloxane (D4) and to a lesser extent of cyclopentasiloxane (D5) plus COSMOS refuses natural certification to products that contain any silicones. However, running counter to this trend is the growth in BB and CC creams, which appear to be universally based on silicones and silicone polymers. In November 2016 the author checked ingredient listings on twenty-five leading brands of BB and CC creams from around the world and found thirteen contained cyclomethicones and eleven contained dimethicone near the top of ingredient listings. Almost all contained at least one other silicone derivative including phenyl dimethicone, diphenylsiloxy phenyl trimethicone, methicone, caprylyl methicone and methyl trimethicone. Silicone polymers also featured in the majority with cetyl PEG/PPG-10/1 dimethicone and PEG-10 dimethicone each appearing in six different compositions and various dimethicone crosspolymers appearing in ten.

BB/CC cream ingredient listings also showed popular alternatives, mostly as replacements for cyclomethicones in products that still included dimethicone or other silanes or siloxanes. The most common were neopentanoates, isononyl isononanoate and isododecane followed by isoeicosane and C13-14 isoparaffin. As an aside, nine of the twenty-five products contained parabens. The author finds these details of interest as BB/CC creams are relatively new to market so are an indication of the trends in mainstream cosmetic products world-wide.

Dimethicones come in a wide variety of viscosities, from 0.65cs to 1m cs. The low viscosity variants are extremely good spreading agents that provide non-tacky semipermeable moisture barriers in skin creams and lotions. High viscosity dimethicones are very substantive, with low spreading qualities that provide a non-greasy skin feel and good pigment dispersion. They are commonly found in association with cyclomethicones where they may be blended to give the exact spreading properties and skin feel required and they are also used with elastomers when cyclic siloxanes are not wanted

Cyclomethicones are volatile silicones that spread readily and provide a soft silky feel to the skin. They have excellent solvent properties and are used to prepare silicone elastomers and to reduce the viscosity and greasy feel of more viscous silicone products. Typical elastomer blends are a mixture of a high molecular weight dimethicone crosspolymer in cyclopentasiloxane or a low molecular weight dimethicone. They contribute a dry smoothness and a light, silky, non-greasy skin feel to anhydrous and water-in-oil (W/O) cosmetics and are often found in antiperspirants and products with a high pigment loading such as sunscreens based on inorganic oxides and in fluid makeup.

A typical silicone elastomer is DC 9546 Silicone Elastomer Blend from Dow Corning comprising cyclopentasiloxane, dimethicone crosspolymer, dimethicone/vinyl dimethicone crosspolymer and dimethiconol that adds increased suspension of antiperspirant salts and reduced volatile silicone fluid

syneresis in antiperspirant and deodorants to its skin feel properties. Another is SeraSnow SP13 from KCC Beauty, which is a 100% active high molecular weight, crosslinked silicone elastomer powder claiming to enhance the skin feel, spreadability, absorption and soft-focus effect of the finished product. It is a crosspolymer of dimethicone and vinyl dimethicone and may be used in dry shampoo formulations to absorb natural oils whilst offering a soft feel. KCC Beauty silicone elastomers are strong mattifying agents for colour cosmetic applications, where their sebum absorbing properties provide a matte, smooth and non-greasy appearance.

Silicone elastomers have such a unique texture that even if cyclomethicones and dimethicones are to be avoided many companies still use silicone-based materials to create the properties desired. Koda markets KP-4726 IDD Gel [INCI: Isododecane, lauryl dimethicone, adipic acid/neopentyl glycol crosspolymer, hydrogenated polyisobutene] that is described as a gel that enhances product spreadability and confers a dry smoothness and light, non-greasy skin feel without the use of cyclomethicone.

Alzo International utilises either isononyl isononanoate or isododecane as the diluent for its range of NuLastic silicone elastomers. An example is NuLastic Surfa D99-9 [INCI: Isononyl isononanoate, bis-vinyldimethicone/PEG-10 dimethicone crosspolymer], which is a translucent gel that creates stable W/O emulsions and may be used to deliver high levels of water and water-soluble actives to the skin. Grant Industries also produces silicone elastomers that are water-compatible: Gransil SiW-026 [\INCI: Cyclopentasiloxane, dimethicone, aqua, polysilicone-11, butylene glycol, decyl glucoside] is a water-coated silicone elastomer dispersion that offers a simple and effective way to load silicone elastomers into water-based formulations.

Koda Corporation supplies a silicone elastomer [SiliDerm 512] comprising dimethicone/vinyl dimethicone crosspolymer in cyclopentasiloxane that is claimed to have a unique stringy texture arising from a deliberate combination of molecular entanglement and crosslinking that forms a polymer with good skin adhesion and long playtime. In O/W emulsions, the dimethicone/vinyl dimethicone crosspolymer expands to occupy the internal space, imparting greater stability to O/W formulations. It is recommended as a constituent of sunscreen products based on inorganic oxides, where it coats the particles imparting slip and lubricity and improves product adhesion and wear resistance.

Silicones are fundamental to many pigmented cosmetics, where their dispersion properties, ease of application, silky after-feel and film-forming attributes make them unique additives. Kobo has taken silicones selected for optimum application properties and supplies ready mixed pigment dispersions in light, medium and dark shades for final colour matching by the customer. According to Kobo, this makes it possible to combine skin protection and colour uniformity with incredible sensory properties in a multifunctional sophisticated product. The pigment loading is between 30 and 35% to be added to emulsions and gels at up to 60% and they impart a soft-focus affect. The principal constituents are iron oxides and titanium dioxide with dimethicone/vinyl dimethicone crosspolymer, disteardimonium hectorite, tocopheryl acetate, isopropyl titanium triisostearate and triethoxysilylethyl polydimethylsiloxyethyl dimethicone with D5 and D6.

Many silicones find use as pigment dispersants: examples are Silsoft 034 Organosilicone Fluid [INCI: Capryl methicone] and Silsoft ETS Trisiloxane [INCI: Ethyl trisiloxane] from Momentive. Silsoft 034 can significantly improve dispersion of inorganic pigments in formulations that contain organic oils. Silsoft ETS is a highly volatile linear siloxane that spreads easily and rapidly and feels dry and light upon application and it also has good pigment dispersal properties. Other materials from

Momentive include Silsoft MM low molecular weight siloxane fluid [INCI: Hexamethyldisiloxane] suggested as a functional replacement for cyclopentasiloxane and Silform Flexible Resin. This is polymethylsilsesquioxane, which dries to leave a soft flexible film on the skin that bestows significant transfer resistance to colour cosmetics.

If silicone-like properties are desired but silicones are not to be used, then Koda offers two possible alternatives: Kodanol D [INCI: Aqua, glycerin, sodium acrylic acid/MA copolymer, butylene glycol, caprylyl glycol, 1,6 hexanediol] and Kodanol P [INCI: Aqua, glycerin, PEG-100/IPDI copolymer, phenoxyethanol, caprylyl glycol, chlorphenesin]. They provide silicone-like aesthetics, spreading evenly on application, leaving a light and pleasant feel without tackiness and are recommended for colour cosmetics, where their film-forming attributes suggests use in long lasting colour cosmetics. When dry, the film formed does not flake, is flexible and pulls the skin tighter.

The focus in providing silicone alternatives has been on the replacement of D4 and D5 and dimethicones but substitutes must provide similar properties to the material being replaced. Dr Straetmans suggests Dermofeel Sensolv [INCI: Isoamyl laurate], which is a polar oil that exhibits excellent solvating power for commonly used UV filters and it has good dispersing properties for inorganic sunscreens and cosmetic pigments. Its low viscosity and surface tension contribute to its silicone-like sensorial profile. Similar claims are made by Stearinere Dubois for its DUB 810C [INCI: Coco caprylate/caprate] that is said to improve skin hydrating and to extend the wear and water-proof properties of makeup. DUB Zenoate [INCI: Propanediol dicaprate] with its pigment dispersing properties and silken skin feel is offered as an alternative to cyclomethicones in sun care and colour cosmetics.

If looking for silicone alternatives, then ingredients claiming natural origin and to be environmentally friendly are a bonus. Amedeo Brasca is an Italian company that prides itself that all its product lines and technologies focus on people safety and environmental preservation. It has recently launched a new line of Celus-Bi biodegradable esters obtained through an innovative process from European crops. Celus-Bi Silky Ester [INCI: Neopentyl glycol dicapelargonate] provides a soft and silky skin feel with emollient properties and good absorption and is offered as a natural alternative to cyclopentasiloxane and to synthetic esters such as C12-15 alkyl benzoate and isononyl isononanoate.

Starting with castor oil Cosphatec has produced Cosphaderm Touch [INCI: Heptyl undecylenate] that has an extremely light and dry character, making it a natural alternative to synthetic fluids such as cyclomethicone and mineral oils. The Emogreen range from Seppic comprises Emogreen L15 and Emogreen L19; both are C15-C19 alkane from renewable sources; are non-polar and stable at extremes of pH and in the presence of oxidising or reducing agents, varying only in their viscosities. Emogreen L15 with a viscosity of 4.5 mPa.s imparts a fresh and gliding sensation with a powdery after feel and is offered as an alternative to volatile cyclomethicone whereas the higher viscosity L19 variant leaves a soft finish similar to dimethicone. Seppic also produces several biodegradable non-polar alkanes under its Emosmart trade name that find application in colour cosmetics.

Finding application in antiperspirants and decorative makeup are the Puresters from Phoenix, which include Purester 24 [INCI: Lauryl laurate]; Purester 34 [INCI: Stearyl palmitate] and Purester 40, which is stearyl behenate. They are described as functional emollients that improve gloss and whiteness in creams and impart substantivity and enhanced payoff in lipsticks and antiperspirants. Phoenix Chemicals has also developed 100% vegetable derived ester replacements for dimethicone fluids that have improved solubility characteristics and higher refractive indices compared to the corresponding silicone products.

TRADE NAME	INCI NAME (PROPOSED)	To Replace
Pelemol SR-20	Coco-caprylate/caprate, trioctyldodecyl citrate	Dimethicone 20cst
Pelemol SR-100	Coco-caprylate/caprate, dimer dilinoleyl dimer dilinoleate	Dimethicone 100cst
Pelemol SR-350	Coco-caprylate/caprate, dimer dilinoleyl dimer dilinoleate	Dimethicone 350cst
Pelemol SR-1000	Coco-caprylate/caprate, dimer dilinoleyl dimer dilinoleate	Dimethicone 1000cst

Bionat Consult uses olive oil as its source material for Polyssan O [INCI: Olea europea (Olive) fruit oil, Olea europea (Olive) fruit oil glyceryl oleate] offered as an alternative to dimethicone It is particularly interesting for its ability to disperse pigments and mineral sunscreens, which is due to the amphiphilic structure of the glyceryl oleate. It exhibits a rich shine and is recommended for lip glosses and lipsticks.

Neossance Hemisqualane [INCI: C13-15 alkane] is a light emollient from Amyris derived from a renewable source of plant sugar. With high spreadability and a great sensorial profile it is a natural alternative for petroleum based paraffin and silicone ingredients. It is recommended for hair care applications and protects hair from colour degradation when used at 5% and at 2% to prevent damage from hot styling tools. Descriptions of cyclomethicones and low viscosity silicone fluids invariably claim that they are emollient with excellent spreading characteristics and a non-oily skin feel. These descriptors are applied by Cremer Care to its Miglyol 880 [INCI: Butylene glycol dicaprylate/dicaprate]. It is a polar ester based on 1,3-butanediol and caprylic/capric fatty acids derived from coconut and palm kernel oil that is saturated and non-oxidising and is recommended as a silicone replacement in facial foundations. A similar material from Cremer Care is CremerCOOR PPG 810 [INCI: Propylene glycol dicaprylate/dicaprate] that has good pigment dispersing properties and is used in lipsticks and foundations.

An alternative to silicone elastomers is Ecogel from Lucas Meyer Cosmetics. It is an optimised combination of lysolecithin, sclerotium gum, xanthan gum and pullulan derived from a green process contributing to the sustainable preservation of the environment. It is described as the first natural phospholipid-based gelling-emulsifying agent on the market for the creation of natural gel-creams with an ultra-soft silicone-like skin feel.

Another polymer with silicone elastomer-like properties and sensory attributes is Polymatrix 12AP from Koda. It is described as s highly crosslinked polyacrylate dispersed in a moisturising, lubricious polyol/copolymer blend of sodium acrylates/vinyl alcohol copolymer with sodium acrylic acid/MA copolymer in a solution of water, glycerin, caprylyl glycol and 1,2 hexanediol. It is claimed that, like silicone gels, the dispersed, hydrated particles perform like polymeric ball bearings, imparting cushion and slip.

In summary, it does appear that despite resistance to silicones in some quarters the flexible functional and sensory capabilities of silicones are hard to reproduce and they will be used in cosmetics for a long time to come.

NOTE: INCI listings mention the principal ingredients but for full disclosure those interested should contact the supplier.