Masking Wrinkles and Enhancing Skin Feel with Silicone Elastomer Powder

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ABSTRACT: *The authors describe a silica-coated silicone elastomer powder that can be incorporated into skin care and color cosmetic applications for wrinkle-masking and sebum control properties, as well as to create novel textures and sensory characteristics.*

In today's competitive personal care market, consumers look for products that provide superior aesthetics and improve the skin's appearance. Sensory effects and antiaging benefits are more frequently being touted in color cosmetics, especially foundations and lipsticks. The demands of the aging baby boomer generation for products that retain youthfulness continue to drive the premium skin care market. In response, formulators strive to create products that are multifunctional, easy-to-use and effective in small quantities.

At the same time, products must deliver benefits that stand out from similar products—for example, creams must be easy-to-spread; leave a silky, smooth film on skin; and reduce the appearance of fine lines, often with a matte appearance. The current purchase pattern suggests that products claiming to counteract or mask the signs of aging in a gentle, believable way will continue to capture the interest of consumers.

Silicones have been used in skin care for more than 20 years. They are known for their emolliency, wetting, spreading characteristics and ability to reduce tackiness. Silicone elastomers are among the newest performance-enhancing ingredients in this category.

A Next-Generation Silicone Elastomer

Silicone elastomers for personal care applications were first developed in Japan.[1] The original material was an elastomer powder prepared by cryogenic grinding of cured silicone elastomer. Several years later, a commercial powder, dimethicone/vinyl dimethicone crosspolymer, was made by suspension polymerization[a]; elastomer pastes composed of silicone elastomers swollen by solvents such as cyclomethicone followed. Today, a wide variety of silicone elastomers are available.

> The aesthetics of silicone elastomers and their ability to absorb various oils and sebum are the two most important properties.

Silicone elastomers differ from linear silicone polymers because of cross-linking.[1] Many silicone elastomers are made from linear silicone polymers that have reactive sites along their polymer chain. These sites react with the cross-linker to form connections between the linear polymer chains.

The suspension polymerization process used to form silicone elastomer powder begins with an aqueous emulsion of the dimethicone polymer, with its reactive sites, and a cross-linker. This suspension typically has a droplet size of less than 5 µm and usually is stabilized with a small amount of surfactant. Adding a catalyst such as platinum initiates cross-linking, and heating drives the reaction to completion. This cross-linking process changes the liquid droplets into small, spherical particles of silicone elastomer that can be spray-dried to produce a powder.

Silicone elastomers have a different feel on the skin than silicone fluids and have been described as dry, smooth, silky and powdery. The shape of the elastomer particles also affects their sensory properties. Because they are spherical, the particles have a ball-bearing effect when spread on the skin that produces a dry, lubricating feel.

In skin care applications, the aesthetics of silicone elastomers and their ability to absorb various oils and sebum are the two most important properties. Among the newest of these materials is a silicone elastomer cosmetic powder[b] that consists of silicone elastomer spheres coated with silica.

In addition to its ability to absorb sebum, this elastomer powder has been shown to provide wrinkle-masking benefits and impart rec-

[a] *Dow Corning 9506 Powder is a product of Dow Corning Toray, Chiba, Japan.*

[b] *Dow Corning 9701 Cosmetic Powder (INCI: Dimethicone/vinyl dimethicone crosspolymer (and) silica) is a product of Dow Corning Toray, Chiba, Japan.*

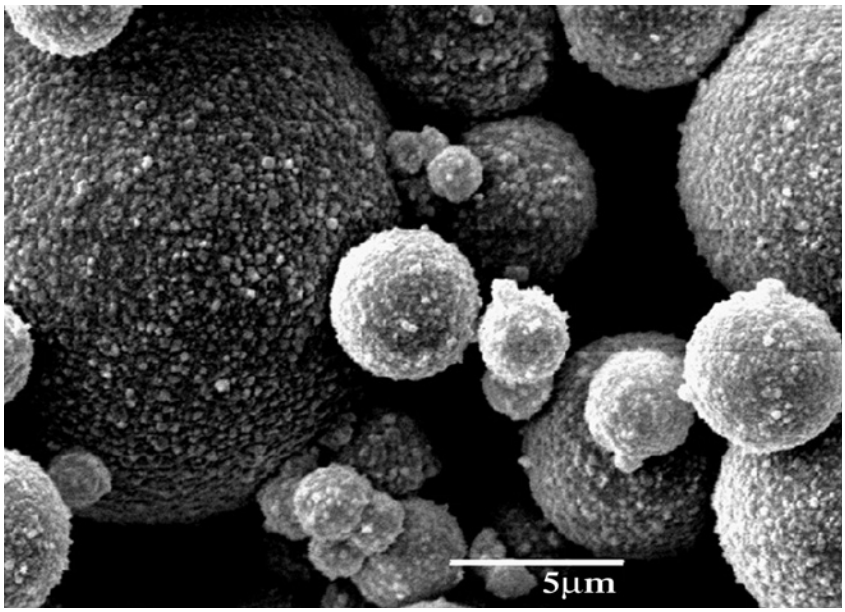

Figure 1. The elastomer powder is formed from silicone elastomer spheres coated with smaller silica particles. (SEM image courtesy of and copyright by LVMH Labs.)

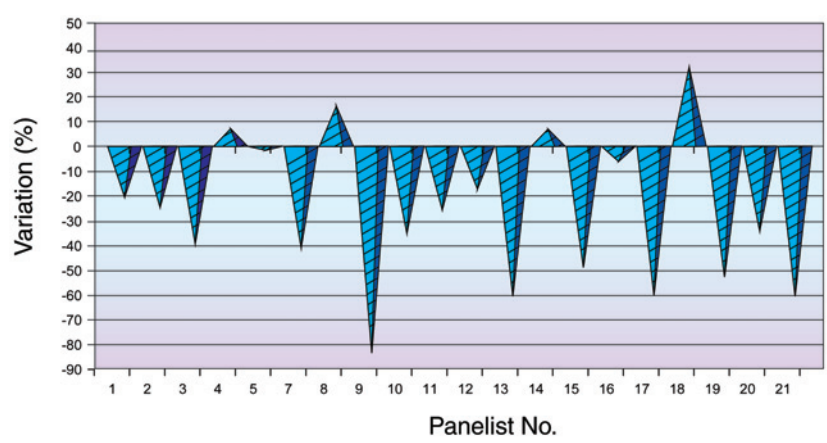

Figure 2. Results of wrinkle-masking evaluations

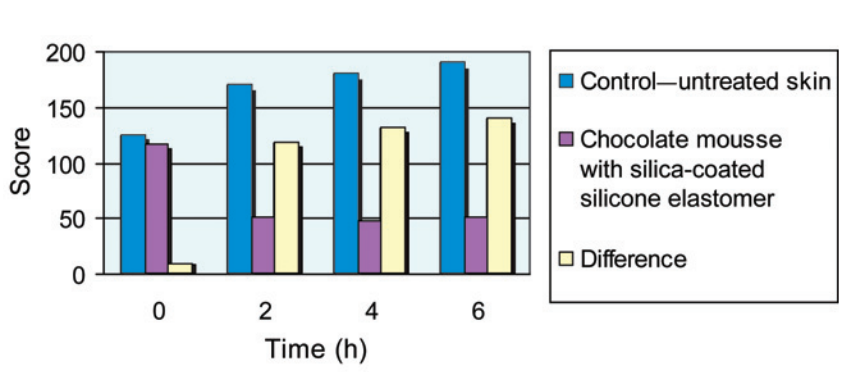

Figure 4. Results from sebum meter measurements using a chocolate mousse formulation (Formula 2) containing the elastomer powder

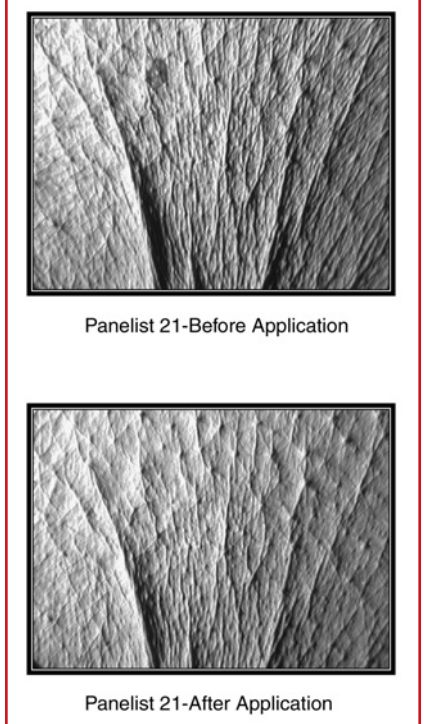

Figure 3. W/S cream with 4% silicone elastomer powder, showing improvement of crow's-feet wrinkles; above, before treatment; below, 1 h after treatment (panelist 21 from Figure 2).

ognized silicone aesthetics. The spherical structure gives the powder free-flowing properties without agglomeration and makes it possible to incorporate the material into a range of formulations, including hydrogels, without the need for processes or equipment. **Figure 1** illustrates the structure of the spheres, with an average particle size of 1–10 µm.

A Multifunctional Material

The versatile properties of the powder can be used to create novel products for the premium skin care market.

Wrinkle-masking: Evaluations of the immediate wrinkle-masking effect of this material were conducted in vivo based on a documented internal protocol.[2] Twenty-one panelists were treated with a skin care formulation containing 4% and 10% of the silicone elastomer cosmetic powder applied directly to the skin. A print of each panelist's crow's-feet was taken before and one hour after treatment. Then prints were compared by image

Formula 1. Water/Silicone (W/S) Skin Cream

A.	Dimethicone/vinyldimethicone crosspolymer (and) silica (DC 9701 Cosmetic Powder, Dow Corning)	4.0%w/w
	Cyclopentasiloxane (and) PEG/PPG-18/18 dimethicone (DC 5225C Formulation Aid, Dow Corning)	10.0
	Cyclopentasiloxane (DC 245 Fluid, Dow Corning)	16.0
	PPG-3 myristyl ether (Promyristyl PM-3, Croda Inc.)	0.5
B.	Water *(aqua)*	qs to 100.0
	Glycerin	5.0
	Sodium chloride	2.0
	Propylene glycol (and) diazolidinyl urea (and) methylparaben (and) Propylparaben (Germaben II, ISP)	0.5
		100.0

Procedure: Combine A. In a separate container, combine B. Slowly add B to A with strong mixing. Homogenize using a high-shear mixer (Ultra-Turrax or Silverson type).

analysis[c] and showed the immediate smoothing effect of the elastomer powder.

Results indicated a lifting effect on panelists' crow's-feet and an immediate improvement of the skin's appearance. The most efficient formula tested was a prototype w/s cream containing 4% elastomer powder (**Formula 1**).

The same formula containing 10% elastomer powder did not show additional improvement in the appearance of the crow's-feet. **Figure 2** on Page 66 shows the results of the wrinkle-masking evaluations. An improvement of wrinkles up to 84% occurred for 75% of the subjects, with a significant total mean decrease of 28% ($p<0.01$) for the panelists shown on the graph.

Figure 3 on Page 66 shows the results of treatment for crow's-feet with the w/s skin cream in **Formula 1**.

Sebum control: The powder is a cross-linked polymer that swells as it comes into contact with oils, entrapping them. This ability of silicone elastomers to absorb oils other than silicones has led to their applications as oil control ingredients in facial products. The absorption mechanism also can be useful for its mattifying effect on the skin. The evaluation in **Figure 4** on Page 66, was performed using the chocolate mousse formulation in **Formula 2** on Page 70. The silica-coated elastomer powder exhibited good sebum-absorption properties.

Absorption capacity: In addition to its ability to absorb sebum, the silica-coated elastomer can absorb significant amounts of fluids. The

[c] *The image analyzer used is a device of BioHC.*

presence of the silica coating on the surface of the elastomer spheres does not negatively impact absorption ability compared to silicone elastomer without the coating. **Table 1** summarizes the absorption capacity for several fluids.

Shear-thinning: The silicone elastomer powder has useful shear-thinning properties, as illustrated in **Figure 5** on Page 70. The shear-thinning properties of the gel foundation in **Formula 3** on Page 72, which has a high viscosity, allow the use of a pump dispenser. The thick, creamy gel transforms to a fluid-like texture and is easy to spread for good skin coverage and an even skin tone. The foundation incorporates the elastomer powder in combination with a silicone polyether emulsifier.

Enhanced viscosity: Because of their ability to swell when mixed with solvents, silicone elastomers are recognized as effective oil-phase thickeners. Compared to other organic powders, silicone elastomer powder shows superior viscosity enhancement based on the same use level of powder in the same formulation. For example, a w/s cream, incorporating 5% silicone elastomer powder, enhanced viscosity by approximately 33% over a control formulation without the elastomer powder.

Table 1: Absorption Capacity of Fluids (g fluid/1 g powder)

Ingredient	Dimethicone/vinyl dimethicone crosspolymer (and) silica	Dimethicone/vinyl dimethicone crosspolymer
Water (*aqua*)	1.18	1.50
Ethanol	1.08	1.30
Dimethicone (and) trisiloxane	3.54	5.56
Cyclopentasiloxane	4.10	6.30
Cyclohexasiloxane	3.92	6.20
Dimethicone, 5 cSt	2.98	4.74
Isododecane	3.12	5.00
Paraffinum liquidum (mineral) oil	1.48	1.97

Formula 2. Chocolate Mousse

A.	CI 77891 dimethicone (SAT-T-47051, US Cosmetics Corp.)	0.528%w/w
	CI 77491 dimethicone (SAT-R-33128, US Cosmetics Corp.)	0.456
	CI 77492 dimethicone (SAT-Y-338073, US Cosmetics Corp.)	0.732
	CI 77499 dimethicone (SAT-B-33134, US Cosmetics Corp.)	0.284
B.	Dimethicone/vinyl dimethicone crosspolymer (and) silica (DC 9701 Cosmetic Powder, Dow Corning)	23.000
	Zinc oxide (and) dimethicone (Z-Cote HP-1, BASF Corp.)	6.000
C.	Water (*aqua*)	4.000
	Water (and) propylene glycol (and) *Helianthus annuus* (sunflower) seed oil (and) *Theobroma cacao* (cocoa) extract (and) sclerotium gum (Cocoa Phytolait, Alban Muller International)	1.000
	Dimethicone (DC 200 Fluid, 5 cSt, Dow Corning)	22.750
	Cyclopentasiloxane (DC 245 Fluid, Dow Corning)	22.750
	Cyclopentasiloxane (and) dimethiconol (DC 1501 Fluid, Dow Corning)	5.000
	Cyclopentasiloxane (and) dimethicone crosspolymer (and) dimethicone/vinyl dimethicone crosspolymer (and) dimethiconol (DC 9546 Silicone Elastomer Blend, Dow Corning)	5.000
	Theobroma cacao (cocoa) seed butter (Cocoa Butter, Alban Muller International)	1.000
	Cocos nucifera (coconut) oil (and) *Gardenia tahitensis* flower extract (Monoï de Tahiti Butter-fragranced, Pacific Sud Cosmétique)	1.000
	Tocopherol acetate (dl-alpha-Tocopheryl Acetate, DSM Nutritional Products)	0.500
	Polysilicone-15 (Parsol-SLX, DSM Nutritional Products)	5.000
D.	Fragrance (*parfum*) (Chocolat Crème 0310585, Expressions Parfumées)	1.000
		100.000

Procedure: Grind A together. Combine A and B in a covered vessel and mix with high-speed dispersing action until uniform. As a safety precaution when making larger quantities, use nitrogen gas to make the head space of the mixer inert. Add C to the main mixing vessel and heat with mixing to 45°C, or until melted and uniform. Add AB to the mixer in increments. Good scraping and high-speed dispersing action is recommended. Add D.

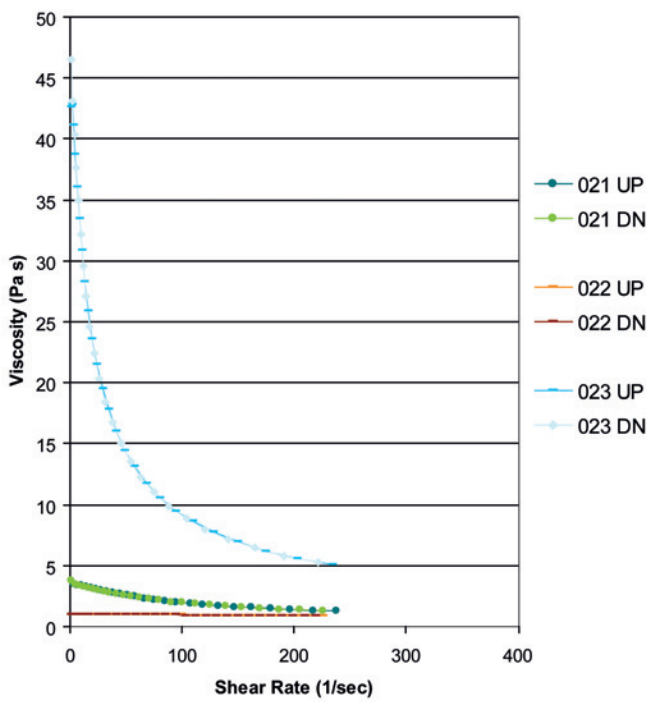

Figure 5. Shear-thinning properties of gel foundation formulation.
021 = gel foundation without silica-coated silicone elastomer powder
022 = gel foundation without water
023 = gel foundation containing 7.1% silica-coated silicone elastomer powder

New Sensory Effects and Product Forms

The silicone elastomer powder can provide sensory benefits and novel textures while remaining cost-effective because low levels are required to impart sensory effects. Triangular sensory testing and threshold testing were conducted comparing formulations with and without the powder. Based on the prototype w/s system (**Formula 1**), the required use level was 4%, and for the prototype hydrogel formulation, 3% (**Formula 6** on Page 74). In a s/w formulation that incorporated an organic co-emulsifier, the required use level was 3%, and when using silicone as a co-emulsifier the required use level was 2%.

Products claiming to counteract or mask the signs of aging in a gentle, believable way will continue to capture the interest of consumers.

The addition of the elastomer powder to a prototype s/w cream using PEG-12 dimethicone[c], a silicone polyether, as an emulsifier resulted in decreased gloss on the skin when compared to the same formulation without the powder. (See **Figures 6** on Page 72 and **7** on Page 74.)

After absorption, the formula with the silicone elastomer resulted in decreased tackiness, greasiness and slippery feel as well as a significant improvement in the powdery feel of the product.

Perfume in a powder form: With its ability to absorb high levels of fluids, the elastomer powder offers a new approach to delivering perfume. **Formula 4** on Page 74 combines fragrance with a novel sensory effect

[c]*Dow Corning 5329 Performance Modifier is a product of Dow Corning Corporation, Midland, Mich., USA.*

Formula 3. Gel Foundation

A. Cyclopentasiloxane (DC 245 Fluid, Dow Corning)	38.43% w/w
Lauryl PEG/PPG-18/18 methicone (DC 5200 Formulation Aid, Dow Corning)	1.50
Cyclopentasiloxane (and) dimethicone copolyol (DC BY 11-030, Dow Corning)	23.50
Dimethicone (and) trisiloxane (DC 2-1184 Fluid, Dow Corning)	7.60
Isononyl isononanoate (Isononyl Isononanoate, LCW Sensient)	7.60
Phenoxyethanol (and) methylparaben (and) ethylparaben (and) butylparaben (and) isobutylparaben (and) propylparaben (Dekaben, Jan Dekker)	0.30
B. CI 77499 (and) triethoxycaprylylsilane (Unipure Black LC 989 AS-EM, LCW Sensient)	0.20
CI 77891 (and) triethoxycaprylylsilane (Unipure White LC 981 AS-EM, LCW Sensient)	4.40
CI 77492 (and) triethoxycaprylylsilane (Unipure Yellow LC 182 AS-EM, LCW Sensient)	0.90
CI 77491 (and) triethoxycaprylylsilane (Unipure Red LC 381 AS-EM, LCW Sensient)	0.40
Cyclopentasiloxane (DC 245 Fluid, Dow Corning)	5.90
C. Dimethicone/vinyl dimethicone crosspolymer (and) silica (DC 9701 Cosmetic Powder, Dow Corning)	7.10
Mica (and) iron oxides (and) titanium dioxide (Lumiral, LCW Sensient)	0.50
Silica dimethyl silylate (Covasilic 15, LCW Sensient	1.00
D. Water (*aqua*)	0.67
	100.00

Procedure: Combine and mix A until completely dissolved. Premix pigments of B in cyclomethicone using Ultra-Turrax. Homogenize until uniform. Add B to A and homogenize. Combine and mix C. Add C to AB, slowly and with turbulent mixing. Continue to stir for 1 h at 1400 rpm. Homogenize using high-shear mixer. Add D with stirring, and reduce stirring speed (viscosity will rapidly increase). Continue to stir for additional 5–10 min. Final viscosity is approx 35,000 to 40,000 cps (Spn, 20 rpm).

in the form of a light, yet absorbent powder perfume. The elastomer powder can also be used to deliver glitter and fragrance for a shimmering and silky effect on skin.

Innovative color cosmetic formulations: The primary ingredients in **Formula 5** on Page 74 are silicone elastomer powder and pigments. The free-flowing and nonagglomeration properties of the silicone elastomer make it possible to create a tinted body powder with the elastomer's distinctive silky aesthetics. In this formulation, the powder is directly ground with the pigments.

Elastomer particles provide a ball-bearing effect when spread on the skin.

Formula 6 is a foundation with a texture similar to that of a "chocolate mousse," where, in addition to the original texture, the elastomer powder provides sebum-absorption properties illustrated in **Figure 4**. This tinted cream formulation has the texture, color and aroma of chocolate mousse.

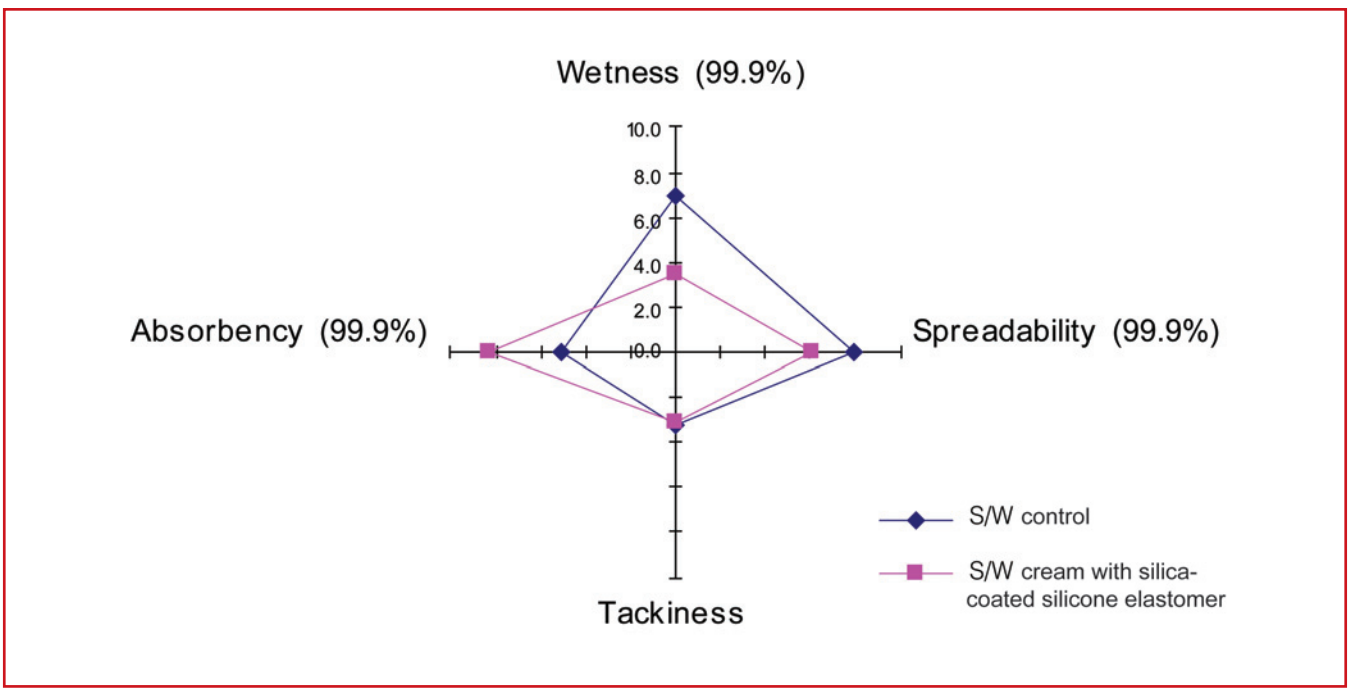

Figure 6. Sensory profile of s/w cream before absorption

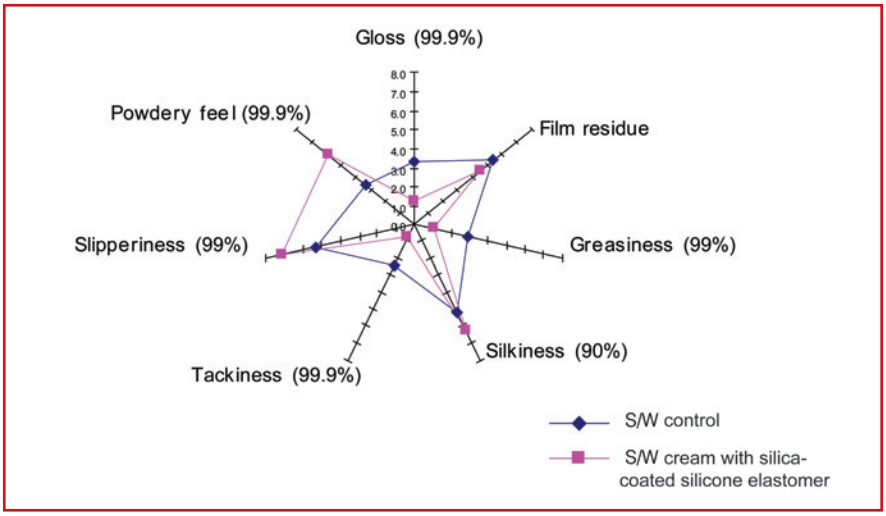

Figure 7. Sensory profile of s/w cream after absorption

Formula 4. Perfume powder

Dimethicone/vinyl dimethicone crosspolymer (and) silica (DC 9701 Cosmetic Powder, Dow Corning)	88.0% w/w
Fragrance (*parfum*) (CelineCe, Symrise)	10.0
Calcium sodium borosilicate (and) titanium dioxide (Reflecks Pinpoints of Pearl, Engelhard Corp.)	2.0
	100.0

Procedure: Mix at RT with an appropriate blender.

Formula 5. Tinted Body Powder

CI 77891 dimethicone (SAT-T-47051, US Cosmetics Corp.)	13.43% w/w
CI 77491 dimethicone (SAT-R-33128, US Cosmetics Corp.)	0.97
CI 77492 dimethicone (SAT-Y-338073, US Cosmetics Corp.)	2.43
CI 77499 dimethicone (SAT-B-33134, US Cosmetics Corp.)	0.17
Dimethicone/vinyl dimethicone crosspolymer (DC 9506 Powder, Dow Corning)	17.00
Dimethicone/vinyl dimethicone crosspolymer (and) silica (DC 9701 Cosmetic Powder, Dow Corning)	34.00
Fragrance (*parfum*) (Coconut Paradise, Symrise)	2.50
Fragrance (*parfum*) (Vanilla, Expressions Parfumées)	2.50
Cyclopentasiloxane (DC 245 Fluid, Dow Corning)	25.00
Calcium sodium borosilicate (and) titanium	2.00
	100.00

Procedure: Grind pigments together. Add remaining ingredients in order, and mix at RT using an appropriate blender.

Formula 6. Hydrogel

A. Ethyl acohol	20.00%w/w
Bis-PEG-18 methyl ether dimethyl silane (DC 2501 Cosmetic Wax, Dow Corning)	0.50
Triethylhexanoin (Estol 3609, Uniqema)	2.00
Dimethicone/vinyl dimethicone crosspolymer (and) silica (DC 9701 Cosmetic Powder, Dow Corning)	3.00
B. Water (*aqua*)	66.50
Pentylene glycol (Hydrolite-5, Symrise)	5.00
Hydroxyethyl acrylate/sodium acryloyldimethyl taurate copolymer (and) squalane (and) polysorbate 60 (Simulgel NS, Seppic)	3.00
	100.00

Procedure: Combine A and B separately. Add A to B and stir until homogeneous.

Compared to the same formula in which a silicone elastomer without silica coating is substituted, the initial formula is easier to spread, is smoother and more slippery. It demonstrates enhanced and faster sebum absorption, more even pigment dispersion and improved homogeneity of the color on the skin with less gloss.

Conclusions

The new silica-coated silicone elastomer powder exhibits useful properties for skin care and color cosmetic applications where wrinkle-masking, sebum control, novel textures and superior sensory profiles are required. Because this multifunctional material is also easy to process, formulators have expanded opportunities to create high-performance, unique product forms to meet the needs of a growing premium skin care market.

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