

The PTB Cleaning Procedure for Silicon Spheres





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1 Introduction

At present, a new approach to define and realize the SI unit of mass (the kilogram) is being investigated. Essentially, the kilogram could be defined as the mass of $\{N_A\} \cdot 1000/12$ carbon-12 atoms by fixing the numerical value of N_A . A Si sphere is used for the realization of the kilogram based on N_A . In this case, a relative uncertainty of 2×10^{-8} on N_A has been recommended. To achieve this, the appropriate handling of Si spheres including cleaning is very important. So PTB developed new procedure for that.

The procedure for handling of Si spheres consists of inspection, cleaning, storage, etc. Specially, this procedure will be describing the cleaning of Si spheres.

2 The PTB cleaning method for silicon spheres

2.1 Preparation

To prepare the cleaning of the silicon spheres, a clean workspace has to be equipped with a laboratory tray and a cleaning holder with PEEK (Poly Ether Ether Ketone) bearing. Before starting the holder upon which Si spheres rest need to be cleaned and washed by the same method as used for Si spheres. In addition, it is necessary to use clean glass beakers.

The deconex OP 163 which is used for cleaning is a pH neutral, salt-free cleaning concentrate for precision optical components. Due to special surfactants, it provides glass surfaces with a complete wetting and therefore, guarantees thorough cleaning and removing of slightly adhering organic and inorganic residues like fingerprints, dust etc.

Filling the fluids into the beakers should take place shortly before the actual cleaning, to reduce the danger of contamination. Personal lab coats should be "lint free" and clean; suitable gloves should also be worn.

All devices which are required in the cleaning process are listed below.

2.1.1 Cleaning supplies



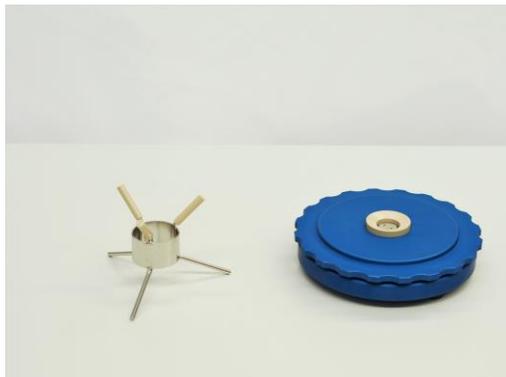
- Ethanol for analysis in purity of 96%
- Distilled water
- Deconex OP163 solution (2%)
- Cleaned beakers (600 ml, 250 ml and 100 ml)

2.1.2 Cleaning deconex solution



- Surfactants (deconex OP 163)
- Fill 2 ml of surfactants in 250 ml beaker by using a pipette
- Fill about 100 ml of distilled water in the beaker to make a surfactant solution of approximately 2 %.
- This solution is used for cleaning.

2.1.3 Sphere holder and rotary plate



- Stainless steel holder covered with PEEK and rotary plate made of aluminum with PEEK to place Si sphere.
- One of both can be used for placement of Si sphere during initial inspection and final check.
- Rotary plate is used in this instruction.
- PEEK material is very important to avoid scratches on the surface of the Si sphere

2.1.4 Torch and air bellows



- Torch and air bellows are used for initial inspection before cleaning and the final check after cleaning.

2.1.5 Microfibre cloth and pads



- Microfibre cloth is a knit wiper for precision cleaning.
- Specification:
 - knitware structure,
 - mesh density per 900 cm²,
 - thickness 0.72 mm.
- Within this cleaning method, 3 kinds of microfibre cloth are used for cleaning, storage and drying of Si spheres.

2.1.6 Nitrile Gloves



- Powder-free and 100% accelerator-free nitrile gloves with textured fingertips.

2.1.7 Transport container



- The transport container is used to store and transport the Si sphere to laboratory after cleaning.
- The base is made of PEEK and covered with a microfiber pad to avoid Si sphere's surface scratch.



2.2 Cleaning

The cleaning method for Si spheres used at the PTB now will be introduced. For cleaning microfibre cloth, the distilled water, the diluted surfactant solution and ethanol are used. This procedure is divided into the following steps and starts with the disassembly of the transport container, then carried out initial inspection, cleaning with deconex OP163 solution, rinsing with distilled water, rinsing with ethanol, final check, and assembly of transport container.

During cleaning of Si spheres, it is important not to move the Si spheres in the holder to avoid scratch marks. So it is recommended to hold it with one hand during cleaning.

First the transport container is disassembled and after that gloves are put on. The silicon sphere is taken out and is carefully placed on the cleaning holder for the initial inspection. The surface of the sphere is checked for any contamination using a torch. The sphere is carefully lifted and turned over, so that the underside can be checked. This procedure gives us an impression of where any contaminants are located, and of the degree of contamination.

About 500 ml of the distilled water are to be filled into a beaker. The deconex solution is to be prepared freshly. To do this, the cleaning fluid is put into the clean beaker using a pipette. Then the beaker is filled up to the required level with distilled water. The fluids are mixed together by slewing the beaker. At least approximately 80 ml of ethanol are filled in the third beaker.

Before the actual cleaning begins, the gloves have to be cleaned with deconex solution. After rinsing them off with distilled water, the individual steps in the cleaning procedure can be carried out.

For cleaning, microfibre pads with a diameter of 60 mm are used. These are only now placed ready to hand. After being pre-rinsed with distilled water, the microfibre pads are then used for the cleaning process with the deconex solution. The cleaning itself is carried out by applying light pressure and moving the microfibre pads in circles.

The sphere is lifted and turned over once again, so that the underside can also be cleaned. The cleaning pads are thrown away after the successful cleaning of the sphere.

After the gloves have been rinsed with distilled water to remove the surfactant, the sphere itself is rinsed several times with distilled water. This needs to be done from both sides.

Following this, the gloves are rinsed with ethanol and dried.

Next, the silicon sphere is rinsed with ethanol several times. Apart from drying more quickly, the even drying off of the ethanol is a sign of successful cleaning. This procedure is also done from both sides.

To finish the procedure, the silicon sphere is lifted up with a microfibre cloth and dried off. Direct contact between the sphere and the gloves is avoided while doing this. For safety reasons, the drying process takes place over a padded plastic box. The cleaned sphere is then placed on a rotary plate for the final check.

During the final check, any dust particles are removed with air bellows, if necessary. A protective glass bell is placed over the sphere which has now been cleaned. The sphere is now ready for the next measurement.

2.2.1 Disassembly of transport container



- Disassemble the cover of the transport container by releasing top screw first.



- Remove the 3 bottom screws and lift the cover carefully without contact to the Si sphere by using the guide plate.



- Remove the microfiber pad on the top of the Si sphere.



- Move the Si sphere to the cleaning holder.



- Remove the microfiber pad on the base of transport container.



- Assemble the cover of transport container to prevent dust from getting in transport container.

2.2.2 Initial inspection before cleaning

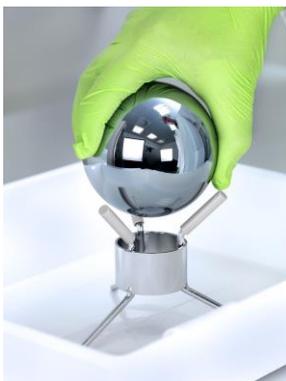


- Put the nitrile glove on hand clean it with the deconex solution, and rinse with distilled water.
- Put the Si sphere on the rotary plate very carefully.



- Carry out initial inspection to find dust and scratch on the surface of the Si sphere with a torch and use air bellows to remove dust before cleaning, if necessary.

2.2.3 Placement of sphere on a cleaning holder



- Put the Si sphere carefully on the cleaning holder.

2.2.4 Cleaning with deconex solution



- Rinse the surface of Si sphere several times with 2 % deconex solution.



- The Si sphere is rubbed several times with light pressure by hand over its upper surface using a microfibre pad which has been saturated with the surfactant's solution of about 2%.
- Avoid moving the sphere in the holder during rubbing.
- The Si sphere is then turned up so that it now rests on the surface which has just been cleaned.
- Repeat the previous procedure.

2.2.5 Rinsing with distilled water



- Rinse the nitrile glove with distilled water, and after that with ethanol.
- Let the gloves dry.
- Rinse the surface of the Si sphere several times with distilled water.
- The Si sphere is then inverted so that it now rests on the surface which has just been rinsed.
- Repeat the previous procedure.

2.2.6 Rinsing with ethanol



- Rinse the surface of the Si sphere several times with ethanol.
- The Si sphere is then inverted so that it now rests on the surface which has just been rinsed.
- Repeat the previous procedure.
- Check for even drying off of ethanol

2.2.7 Final check after cleaning



- Lift the silicon sphere with microfiber cloth on the top of the sphere.



- Dry off with microfiber cloth.



- Put the Si sphere very carefully on the rotary plate.



- Carry out final check to find dust and scratches on the surface of the Si sphere with torch. Use air bellows to remove dust after cleaning, if necessary.

2.2.8 Storage of Si sphere and assembly of transport container



- Put a microfibre cloth on the base of the transport container.



- Place the Si sphere on the base of transport container.



- Put a small microfibre cloth on the top of the Si sphere.



- Assemble the cover of transport container carefully without contact to the Si sphere.



- Fasten the lower bolts.



- Fasten the top screw finally.