Beauty Bulletin

Newsletter for silica in personal care

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Another newsletter?

Manufacturers of personal care products have thousands of different raw materials to choose from. New raw materials are constantly being developed that offer new and unique properties for the cosmetics of today and tomorrow. AEROSIL® fumed silica and SIPERNAT® precipitated silica have been used in personal care products for many years and therefore might be considered as "traditional" ingredients that, although very useful and of high quality, don't have much new to offer. But is this really true?

We at Evonik strongly believe that AEROSIL® and SIPERNAT® silica enable new and exciting formulation opportunities. Innovations don't always have to be the result of new products, but can be the reimagining of existing ones. This newsletter is to inform personal care formulators and other interested persons of novel concepts and new developments relating to the use of silica in cosmetic formulations.

If you do not focus on new product formulation yourself, please feel free to distribute this newsletter to your R&D colleagues or whoever else in your organization might be interested.

Topics

SIPERNAT® hydrated silica: a product for innovative formulations in personal care

Hydrated silica such as SIPERNAT® precipitated silica has a long track record in dentifrice formulations in which the material is used both as a rheological additive and for assisting the cleaning action of the toothbrush. In personal care formulations other than dentifrice the particle size, morphology and porosity of SIPERNAT® hydrated silica particles open exciting pathways to innovative formulation concepts that so far have only been sparingly used.

Formulation opportunities with SIPERNAT® hydrated silica

AEROSIL® fumed silica has found widespread acceptance in personal care formulations for improving the flow of sensitive powders (e.g. sodium persulfate), for stabilizing dispersions of pigments in decorative cosmetics as well as enabling unique powder hair styling formulations.

SIPERNAT® precipitated silica is produced in aqueous suspension by a precipitation process. Targeted conditions allow production of a wide variety of products with different particle sizes, specific surface areas and intra-particle porosities. All products have an agglomerated aggregate structure. Typical SIPERNAT® aggregates are bigger than those of fumed silica and feature a high porosity. All SIPERNAT® hydrated silica products offered by Evonik Industries for the personal care industry are produced under the same stringent HACCP[1] quality conditions that are a prerequisite for using the material in food applications. For an overview of the product portfolio and the important physicochemical characteristics see Table 1.

The high absorbtion capability of SIPERNAT® precipitated silica as well as the bigger aggregate size make the material a preferred material for

- Absorption of liquids
- Formulations where a particle sensation is desired

Table 1 SIPERNAT® product range for personal care formulations: typical physicochemical properties

Product	INCI[b]	Particle size (d_{50}, µm)[c]	Specific surface area BET (m^2/g)[d]	pH[e]	DOA absorption ($g/100\ g$)[f]
SIPERNAT® 22 PC	Hydrated Silica	120	190	6.5	235
SIPERNAT® 22 S	Hydrated Silica	13.5	190	6.5	240
SIPERNAT® 22 LS	Hydrated Silica	9.0	180	6.5	235
SIPERNAT® 50	Hydrated Silica	50	500	6.0	305
SIPERNAT® 50 S	Hydrated Silica	18	500	6.0	305
SIPERNAT® 500 LS	Hydrated Silica	10.5	500	6.0	270
SIPERNAT® 2200 PC	Hydrated Silica	320	190	6.0	225

[a] Target values. For more information please refer to the product specification.
[b] Cosing database
[c] Laser diffraction in DI water, following ISO 9277
[d] Multipoint, following ISO 9277
[e] 5 % dispersed in water, following ISO 787-9
[f] Internal method, based on original substance. DOA stands for dioctyl adipate.

SIPERNAT® 22 PC and SIPERNAT® 2200 PC for environmentally friendly exfoliant formulations

In a prior issue of our Beauty Bulletin newsletter we introduced SIPERNAT® 22 and SIPERNAT® 2200 as eco-friendly replacements of the commonly used exfoliating polyethylene (PE) particles[2]. In order to address industry concern about microbiological contamination in the final exfoliant formulations we implemented a stringent microbiological control resulting in the new products **SIPERNAT® 22 PC** and **SIPERNAT® 2200 PC**. In addition to their physicochemical profile, a tight microbiological contamination level is now specified. Both products comply to a total aerobic microbial count of not more than 300 cfu/g and a total yeast and mold count of not more than 100 cfu/g. Additionally, the absence of bile tolerant gram negative bacteria[3] is specified[4], in line with Cosmetic Europe's "Guideline on Microbial Quality Management"[5].

To allow formulators to use the material in formulations with a "natural" claim SIPERNAT® 22 PC and SIPERNAT® 2200 PC are both ECOCERT certified, and additionally comply with NATRUE's list of "nature identical inorganic pigments". This emphasizes the high level of sustainability which can be achieved using these products as the exfoliating particles in peels.

Turning liquids into powders: SIPERNAT® Dry Binder for pressed powder formulations

One of the special features of SIPERNAT® hydrated silica is its porosity. This porosity can be used to absorb a wide variety of liquids. The porosity and therefore the absorption capacity is different from one SIPERNAT® product to the other and is reflected by the DOA absorption value given in Table 1. Products with high DOA absorption values as SIPERNAT® 50, SIPERNAT® 50 S or SIPERNAT® 500 LS are the preferred products for this effect. The absorption of liquids on SIPERNAT® is due to the high capillary forces of the pores because of their small pore diameter in the mesopore range (pore diameter 2 – 50 nm). As this mechanism is purely physical the absorption therefore is independent from the chemical identity of the liquid as long as its viscosity allows a good liquid flow into the pores.

There are different ways to release the absorbed liquid from the SIPERNAT® carrier silica:

- **Vaporization**
  Volatile substances such as fragrances can be released by simple vaporization. Vaporization of absorbed liquids can be higher or lower than the pure liquid depending on the attractive forces the silica has on the liquid.
- **Displacement by liquid with a higher affinity to the binder**
  Highly polar liquids such as alcohols, water or ethers (e.g. polyethylene glycol) can effectively displace liquids which are less polar and therefore have a smaller affinity to the hydrophilic surface of the silica.

[1] Hazard Analysis and Critical Control Points (HACCP) is a concept used for food ingredients. The concept aims to identify any risks to the consumer ingesting the product and defines control points in the process to eliminate such risks. Production under this concept is required to market foodstuff in Germany and has found Europe wide acceptance.
[2] Please see Beauty Bulletin 4/2013, available at https://www.aerosil.com/product/aerosil/Documents/Beauty-Bulletin-2013-04-EN.pdf
[3] Bile tolerant gram negative bacteria contain important pathogens such as pseudomonas aeruginosa, staphylococcus aureus and enterobacteriaceae.
[4] For the complete specification please contact Evonik Industries' customer service or your sales representative.
[5] The guideline is available at https://www.cosmeticseurope.eu/publications-cosmetics-europe-association/guidelines.html?view=item&id=28.

- **Mechanical desorption**
  Upon pressure or shear induced destruction of the pore structure of the silica, the liquid is liberated and becomes available for any function that may be desired.

The universal carrier function of SIPERNAT® hydrated silica has already been introduced in the well-known Powder-to-Cream platform concept[6]. Examples of liquids that can be easily turned into powders comprise:

- **Surfactants**
  By absorbing liquid ionic or non-ionic surfactants on SIPERNAT® hydrated silica powdered cleansing formulations with a mild cleaning effect can be produced.
- **Fragrances**
  Liquid fragrances can be easily added to powder formulations after absorption on highly absorptive SIPERNAT® hydrated silica.

In this newsletter the beneficial use of SIPERNAT® hydrated silica in Dry Binders for pressed powder products shall be exemplified.

Pressed powders are state of the art for decorative cosmetic products such as eye shadows, face and rouge powders. In these formulations usually a binder oil (e.g. TEGOSOFT® CT[7]) is sprayed on the powder mixture containing color pigments, fillers and additives. For every color shade a new mixture needs to be prepared, making small scale production necessary.

Producing pressed powders with SIPERNAT® hydrated silica Dry Binders facilitates the processing. Using this concept, a Dry Binder is produced by spraying the oil onto a SIPERNAT® silica carrier. This Dry Binder can be produced at higher scale and only needs to be powder mixed with the different pigments and other solid additives to produce products in different color shades. By pressing the powder mixture the binder oil is released from the silica, binds the powder mixture and produces powder cakes with sufficient mechanical stability and good applicability. For a guide formulation using this concept please see Table 2.

Table 2 Talc free face powder with SIPERNAT® based Dry Binder

Ingredients	INCI name	% w/w
Dry-FLO TS	Tapioca Starch Polymethylsilsesquioxane	45.50
TEGOLON® 12-10[2]	Nylon-12	11.50
Serica 5 COVASIL 4.05	Mica, Dimethicone, Trimethylsiloxysilicte	7.50
Protchem LL	Lauroyl Lysine	3.00
Color Base		20.00
Dry Binder		12.50
Preservative	Preservative	q.s
Total		**100.00**
Dry Binder	**INCI name**	**% w/w**
SIPERNAT® 50 S[1]	Hydrated Silica	31.00
TEGOSOFT® CT[2]	Caprylic/Capric Triglyceride	69.00
Total		**100.00**
Color Base	**INCI name**	**% w/w**
Unipure Brown LC 881	CI 77491, CI 77492, CI 77499	16.00
Unipure Yellow LC 182	CI 77492	14.00
Unipure White LC 981	CI 77891	70.00
Total		**100.00**

[1] Evonik Industries AG, Business Line Silica [2] Evonik Industries AG, Business Line Personal Care

Dry Binder Premix
1 Weigh SIPERNAT® 50 S into a suitable blender (e.g. ribbon blender). While mixing at low to medium speeds, add TEGOSFT® CT slowly and continuously.
2 Allow to stand and pass through screen if necessary.

Color Base
Combine components of color base and mill to a fine powder that doesn't change its shade anymore.

Pressed powder preparation
1 Combine all powdered ingredients, including preservative and color base, and mix using a suitable blender.
2 Add the Dry Binder Premix and continue to blend with low to medium shear until uniformly dispersed.
3 Fill the mixture into godets and apply direct pressure to compact the powder.

Figure 3 Face powder according to formulation of Table 2

Temperature stabilization of stick formulations with SIPERNAT® hydrated silica

Stick formulations such as lip or deodorant sticks are usually based on low melting waxes. When selecting the waxes, formulators need to find a compromise between the temperature stability of the stick and the ability to apply the stick formulation to the skin or lips. Higher melting waxes are beneficial to increase the temperature stability but may overly reduce the pay-off of the stick making it hard for the consumer to apply it. Highly milled SIPERNAT® LS grades can help formulators to increase the temperature stability of the stick formulation without significant influence on pay-off. The finely ground SIPERNAT® LS particles form a three dimensional particle network which greatly influences the rheology of the mixture. The movement of the molecules in the liquid is limited. This prevents the softening of the formulations and thereby leads to higher temperature stability.

[6] For more information please see Technical Information TI 1394 which is online available at http://www.aerosil.com/product/aerosil/Documents/TI-1394-Powder-to-Cream-EN.pdf
[7] TEGOSOFT® CT (INCI: Caprylic/Capric Triglyceride) is available from Evonik Industries, Business Line Personal Care, Essen, Germany.

Figure 3 shows lipstick formulations with increasing SIPERNAT® 500 LS concentrations which were subjected to a heat treatment at 65 °C for 4 hours. While the silica-free formulation A completely loses its shape, SIPERNAT® 500 LS containing formulations B and C show almost no change in stability. Formulation C with the highest silica content in the row remains completely unchanged. The higher the silica concentration in the stick, the higher the temperature at which softening occurs. In Figure 5 the pay off of the silica-free formulation A and formulation C containing 4 w.-% SIPERNAT® 500 LS is compared.

For a guide formulation using this effect please see Table 3.

Table 3 Lipstick with excellent thermal stability

Phase	Ingredients	INCI name	% w/w
1	TEGOSOFT® Liquid[2]	Cetearyl Ethylhexanoate	11.48
	TEGOSOFT® SH[2]	Stearyl Heptanoate	0.50
	ABIL® Wax 2434[2]	Stearoxy Dimethicone	0.75
	ABIL® Wax 2440[2]	Behenoxy Dimethicone	0.75
	REWOPAL® PIB 1000[2]	Polyisobutene	5.00
	Antaron V 220	PVP/Eicosene Copolymer	0.25
	Isostearyl Alcohol	Isostearyl Alcohol	30.70
	Isododecan	Isododecane	8.25
	Castor Oil	Ricinus Communis (Castor) Seed Oil	6.70
	Carnauba Wax	Cera Carnauba	2.55
	Candelilla Wax	Candelilla Cera	7.55
	Ozokerite Wax White	Ozokerite	3.70
	Oxynex® K liquid	PEG 8/ Tocopherol/Ascorbyl Palmitate/Ascorbic Acid/Citric Acid	0.02
2	SIPERNAT® 500 LS[1]	Hydrated Silica	4.00
	Pigement Blend	Pigements predispersed in Castor Oil	17.80
	Total		**100.00**

[1] Evonik Industries AG, Business Line Silica [2] Evonik Industries AG, Business Line Personal Care

1 Heat Phase 1 to approximately 85 °C until waxes have melted.
2 Add Phase 2 and disperse for at least 30 min.
3 Pour into lipstick molds and freeze about 30 to 60 min.

Figure 4 Lipsticks after treatment at 65 °C for 4 hours

Formulation A contains no silica, formulation B has 2 w.-% SIPERNAT® 500 LS and formulation C 4 w.-% SIPERNAT® 500 LS.

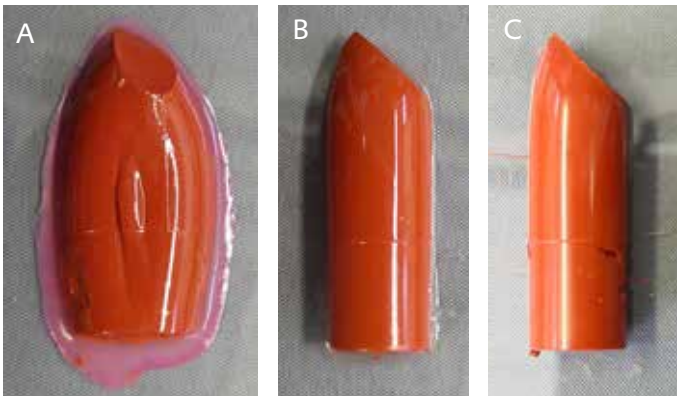
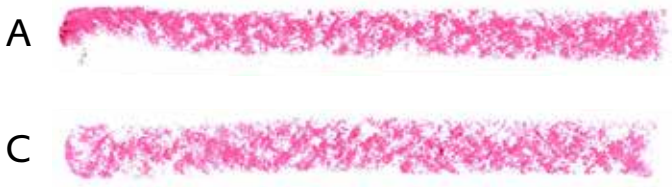


Figure 5 Pay off comparison

Formulation A contains no silica, formulation C is formulated with 4 w.-% SIPERNAT® 500 LS



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