# THE QUEST TO UNDERSTAND AND CONTROL THE SURFACE OF SILICA

**The surface area of silica is reduced by treatment in water at elevated temperatures and it does not evidently affect the surface chemistry. Both properties are important for its use as adsorption and absorption material.**

Silica consists of silicon atoms connected to oxygen atoms. Amorphous silica is usually produced as spherical particles on the micrometer scale with a high amount of pores (see Figure 1). Every pore in the material increases the surface area and decreases the weight. The high surface to mass ratio makes it useful as adsorption and absorption material. Silica absorbs water and is therefore used in packaging products to prevent corrosion and deterioration by moisture. Silica is used as an adsorption material in catalysts and as stationary phase in chromatography.

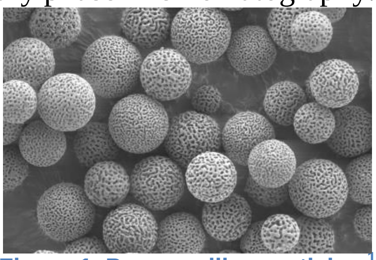

Figure 1. Porous silica particles.[1]

Since the surface area is of such great interest, it is important to understand and control it. If the surface area is too large, a method is needed that can be used to controllably reduce the surface area. This leads to a reduced disposal of product.

A rough surface consisting of alternating peaks and valleys has a high surface area compared to a smooth surface. The surface can be smoothed through dissolution of the peaks and re-precipitation in the valleys. The process is controlled by the solubility of silica. Increased temperature and pH increases the solubility of silica in water.

A treatment method of amorphous silica was developed that reduces the surface area with approximately 1m$^2$/gh. The silica had a surface area of approximately 550m$^2$/g. This means that the surface area of 1g can be compared to the surface area of a football field.

The temperature was used as a parameter in this work to increase the solubility. In agreement with theory the surface area was reduced faster at 100°C than at 80°C. Silicas with different pore diameters were tested and the material with the smallest pore diameter had the largest surface area. A larger surface area means a higher amount of peaks and valleys that can be smoothed. Therefore, the reduction was faster for the silica with a larger surface area.

The surface of silica consists of siloxanes (Si-O-Si) and of silanols (Si-OH) (see Figure 2). The silanols are considered to be the active sites in its applications and there are three different kinds; isolated geminal and vicinal silanols. A treatment of silica may affect the surface chemistry, both regarding the amount of silanols and also the relative amount of the different types.

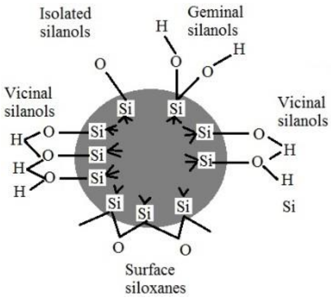


Figure 2. The surface of silica.

The surface chemistry of silica has been studied with many different techniques, both chemical and physical. In this work, spectroscopic and thermogravimetric techniques were used. The results from these measurements showed that the amount of silanols did not change by the treatment but there was an increase of the relative amount of the geminal silanols. Other conclusions that were drawn from the characterizations were that a combination of techniques is needed to get the whole picture of the surface chemistry and since silica absorbs and adsorbs water easily it is hard to distinguish silanols from water during the characterization.

[1] Courtesy of AkzoNobel.