TechNote 104

# Silica Microspheres

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## I. INTRODUCTION

Our inorganic microspheres, made from pure silica ($SiO_2$), are available as aqueous suspensions or as free-flowing, dry powders. These particles are important in a variety of diverse applications, like DNA or RNA purification, flat panel displays, velocimetry studies, and immunoassays.

## II. DESCRIPTION

| | |
|---|---|
| Diameters Available: | 150nm-6.0µm |
| Standard Deviation: | < 10% |
| Density: | 2.0 g/cm$^3$ |
| Refractive Index: | ~1.43-1.46 (589nm) |
| Dielectric Constant: | 2.8 |
| Porosity: | None |
| Surface Groups: | SiOH (non-functionalized), $NH_2$, or COOH |
| Glass Transition Temp: | >>1000˚C* |

** Reported value for bulk silica.*

## III. APPLICATIONS

### A. Nucleic Acid Adsorption to Silica Microspheres

Nucleic acid (and not protein) is isolated from materials, such as serum or cell lysates, by mixing the material with a chaotropic substance and a nucleic acid-binding solid phase (silica). DNA is isolated from human serum when 3 M KI, NaI, or NaSCN in combination with 8 M urea are used as chaotropic substances. HIV virus RNA is isolated from human serum using guanidine thiocyanate and silica. The isolated DNA or RNA is then amplified using PCR.[1,2]

It should also be possible to reverse the silica charge and adsorb negatively charged DNA. This is accomplished by rinsing clean silica in a 0.1-1 M $CaCl_2$ solution.

The $Ca^{++}$ ions would normally coagulate the microspheres. But, if the microspheres are put into a solution with excess $Ca^{++}$ ions very quickly, with good mixing, then every negative charge will pick up a $Ca^{++}$ ion. The result will be a positively charged surface. Wash the microspheres with very clean deionized water to remove excess $Ca^{++}$ and counterions. Negatively charged DNA should then adsorb directly onto positively charged silica microspheres.

### B. Spacers in Flat Panel Displays

Microspheres maintain a uniform gap between the two glass panels used to form a flat panel display (such as the display on your laptop computer). Our silica microspheres are the perfect material for displays that require great uniformity in gap space, coupled with little compressibility and high temperature tolerance (~1000˚C). Especially suited for use in epoxy seals that require high curing temperatures, these chemically inert microspheres won't stack on top of each other as cut glass rods sometimes do. We are happy to accommodate display manufacturers by supplying our microspheres as either free-flowing powders or in aqueous suspensions.

### C. Seed Particles for Velocimetry

Because of our silica microspheres' unique properties, researchers are using them for Laser Doppler Velocimetry (LDV), Particle Imaging Velocimetry (PIV), Digital Imaging Velocimetry (DIV), Laser Speckle Velocimetry (LSV), and other methods of flow visualization and measurement. The wide variety of diameters permits optimum choice of microspheres large enough to give good signal-to-noise ratios, yet small enough to accurately follow the flow.

Tight control of the microsphere diameter (standard deviations usually <10%) means that the microspheres respond uniformly, with all particles moving at the same speed in a flow stream. High temperature resistance (up to 1000˚C) makes them especially well suited for studying flows at elevated temperatures.

**D. Immunoassay and Miscellaneous Applications**

Because hydrophilic silica does not adsorb proteins, our microspheres are used in immunoassays in which very low nonspecific protein binding is vital. Silica's density makes it ideal for easy, rapid separation in tests and immunoassays. Optical based tests and assays take advantage of silica's unique refractive index (1.37 versus 1.59 for polystyrene).

Silica microspheres (1µm in diameter) were used as the solid support in a series of laser trapping experiments to study the interaction of actin and myosin. These microspheres are very easily manipulated.[3,4,5]

Applications of silica are limited only by your imagination. We welcome the opportunity to hear about your ideas!

## IV. WORKING WITH THE MICROSPHERES

**A. Drying Silica Microspheres**

Silica microspheres (> 0.5µm in diameter) can be dried to a free-flowing powder; however, they should first be washed with an organic solvent, such as ethanol or THF. To change the liquid phase, gradually move the microspheres through water / ethanol (or THF) solutions with increasing solvent concentration.

Separate the microspheres from solution by allowing them to settle, then remove most of the liquid. Alternatively, they may be centrifuged or filtered.

The microspheres are then dried from a moist cake, either in the open air or in a drying oven (with or without a vacuum). If using a drying oven at 70˚C, it will take approximately 24 hours. After drying for the specified amount of time, the cake should be crushed with a mortar and pestle and dried again. After the final crushing with a mortar and pestle, the microspheres will be in the form of a free-flowing powder.

**B. Suspending Powdered Microspheres**

Our 100% solids silica microspheres can be easily dispersed in water or aqueous solutions. Begin by adding the appropriate weight of silica powder to buffer. Dilute solutions are easier to work with, so use the lowest concentration possible. Vortex well to mix.

Suspend the vial or tube containing the silica suspension in a sonic bath. (Sonic probes are virtually useless at dispersing powders.) Better sonication is achieved if the vessel containing the suspension is held above the floor of the sonic bath with a clamp, rather than resting on the bottom. The bath must also be filled to the proper level, which depends on the model. Apparently, sonication is something of an art form.

Sonicate for approximately 10 minutes, then confirm that the microspheres are dispersed by viewing under a light microscope. Individual microspheres ~1µm in diameter are visible under 1000x magnification. Clumps made of microspheres < 1µm in diameter will be clearly visible under the same magnification. If clumps are visible, sonicate again for 10 minutes. Continue with 10 minute cycles until the microspheres are completely dispersed.

## V. REFERENCES


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