U. S. Department of Commerce
Malcolm Baldrige
Secretary

National Bureau of Standards
Ernest Ambler, Director

National Bureau of Standards

Certificate

Standard Reference Material 1965

Microsphere Slide (10-μm Polystyrene Spheres)

This Standard Reference Material (SRM) is intended for use as an optical microscopy measurement standard and teaching tool. The SRM is a microscope slide with two different groupings of 10-μm "space beads" permanently deposited on the surface and sealed in an air chamber (Figure 1). Each slide contains a few thousand microspheres. The microspheres are from SRM 1960, Nominal 10-μm Diameter Polystyrene Spheres, the first commercially available made-in-space product.

The microspheres in SRM 1965 are deposited in two different groupings: hexagonally ordered arrays and unordered clusters. The number average diameter of the particles in both groupings were measured by Center Distance Finding (CDF), an optical technique related to array sizing [1]. The certified values are:

	Number Average Diameter, μm	Uncertainty, μm
Hexagonal array	9.94	±0.04
Unordered clusters	9.89	±0.04

The uncertainty consists of both random and systematic errors, and includes sample-to-sample variability.

The number average diameter of the particles in the unordered clusters is the same as that of the microspheres in SRM 1960, from which the slides were prepared. The number average diameter of the spheres as measured in the hexagonal arrays is slightly greater due to a combination of three effects: (1) the measured mean diameter of spheres in hexagonal arrays is larger than the actual mean diameter by 0.04 μm due to the Kubitschek Effect (See SP 260-107 for detailed discussion); (2) the spheres are slightly swollen, by 0.03 μm, due to the processing required to produce the hexagonally-ordered arrays; and (3) the spheres are flattened at the contact areas by 0.02 μm.

The size distribution of the polystyrene spheres from which SRM 1965 was prepared, as determined by CDF [1], is a narrow Gaussian with a standard deviation of 0.9% (excluding particles with diameters not on the main peak). The number of under-sized particles is negligible and the number of oversized particles is less than 1%.

The microsphere slide is expected to have an indefinite shelf life as long as the sealed cavity is not disturbed and the slide is handled with normal precautions and care.

Recommended Use: SRM 1965 can be used for a number of calibrations and exercises in micrometrology. The hexagonal arrays can be used as a two-dimensional microlength standard to replace calibrated "stage" micrometers. The hexagonal array can also be used for array sizing, diffraction experiments in crystallography, and for calibrating microscope image distortion and magnification. These applications, and a number of other exercises and techniques for optical micrometrology are described in detail in NBS Special Publication SP 260-107, which is supplied with the SRM.

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Gaithersburg, MD 20899

Stanley D. Rasberry, Chief
Office of Standard Reference Materials

(Over)

The technology necessary to produce these latex particles was developed by the Lehigh University and the National Aeronautics and Space Administration (NASA) during five shuttle missions in 1982 and 1983. The 10-μm particles in this SRM were manufactured in space aboard the Space Shuttle CHALLENGER during the NASA STS-6 mission, 4-9 April 1983. The particles were provided by NASA for certification by NBS as a Standard Reference Material to be made available to the scientific and technical communities.

The technical direction, production and physical measurements leading to the preparation and certification were provided by A.W. Hartman of the Precision Engineering Division.

Manufacture of the particles was carried out under the direction of J.W. Vanderhoff of the Lehigh University and D.M. Kornfeld of the National Aeronautics and Space Administration.

The technical and support aspects involved in the preparation, certification and issuance of this Standard Reference Material were coordinated through the Office of Standard Reference Materials by R.L. McKenzie.

[1] Hartman, A.W., Powder Technol, **42** (1985) 269.