Powder-to-Cream – An innovative concept for cosmetic formulations in powder form

Technical Information 1394

Evonik. Power to create.

Powder-to-Cream –

an innovative concept for cosmetic formulations in powder form

Cosmetic products constantly compete for the attention of shoppers through packaging and advertising. But cosmetic formulators also need fresh new concepts to help their products stand out from the crowd.

The novel Powder-to-Cream concept from Evonik Industries aims to assist cosmetic producers in creating eye-catching formulations that awaken the consumer's immediate interest. With this formulation concept almost any cosmetic product can be formulated in a powder form which will turn creamy when applied to the skin or hair. Products formulated using Powder-to-Cream let consumers experience something out of the ordinary and unexpected while delivering the benefit of the active cosmetic ingredients. Powder-to-Cream fits an almost unlimited number of applications in a variety of segments like color cosmetics, skin care, hair styling and sun care. As a formulation platform it offers the opportunity to produce different products with a limited set of raw materials.

Evonik silica is the key component of the Powder-to-Cream concept. Evonik is a leading producer of both fumed and precipitated silica products which both play an important role in this novel approach.

Powder-to-Cream consists of two components. AEROSIL® fumed silica is used in the "Powdered Water" phase to turn aqueous solutions or dispersions into a free flowing powder. SIPERNAT® precipitated silica is used in the "Actives Absorbate" phase to formulate active cosmetic ingredients into powder form. Mixing the Powdered Water and the Actives Absorbate gives the formulator almost unlimited formulation flexibility to generate a multitude of cosmetic products in a fascinating powder form.

Powdered Water

The ability of hydrophobic AEROSIL® fumed silica particles to settle on the surface of water droplets is exploited in the Powdered Water part. The hydrophobic AEROSIL® fumed silica particles form a layer on the surface of the droplets that prevents them from coalescing back into liquid water. This stabilizes the droplets and makes it possible to formulate an aqueous phase into a free flowing powder.

There are two scientific reasons for this unusual behavior of aqueous solutions: the high surface tension of water and the repulsion between the aqueous phase and the hydrophobic AEROSIL® particles. The extraordinary surface tension of water facilitates the generation of stable fine water droplets. The hydrophobic nature of the AEROSIL® particles prevents them from being wetted by the aqueous solution. Therefore the particles collect at the outer boundary of the droplets, separating the droplets from each other and keep them from coalescing.

Different substances can be dissolved or dispersed in the aqueous phase: pigments, actives, plant extracts to name a few. The choice of the ingredients and their concentration in the aqueous phase is only limited by the fact that they may affect the droplet stability. Substances that wet out the surface of the hydrophobic AEROSIL® particles, or affect the surface tension of water, may lead to a destabilization of the Powdered Water so that a cream, and not a powder results.

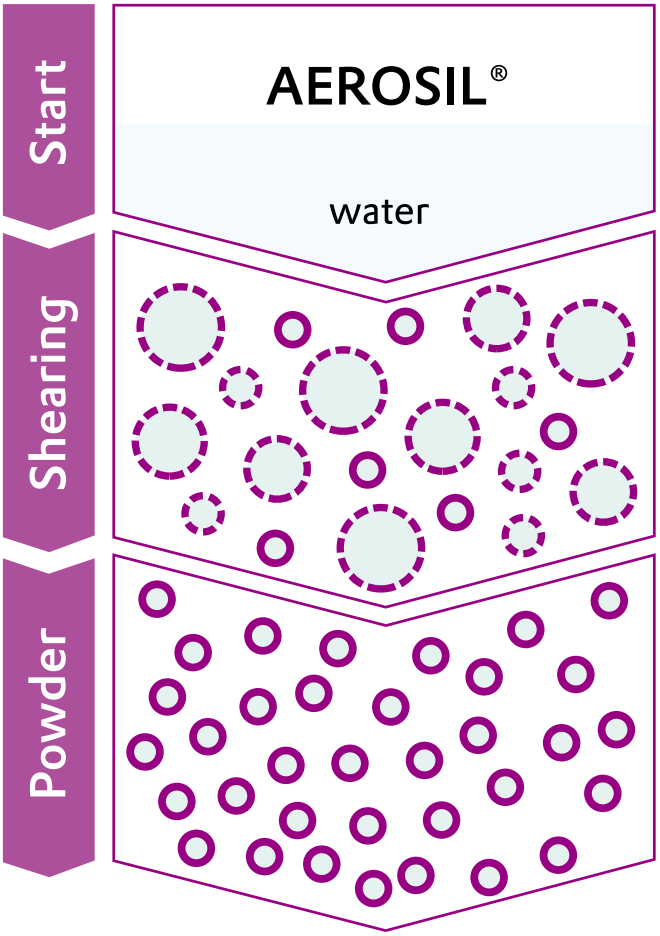

Figure 1
Process for preparing Powdered Water

AEROSIL® R 812 S as well as AEROSIL® R 202 are suitable fumed hydrophobic sílica products that can be used for the production of the Powdered Water. The necessary concentration of these products is dependent on the individual composition of the aqueous phase. A good starting point is a concentration of 5 weight-% silica which for both AEROSIL® products results in Powdered Water for a pure water phase without any other ingredients.

AEROSIL® R 812 S is the preferred product for Powdered Water production. The product features a smaller particle size compared to AEROSIL® R 202 which is reflected in the higher BET surface area (see **Table 1**). This adds to the economy of the Powdered Water production as for any given AEROSIL® concentration there are more particles present than for the same quantity of AEROSIL® R 202. Due to its higher hydrophobicity (seen as higher carbon content in **Table 1**) AEROSIL® R 202 can be used for formulations for which AEROSIL® R 812 S is not successful. Independent if AEROSIL® R 812 S or AEROSIL® R 202 are used the stability of Powdered Water increases with increasing AEROSIL® concentration.

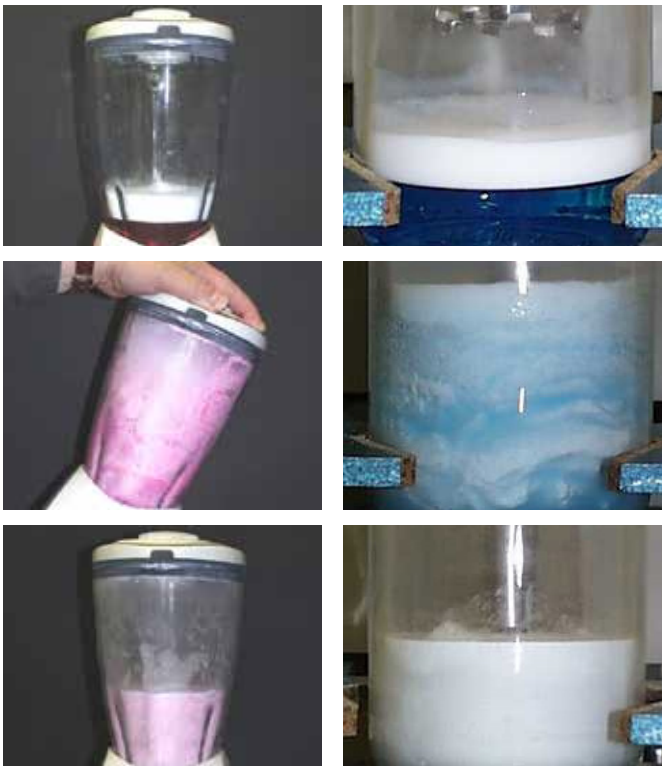

Figure 2
Preparation of Powdered Water on laboratory scale using a kitchen blender (**left**) and a dissolver (**right**)

Table 1 Physico-chemical properties of recommended AEROSIL® types

	AEROSIL® R 812	AEROSIL® R 812 S	AEROSIL® R 202
INCI Name	Silica Silylate	Silica Silylate	Silica dimethicone silylate
Specific surface area BET (m^2/g)	approx. 260	approx. 220	approx. 100
C-Content (weight-%)	2.0–3.0	3.0–4.0	3.0–5.0
Tamped density (g/l)	approx. 60	approx. 60	approx. 60

To obtain Powdered Water from an aqueous phase and a hydrophobic AEROSIL® product the water phase must be dispersed into fine droplets. These fine droplets have to be thoroughly mixed with particles that are strongly water repellent in character. In order to achieve this, high energy mixing equipment is required. Enough shear force is required to properly divide the water droplets from each other and mix in the water repellent AEROSIL® particles. High shear mixing is a prerequisite for successful production of Powdered Water.

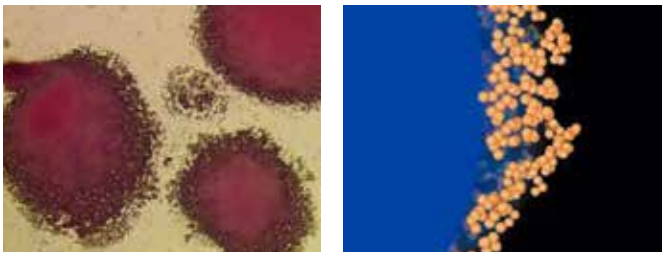

Figure 3
Cryo-Transmission Electron Microscopy image and model of Powdered Water

It is strongly recommended to use mixing equipment with a tip speed at or above 20 m/s. In the laboratory this can be achieved by high quality kitchen blenders or dissolvers. For the production scale rotor-stator or toothed blade (Cowles) mixers can be used. Whatever the equipment used it is important to ensure sufficient mixing throughout the whole reaction vessel so that a good homogenization of the total volume is achieved. Dead zones of insufficiently mixed material must be avoided as these may lead to lower product stability. Processing temperature needs to be controlled to prevent water vaporization. The mixing time has to be optimized for each individual Powdered Water formulation and specific mixing equipment used. Overmixing may lead to insufficient product stability or the production of a cream.

On mechanical destruction, such as by rubbing on the skin, the hydrophobic AEROSIL® layer on the droplets is broken and the aqueous solution is released as a liquid.

Actives Absorbate

Powdered Water already provides way to turn aqueous formulations into a powder product. The formulation freedom for products using this concept is limited by the fact that some ingredients in the desired concentration may destabilize the powder and turn it into a cream. For such formulations another way of adding critical ingredients had to be found.

The absorption of liquids onto hydrophilic SIPERNAT® is well known in other industries. An Actives Absorbate can be produced using that technology for ingredients that are critical for the stability of Powdered Water. Combining the Powdered Water component and the Actives Absorbate component will give a stable powder formulation with the desired ingredients and concentration.

SIPERNAT® precipitated silica carriers are composed of highly porous particles which are produced by a precipitation process. Because of the small dimensions of the pores, liquids are drawn inside the pores by capillary forces. Due to this purely physical absorption process the absorption is independent of the chemical nature of the liquid to absorb. Both polar as well as non-polar liquids are absorbed if they have suitable viscosity. The quantity of liquid that can be absorbed on the carrier depends on the SIPERNAT® type used. For comparison the dioctyl adipate absorption for the different carriers is mentioned in **Table 2**. Particle size is another important parameter as it may influence skin feel. The smaller the particles are, the better the skin feel becomes. Please note that unlike for fumed silica, the BET surface area for porous particles is not a good measure for particle size (**Table 2**).

We recommend SIPERNAT® 22 LS or SIPERNAT® 500 LS for the production of Actives Absorbate. SIPERNAT® 50 S may be an option if a higher density product is preferred.

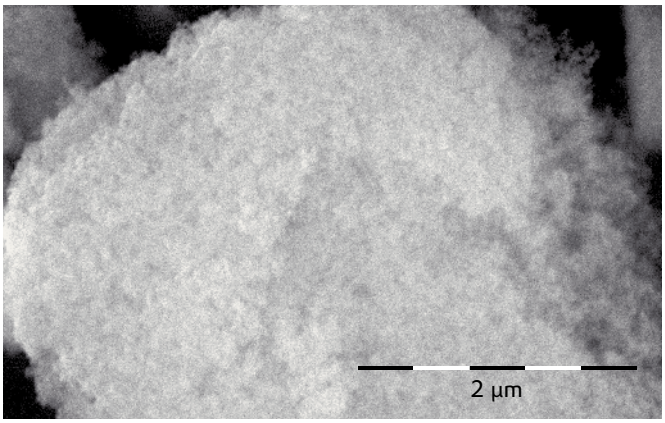

Figure 4
Scanning electron microscopy image of SIPERNAT® 500 LS

To produce Actives Absorbate we recommend charging the mixer with SIPERNAT® silica first. The liquid actives mixture should then be added in a continuous fashion and distributed as finely as possible. For optimum results low shear mixing should be used as high shear forces may partly destroy the pore structure, releasing the absorbed actives. Suitable mixer types include plow share and double paddle mixer types. To optimize flow behavior and pressure stability of Actives Absorbate the liquid should be added in as fine a stream or spray as possible. Where spraying is not possible, dripping is better than pouring. The exact mixing conditions have to be optimized for each specific system and the mixing equipment used. As for the Powdered Water overmixing should be avoided when producing the Actives Absorbate.

Table 2 SIPERNAT® products recommended for Actives Absorbate

	SIPERNAT® 22 LS	SIPERNAT® 50 S	SIPERNAT® 500 LS
INCI Name	Hydrated Silica	Hydrated Silica	Hydrated Silica
Specific Surface Area (m^2/g), multipoint	180	500	500
Particle Size d_{50} (laser diffraction) (µm)	9.0	18.0	5.5
Dioctyl adipate (DOA) absorption (ml/100 g), orig. material	235	290	285
Tamped density (g/l)	70	100	70

Powder-to-Cream formulation

The final Powder-to-Cream formulation is obtained by mixing the Actives Absorbate with the Powdered Water components. Mild mixing conditions are preferred for this step to avoid putting too much mechanical stress on the Powdered Water and releasing the aqueous phase. Low shear mixers (e. g. free fall or plow share mixers at low rotation speed) may be used.

For the formulator the Powder to Cream concept offers several degrees of freedom to obtain the desired properties of the formulation:

1 Powdered Water
- AEROSIL® type
- AEROSIL® concentration

2 Actives Absorbate
- SIPERNAT® type
- Actives to carrier ratio

3 Powdered Water to Actives Absorbate ratio

When the consumer applies a Powder-to-Cream formulation the aqueous phase of Powdered Water component is released by gentle rubbing. The released water helps to liberate the actives component of the Actives Absorbate.

Powder-to-Cream Blush

Overall formulation

Ingredients	INCI name	% w/ww
Water	Water	66.09
SIPERNAT® 500 LS	Hydrated Silica	7.50
AEROSIL® R 812 S	Silica Silylate	6.50
Carbowax PEG, 400	PEG-8	6.13
Dimethisil DM-20	Dimethicone	4.55
Spheron N-2000J	Silica	2.50
Iron Oxide Pigments mixture	Iron Oxides Yellow, Red and Black	1.13
Glycerin	Glycerin	1.71
Butylene Glycol	Butylene Glycol	1.71
Sunprizma Cherry Marmalade	Pigment/ Pearlescent	1.75
Phenonip	Phenoxyethanol (and) Methylparaben (and) Ethylparaben (and) Butylparaben (and) Propylparaben (and) Isobutylparaben	
Total		**100.00**
Break Down of Iron Oxide Pigment Mixture		
AC-5 Red R-516P	Iron Oxide, Cellulose Gum, Microcrystalline Cellulose	75.20
AC-5 Yellow LL-100P	Iron Oxide, Cellulose Gum, Microcrystalline Cellulose	18.80
AC-5 Black BL-100P	Iron Oxide, Cellulose Gum, Microcrystalline Cellulose	6.00
Total		**100.00**

Powder-to-Cream Blush

Preparatory Steps

Pigmented Water

Ingredients	INCI name	% w/ww
Water	Water	94.17
Glycerin	Glycerin	2.00
Butylene Glycol	Butylene Glycol	2.00
AC-5 Red R-516P	Iron Oxide, Cellulose Gum, Microcrystalline Cellulose	1.00
AC-5 Yellow LL-100P	Iron Oxide, Cellulose Gum, Microcrystalline Cellulose	0.25
AC-5 Black BL-100P	Iron Oxide, Cellulose Gum, Microcrystalline Cellulose	0.08
Phenonip	Phenoxyethanol (and) Methylparaben (and) Ethylparaben (and) Butylparaben (and) Propylparaben (and) Isobutylparaben	0.50
Total		**100.00**

Disperse and mix all ingredients in water in a container.

Emollient Mixture

Ingredients	INCI name	% w/ww
Carbowax PEG, 400	PEG-8	35.00
Dimethisil DM-20	Dimethicone	26.00
Pigmented Water	Water, Glycerin, Butylene Glycol, Iron Oxides	39.00
Total		**100.00**

Mix all ingredients together in a container.

Powdered Water

Ingredients	INCI name	% w/ww
Pigmented Water (from above)	Water, Glycerin, Butylene Glycol, Iron Oxides	92.00
AEROSIL® R 812 S	Silica Silylate	8.00
Total		**100.00**

Using a high speed blender (at least 10,000 rpm) blend together pigmented water and AEROSIL® R 812 S for about 45s to 1 minute or until a powder is formed. Store powder in a plastic container for later use.

Actives Absorbate

Step 1

Ingredients	INCI name	% w/ww
Emollient Mixture (from above)	PEG-8, Dimethicone, Iron Oxides, Water	70.00
SIPERNAT® 500 LS	Hydrated Silica	30.00
Total		**100.00**

Mix emollient mixture to re-disperse ingredients, then add SIPERNAT® 500 LS and mix using low shear until emollient mixture has completely absorbed into silica and has turned into a dry powder. Clumping will be normal during initial mixing. Gently pass sample through a 1mm sieve in between mixing to break up large agglomerates. End product should be a fine powder.

Step 2

Ingredients	INCI name	% w/ww
SIPERNAT® Emollients Mixture	Hydrated Silica, Dimethicone, PEG, Iron Oxides, Water	81.00
AEROSIL® R 812 S	Silica Silylate	2.00
Spheron N-2000J	Silica	10.00
Sunprizma star dust gold	Pigment/ Pearlescent	7.00
Total		**100.00**

Mix AEROSIL® R 812 S with Actives Absorbate then mix in rest of ingredients. Pass mix through 1mm sieve 2-3 times to break up any agglomerates and to ensure an even mix.

Powder-to-Cream Formulation

Ingredients	INCI name	% w/ww
Powdered Water	Water, Silica Silylate, Glycerin, Butylene Glycol	75.00
Actives Absorbate	Dimethicone, PEG, Iron Oxides, Hydrated Silica, Water	25.00
Total		**100.00**

While gently mixing pigmented dry water at low to medium speed (paddle mixer or by hand) slowly add carrier mixture with emollients to pigmented dry water in small doses.

How to Use

Turn powder into cream by rubbing powder with finger tips or cosmetic sponge/brush. Apply cream to face and blend quickly. Color will come out a bit orange or dark at first, but once dried it will tone down to appear much softer. Blend with a blush after blush has dried to achieve an even finish. Silica helps to reduce shine and excess sebum to prolong wear time and prevent acne.

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