Ubiquitous like sand on the beaches: silicon and its compounds

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As a cosmetic agent, silicon plays a wallflower role. Only at the first glance, though: its salts and organic compounds are used in many applications, as e.g. masks, packs or hair care products.

As a matter of fact, the element silicon itself is insignificant as a cosmetic ingredient. However, organic silicon additives in form of silicon oils can be found in more than 50 percent of the cosmetic products. Inorganic silicates are integral parts of decorative cosmetic products and frequent additives in masks and packs. Silicon is a semi-metal and can be found everywhere at our feet as sand, quartz or – in combination with aluminum – in clay, mica and other rocks.

Silicic acid & Co.

When one burns (oxidizes) silicon, then silicon dioxide (SiO_2) (or silica) will form which still today is used in some abrasive hand cleansing products to remove obstinate dirt like tar, dyes or adhesives. These abrasive particles mostly are quartz particles (as e.g. sand from the seashores) which formerly were also applied in cosmetic peelings. They are quite rough on the skin and that is why they are no longer used for cosmetic purposes.
Silicic acid is a hydrated silicon dioxide with completely different properties. The light powder with extensive surface is generally used as a separating agent for spice blends or table salt to increase the pourability. Silicic acid concentrates in diatoms for instance and is available on the market as diatomaceous earth (kieselgur). Horsetail extracts also contain silicic acid and are used as additives in facial tonics and hair care products. Both connective tissue as well as skeleton depends on the intake of silicic acid.
Finely dispersed (colloidal) silicic acid – also known as aerosil – serves as a consistency agent for non-polar oils like paraffin oil. The results are oleogels (lipogels) which play a certain part in pharmaceutical applications, however, are not accepted in the cosmetic field. An interesting fact is that aerosil incorporates oils, a property which allows to transform oils into powders – a technique which is also of interest for processing food.

Cheating a bit...

Silicic acid coated with titanium dioxide and iron dioxide can be used in powders and make-up to minimize the appearance of wrinkles. These raw materials diffusely reflect the light, reduce the contrasting effect of wrinkles and avoid a mask-like effect on the skin due to their skin-identical transparency. Generally, silicic acid is a frequent component of powders (INCI: Silica).
Another form of silicic acid is silica gel. It has a solid consistency and is offered in different grain sizes. It is highly hygroscopic (water-absorbing) and hence serves as a desiccant in laboratories. In the beauty institute, silica gel is used to transfer fresh flower fragrances into skin care oils by drying rose petals in the presence of oils and silica gel in a closed container.

Aluminosilicates

In natural surroundings, there are various minerals in which silicic acid is combined with aluminum oxide: aluminosilicates. Kaolin (or china clay) is used as a whitening pigment, as for instance in the manufacturing of powders and make-up. Kaolin forms with the decomposition process of feldspar. Feldspars are tectosilicates and, besides silicon and aluminum, they also contain elements like sodium, potassium, calcium and barium. Mica (INCI) belongs to the scissile sheet silicates and is used in the field of decorative cosmetics. Micas have specific optical properties and, ground into fine powders, they can be coated with various layers. In combination with quartz and feldspars they form rocks like granite and gneiss which decompose into clay in the course of time. Due to their expansive surface, clays and clayey loams are processed into healing earth. As components of cosmetic packs and masks they absorb the body's own substances and, on the other hand, they release the added active agent components in a controlled way into the skin. The specific property of clay as ion exchanger is still more distinct in zeolites. On a limited scale they even can be used as

water softeners (phosphate replacement) or as an additive for bathing products. The aluminosilicate bentonite absorbs enormous amounts of water and forms inorganic gels. In combination with pigments, glycols and oils, bentonite and analogous aluminosilicates even are appropriate ingredients for the manufacturing of liquid make-ups.

Talcum

The naturally occurring talc (soapstone) is a particularly soft inorganic material. In powdered form it is called talcum, a magnesium silicate which feels like a lipid substance. It is a powder component and widely used in the cosmetic field as it facilitates and enhances the application of the products. Fibrous talcum dusts involve a certain risk, though. Small particles of these dusts may cause granulomas in the lung, similar to asbestos and, they are not degradable. Hence, the cosmetic market today continues to promote talcum free powders.

Silicones

In contrast to silicic acid and silicates, silicones are completely synthetic substances. Actually, their chemical term is siloxanes respectively polysiloxanes as they consist of shorter or longer subsequent silicon-oxygen units. Moreover, every silicon atom has two, and the first and last units of the chain have three hydrocarbyls. If these are two methyl groups we are dealing with dimethicones (dimethylpolysiloxanes) which are widely used in the cosmetic industry. If the chains are ring-like circular structures, they are called cyclomethicones. Specific cyclic siloxanes are explicitly designated with the prefix cyclo and the suffix siloxane (as for instance cyclotetrasiloxane). Methicones have only one methyl group at the silicon atoms as well as another hydrocarbyl which is explicitly listed in the INCI as an additive.
Besides the relatively simple basic types there is a multitude of other polysiloxanes. Instead of the methyl groups, there are other hydrocarbyls as well as different functional groups located at the silicon atoms.

Velvety feeling

Polysiloxanes are widely used in different fields of application. In the cosmetics area mainly the hydrophobic and conditioning properties are made use of. There are volatile and liquid polysiloxanes which facilitate the application of the cosmetic products, and there are highly molecular even wax-like representatives which remain on the skin surface. The fact that the substances have hydrophobic effects and a velvety sensation is very appreciated in cosmetic skin care products. The smoothening and adhesive effect is used in cleansing products and body lotions as for instance for the re-fattening of the skin. The obviously agreeable feeling on the skin subjectively simulates a skin recovery which objectively is non-existent. A broad field of application of these substances are shampoos and hair conditioning products.
A small selection of representatives is listed in the following:
■ Dimethicone (INCI) is offered in different viscosities, from lower viscosity like water to higher viscosity, depending on the chain length. The most basic representative is Hexamethyldisiloxane (INCI). It is as fluid as water, however, without its typical cooling properties. The fluid and volatile compounds are spreading and softening agents with low surface tension. They are frequently used in antiperspirants and deodorants and generally improve the combability of wet hair.
The higher molecular, non-volatile representatives are frequently used in combination with mineral oils as lipid substances in creams as well as water-repellent skin care products. It is quite a disadvantage for the industrial sector that fingerprints originating from silicone-containing products are quite difficult to remove from the work pieces. That is the reason why in this sector products often are promoted with the term “silicone free”. A disadvantage in connection with hair products is that with frequent use of shampoos or hair conditioners for instance, the polysiloxanes may accumulate in the hairs.

Clear the ring for application!

■ Cyclomethicone (INCI): This term refers to differently sized dimethylpolysiloxane rings. The defined Cyclopentasiloxane (INCI) consists of a 10-membered ring and is used as spreading agent for highly viscous silicon oils. This combination allows to treat hair ends and create straight and shiny hair. The combability of wet as well as dry hair is improved. The six-membered ring of Cyclotrisiloxane (INCI) and the 8-membered ring of Cyclotetrasiloxane (INCI) even have stronger spreading properties. They are volatile. Cyclic siloxanes are contained in lipsticks for instance where they replace part of the non-volatile hydrocarbons. Also deodorant sprays and aerosol products are equipped with these substances.
■ Alkyl Dimethicone is a generic term for dimethylpolysiloxanes with a methyl group on the silicon atom partly exchanged by a longer hydrocarbyl. The mostly wax-like substances

are ingredients of skin care creams, sun protection and decorative cosmetic products as e.g. lipsticks, mascara as well as make-up.

Shiny result

■ Phenyl Methicone (INCI): Besides the conditioning properties these compounds also have interesting optical characteristics as they have the same refraction index as hair. They enhance both radiance and brilliance of the hair. On the other hand they form sliding films and create smooth hair.
■ Dimethicone Copolyol (INCI) and cyclomethicones are cleansing product components as they are able to dissolve dirt particles. Dimethicone Copolyol supports stable, thick foam and hence is applied in foam baths, shower gels and liquid soaps.
■ Siliconized silicic acids, as e.g. Silica Dimethyl Silylate (INCI), is used as a consistency agent.
Generally, silicones are highly tolerable substances. It has to be pointed out, however, that they are not compatible with natural cosmetics and physiological concepts. In terms of skin sensation they are well accepted. Compared to physiological lipid substances though, they do not support the recovery of the skin.

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