

Product Information

Silica, fumed

Catalog Numbers **S5130**, **S5505**, **S2128**

Physical Description

Silica, fumed is composed of submicron-sized spheres, which are 40-60% fused into short chains, very highly branched, 0.1-0.2 microns long. The spheres are quite uniform in size for a given product, but the chain lengths are quite variable, 10 to 30 units

in length. The surface area, which varies with the particle size, gives a good approximation of the sphere diameter. The smaller the particles, the larger the estimated surface area.²

| Catalog Number | Particle size (µm) | Surface area (m ² /gram) | Density (lb/cu. ft) |
|----------------|--------------------|-------------------------------------|---------------------|
| S5130 | 0.007 | 395 ± 25 | 2.3 |
| S5505 | 0.2-0.3 | 200 ± 25 | 2.3 |
| S2128 | powder | | |

Method of Preparation:²

Silicon tetrachloride is burned in a flame of hydrogen and oxygen (at ~1800 °C) to produce molten spheres of silicon dioxide (and hydrogen chloride). Depending on process parameters, the size of these silica spheres can be varied and, within a given batch, show excellent uniformity (by electron micrograph). The molten spheres collide and fuse with one another to form branched, three-dimensional chain-like aggregates.

Many aggregates have chains from 10 to 30 spheres in length, or from 0.1 to 0.2 microns (µm) in length. As the aggregates cool down below the fusion temperature of silica (~ 1710 °C), further collisions result in some reversible mechanical entanglement or agglomeration. Further agglomeration occurs during the collection process; this can be reversed by proper dispersion in a suitable medium.

During the formation of the product, hydroxyl groups become attached to some of the silicon atoms on the surface of the silica particles, making the surface hydrophilic and capable of hydrogen bonding with suitable molecules. There are (estimated) 3.5-4.5 hydroxyl groups per square millimicron of silica surface, compared to a theoretical maximum of 7.85. The structure of fumed silica is amorphous (as indicated by absence of lines in its X-ray diffraction pattern.)

The surface area was determined by calculation using a nitrogen adsorption method of Brunauer³, and the value used to calculate particle diameter.

The residual hydrogen chloride on the surface of the fumed silica was reduced to less than 200 ppm by calcining.² The moisture content of the product will vary, depending on storage conditions. Moisture adsorbed on the surface can be removed by evacuation at room temperature (at 10⁻² mm Hg) or by heating at 110 °C. (If the product is heated above 800 °C, it sinters irreversibly.)

Storage / Stability As Supplied:

These products are stable indefinitely at room temperature if kept dry. Their tendency to adsorb moisture suggests an effective shelf-life of about two years, once opened.

Solubility / Solution Stability:²

Fumed silica will form dispersions in water, glycerin, butyl alcohol, mineral oil and a variety of other liquids, causing them to thicken or form gels. The dispersions often have thixotropic properties, i.e., viscosity that varies with rate of stirring.

For liquids with minimal hydrogen bonding, small amounts of fumed silica will increase the viscosity. Addition from 3 to 5% by weight usually suffices to cause the liquid to form a gel. After an initial thorough dispersion, increasing the mixing time has little effect on the viscosity for a given percent of silica.

For liquids with a high degree of hydrogen bonding, small amounts of fumed silica will also increase the viscosity. However, usually 10% or more (by weight) will be needed to form gels. The initial dispersion is rapid. If the dispersion is mixed too long, the result will be an irreversible decrease in viscosity.

Solubility / Solution Stability:²

Dispersions formed with fumed silica are quite stable, remaining unchanged for weeks to months, over a range of temperatures.

Usage:

Fumed silica have been used commercially in a wide range of applications to enhance viscosity of many liquids, including paints. The most common application in biochemistry is for clarifying sera by removing lipids.

Two methods are reported to be successful, each with its own limitations: dextran sulfate extraction and fumed silica precipitation. The use of dextran sulfate MW 500,000 (Catalog Number D6001) has been reported.⁴ However, it does tend to bind blood clotting factors and, in fact, has been used to isolate factors II and X.⁵ Use of fumed silica has generally been successful; one trade name reported is Aerosil 380; Sigma's comparable product is S5130, 0.007 micron particles.

General Procedure For Delipidizing Serum:⁶

Add 20 g of fumed silica, Catalog Number S5130/L serum (or 20 mg/mL serum), mix well for 2-3 hours or overnight. Centrifuge at 2000 g for 15 minutes. Wash the pelleted silica with buffer, then recentrifuge the supernatant liquid. Any pellet can be re-washed to recover as much serum as possible.

Disadvantages:

- a. About 15% of the sample volume will be irretrievably lost, adsorbed to the silica.
- b. The fumed silica is extremely fluffy and somewhat difficult to handle. The use of a fine-dust filter respirator is recommended. The fumed silica must be added as a dry powder to the serum, since once it is wet, the silica becomes very slimy and is extremely hard to handle as a heavy precipitate.
- c. The silica is suitable for serum but cannot be used on plasma. The surface will activate clotting factors.

References:

- 1. Sigma quality control.
- 2. Supplier data.
- 3. Brunauer, S. et al., *J. Am. Chem. Soc.*, 60, 309 (1938).
- 4. Agnese et al., *Clin. Biochem.*, 16, 98-100 (1983).
- 5. Sigma production department.

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