

## Silicones and alternatives 2016

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Cyclomethicone is the generic name for the two most commonly used siloxanes found in cosmetics, which have the INCI names cyclotetrasiloxane (D4) and cyclopentasiloxane (D5) and in this article they will be referred to simply as D4 and D5.

Although repeated safety assessments have shown that D4 and D5 do not pose a risk for human health when used in cosmetic products environmental concerns have led to D4 being phased out in most major markets and in July 2015 a proposed restriction report was published in the UK [Ref 1]. The restriction is that D4 and D5 shall not be placed on the market or used in concentrations equal to or greater than 0.1% by weight of each in personal care products that are washed off in normal use conditions. This proposal was raised under REACH and for more information on cyclomethicones readers are urged to visit <http://www.cyclosiloxanes.org/>

Cyclomethicones found extensive use in personal care products, particularly in deodorants and antiperspirants but also in colour cosmetics because of their pigment wetting and dispersing properties and skin feel after application. With continued uncertainty about their future there have been many alternatives proposed for their replacement. **Dr Straetmans** suggests Dermofeel Sensolv [INCI: Isoamyl laurate] as a low viscosity polar oil with excellent ability to disperse pigments that combines good spreading properties with a pleasant skin feel.

**Dr Straetmans** also recommends Dermosoft GMCY [INCI: Glyceryl caprylate], which has a positive effect on pigment dispersion, improves the payload of pigmented products and aids the colour intensity and shine of lipsticks. Glyceryl caprylate also has antimicrobial properties and it appears in Dermosoft MCA Variante [INCI: Caprylyl glycol, dipropylene glycol, glyceryl caprylate], which is claimed to speed up pigment dispersion times, intensify colour and increase the homogeneity of pigments in the oil phase.

If hoping to replace cyclomethicones with a material from natural renewable resources **Gova** suggests Gosulin IL [INCI: Isoamyl laurate, isoamyl cocoate]. It has pigment wetting properties and, because of its volatility, it shows similar skin feel characteristics to D4 and D5. Beantree-A [INCI: Methylheptyl isostearate] is offered as a natural alternative to cyclomethicones by **Alzo International**. It has similar dry feel and rapid evaporation properties to D5 and has good pigment wetting, dispersing and spreading attributes.

**Alban Muller International** is promoting Lipolami ER [INCI: Silybum marianum ethyl ester] as an environmentally responsible alternative to volatile silicones, which unlike silicones, also functions to help the skin's natural barrier. It is obtained from milk thistle (Silybum marianum) oil by a process of transesterification and a presentation about its properties shows it to be comparable to D4/D5 when

## Silicones and alternatives 2016

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used to disperse pigments and sunscreens. Its very low viscosity and excellent spreading properties contribute to the pleasant skin feel imparted to skin care and colour cosmetics.

Staying with the natural theme **Berg and Schmidt** have introduced Bergacare FG5 [INCI: Ethyl hexyl palmitate, ethyl hexyl stearate, hydrogenated olive oil unsaponifiables, caprylic/capric triglyceride]. This blend, based on renewable vegetable sources, is described as a low-viscosity, transparent and odourless liquid resulting from a carefully chosen combination of precisely dosed natural ingredients and is said to provide a sensory performance very close to D5.

The properties of D4 and D5 that make them such desirable ingredients in personal care are their dry feel; their volatility that provides a light and silky skin texture; their pigment wetting and dispersing properties and their compatibility with other silicone compounds. As we have already seen suggested substitutes are mostly light and volatile esters and Neolight 100P [INCI: Isodecyl neopentanoate] from **Kokyo Alcohol Kogyo** (KAK) of Japan and Miglyol 8810 [INCI: Butylene glycol dicaprylate/dicaprate] and CremerCOOR PPG 810 [Propylene glycol dicaprylate/dicaprate] from **Cremer Care** are further examples.

**Croda** markets Crodamol STS [INCI: PPG-3 benzyl ether myristate], said to have a silicone-like feel and pigment wetting properties allied with a high refractive index that makes it ideal for lipsticks and lip gloss. The ability to disperse pigments is an important factor in colour cosmetic formulations and Crodamol SFX [INCI: PPG-3 benzyl ether ethylhexanoate] is shown to offer similar sensory benefits to D5 with the added benefit of pigment wetting.

Not all alternatives are esters and the Aphaflow range of hydrogenated polydecenes from the **Innovation Company** are claimed to be excellent emollients with high pigment wetting capacity that allow maximum colour development. Alphaflows provide softness and lubricity to formulations and can also be used as binders in powder applications. CremerCOOR MCT27 [INCI: Triheptanoin] from **Cremer Care** is an emollient that shows excellent dissolving properties for sunscreens and dispersing properties for pigments and imparts a light, non-oily, smooth and velvet skin sensation. Smart 5 is a mixture of isododecane and hydrogenated tetradecenyl/methylpentadecene developed as a multifunctional replacement for volatile silicones by **IMCD**. It has similar spreading properties and a comparable vapour pressure to D5, ensuring a silky, dry skin feel on application.

Arlamol LST from **Croda** is PPG-3 isostearyl methyl ether with pigment wetting and dispersing properties and the ability to quickly spread on the skin and it confers a pleasant emolliency to anhydrous products such as lipstick. Croda suggests that it be used with Cromollient DP3A [INCI: Di-

## Silicones and alternatives 2016

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John Woodruff

PPG-3 myristyl ether adipate] for pigment wetting to deliver even coverage and a smooth appearance to skin from liquid foundations.

Silwax D02 from **Siltech** is a low carbon alkyl methicone that can be used as a direct replacement for D4 or D5 in various cosmetic products. A novel use of Silwax D02 is blending 5% of it into a natural oil such as soybean, safflower or olive oil. Because of Silwax D02's unique ability to reduce the surface tension of such natural oils the resulting product has a similar feel to cyclomethicones. It is particularly useful for formulating antiperspirant sticks and other products where the use of cyclomethicone is traditionally very high.

Silicones find extensive application in sunscreen products because of their solvent properties for organic UV absorbers and ability to disperse inorganic screens plus they add water-resistant properties to the final composition. The majority of alternative materials suggested for pigment dispersion will also disperse inorganic absorbers and add emolliency and pleasant sensorial properties to the finished product. Most also show excellent solvent properties for organic UV absorbers.

Providing water-resistance without the use of silicones is the claim for Cosmosurf DDG-28 [INCI: Dodecylhexadecyl propane diol/dimer dilinoleate copolymer] from **Siltech**. Derived from natural raw materials it is said to provide outstanding skin aesthetics, barrier properties and film formation plus water resistance properties to sun care formulations. **Siltech** also provides CosmoSurf CE-100HV [INCI: Polyoctyldodecyl propyl citrate] as a naturally derived polyester that performs exceptionally well as a binder for pressed powder make-up such as eye shadows.

Although the emphasis has been on finding alternatives to cyclomethicones some companies wish to avoid silicones altogether. **Phoenix Chemicals** have developed a number of alternatives to dimethicone fluids that are both REACH and China compliant. They are available as a range of materials under the Perlomol trade name and three comprise different ratios of coco-caprylate/caprinate and dimer dilinoleyl dimer dilinoleate in order to provide differing viscosities while the fourth is a mixture of coco-caprylate and trioctyldodecyl citrate. They are said to have improved solubility characteristics and higher refractive indices compared to the corresponding silicone products.

Coco-caprylate is a favourite when looking at vegetable-based alternatives to silicones and it appears in Plantasens LD-SP-Eco with hydrogenated olive oil saponifiables from **Clariant**. **Inolex** has also proposed a series of alternative materials to dimethicone fluids of varying viscosities. They are available under its Lexfeel trade name and are a combination of diheptyl succinate and capryloyl

## Silicones and alternatives 2016

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glycerin/sebacic acid copolymer. They are from 100% renewable resources and are said to be better at wetting and dispersing pigments than the corresponding dimethicone.

**Ajinomoto** emollients arose out of research into amino acids and the mechanisms of skin moisturisation. Eldew PS-203 [INCI: Phytosteryl/octyldodecyl lauroyl glutamate] is an emollient that helps skin recover its ability to retain moisture and research by Ajinomoto confirmed that it forms lamella liquid crystals identical to ceramide. It was also found to be an excellent dispersing aid for pigments and is particularly recommended for makeup products such as foundations and lipsticks.

Real or imagined environmental concerns are the driving forces behind finding alternatives to silicones but they continue to provide unique properties that are very difficult to reproduce using non-silicone chemistry. Providing a non-greasy, non-sticky flexible film to the skin is one of those areas and a presentation by **Dow Corning** on film forming entitled Infinite Beauty discusses market trends and the role of film forming in detail. A cosmetically acceptable film-former is defined as a polymer capable of forming a cohesive and continuous film on a solid surface with optimal adhesion and flexibility properties.

**Dow Corning** markets a number of silicone-based film forming polymers and the presentation discusses their various properties such as water repellence, sebum repellence, permeability to water vapour and the integrity, durability and flexibility of the film. Its latest introduction is DC FC-5002 IDD Resin Gum, which is a mixture of trimethylsiloxysilicate with dimethiconol crosspolymer in isododecane. It is described as a new type of film-former designed to form highly flexible and breathable films for improved comfort and to offer long-lasting properties with excellent water repellence and transfer resistance for colour cosmetics applications.

From **Wacker Silicones** Belsil REG 1100 resin elastomer gel is a non-emulsifying silicone copolymer network blended with a non-volatile, low viscosity dimethicone. It is a transparent gel, which provides a very pleasant sensory property both during and after application and it can act as a thickener in formulations while delivering a smooth application. It exhibits shear-thinning behaviour that allows cosmetic products to spread easily and facilitates the incorporation of pigments into a formulation.

**Nusil** offers silicone elastomer gels under its Caresil trade mark that are based on the rheological properties of dimethicone/vinyl dimethicone crosspolymer when combined with cyclopentasiloxane and/or dimethicone to give gels of differing viscosity. The Caresil trade name is also used for two encapsulated silicone materials. Caresil CES-1104 is an elastomer gel with mattifying properties and CFF-3401 is a fluorosilicone that gives a velvety and long lasting feel to cosmetic products.

## Silicones and alternatives 2016

1<sup>st</sup> published SPC 2016

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Velvesil Mul-T-Gel [INCI: Caprylyl methicone, boron nitride, C30-45 alkyl cetearyl dimethicone crosspolymer] from **Momentive Performance Materials** is described as a highly versatile material that combines the translucent soft-focus ability of boron nitride with the powdery, velvety touch of patented Velvesil chemistry. The addition of a spreading agent greatly improves the dispersion of boron nitride within the gel matrix for a more natural-looking, even-tone skin finish.

Bis-carboxydecyl dimethicone is available from **Momentive** as Silform INX. It is an acidic material that requires neutralising to pH 7 – 9 to create a film-forming ingredient that is claimed to enhance transfer resistance, shine and moisturising properties in colour cosmetics. Also from **Momentive**, Silform Flexible Resin [INCI: Polymethylsilsesquioxane] provides a soft and flexible film that mimics skin movement and feel and imparts exceptional transfer-resistant properties to colour cosmetics.

Silicones can impart a perception of softness on the user's skin and **Health & Beauty Solutions (HBS)** favours Polytrap 6035 as a means of extending the availability of the silicone on the skin after application. It is provided in powder form as lauryl methacrylate/glycol dimethacrylate crosspolymer loaded with cyclomethicone. On application cyclomethicone is released and the particles broken down by friction. The remaining polymer particles have the ability to adsorb excess skin oils, thus providing extended use benefits such as long lasting colour in lipsticks and facial make-ups and shine reduction in facial cleansers, moisturisers, and treatment products. **HBS** specialises in providing sustained release from polymer particles under its Poly-Pore, Microsponge and Macrobeads trade names.

Generally water and silicones don't mix but by utilising water-coated silicone technology **Grant Industries** supply Gransil SiW elastomer gels that offer formulators the opportunity for loading high levels of Polysilicone-11 elastomer into water-based gel structures. Requiring less than 0.5% emulsifier, stable formulations are achieved that also serve as excellent delivery vehicles for active ingredients. New to the range are Gransil SiW-MQIZ [INCI: Isododecane, trimethylsiloxysilicate, aqua/water, propanediol, decyl glucoside] and Gransil SiW-GVL [INCI: Coconut alkanes, polysilicone-11, aqua/water, butylene glycol, polysorbate 20, decyl glucoside].

Whether used as a replacement for cyclomethicones in combination with less controversial silicone materials or as a major ingredient in silicone-free compositions isododecane is the most frequently recommended material and appears in many of the mixtures described above. Gelled version are available from **Calumet** as Versagel MD 1600 and MD 500 and both are mixtures of ethylene/propylene/styrene copolymer and butylene/ethylene/styrene copolymer in isododecane.

## Silicones and alternatives 2016

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They are designed to deliver pigments for lipsticks and mascaras and for any application that requires quick set-up and fast-drying anhydrous systems.

**Elementis** also supply a gelled version of isododecane; in this instance utilising disteardimonium hectorite and propylene carbonate to provide a smooth after feel and a pleasant residual silkiness on the skin, masking greasy or tacky components. It has suspending and dispersing properties and its thixotropic flow behaviour ensures that products like foundation creams spread readily and evenly on the skin.

Ref 1 Health & Safety Executive, Redgrave Court, Bootle, Merseyside L20 7HS United Kingdom

NOTE: Only the principal ingredients are listed by their INCI names in mixtures and those interested are urged to contact the suppliers for further information.

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**[www.creative-developments.co.uk](http://www.creative-developments.co.uk)**