National Institute of Standards & Technology

Certificate of Analysis

Standard Reference Material 2072

Sinusoidal Roughness Specimen

Serial No.

This Standard Reference Material (SRM) is certified for roughness average, R_a, and surface wavelength, D, and is intended for use as a standard for the calibration of stylus instruments that are used to measure surface roughness. The SRM is a steel block of nominal Knoop hardness 500 which has been nickel coated by the electroless nickel process. A sinusoidal roughness profile was machined onto the top surface of the specimen in a facing operation by a single-point, diamond tool on a numerically controlled lathe.

The roughness average, R_a, is the average absolute deviation of the surface peaks and valleys about the mean line and is defined in the ANSI Standard B46.1 entitled "Surface Texture". The surface wavelength, D is the average period of the sinusoidal surface profile.

The parameters R_a and D were calculated from roughness profiles of the SRM's measured with a stylus instrument interfaced to a minicomputer and a laser interferometer. The profiles were measured following the procedures in ANSI Standard B46.1. The instrument was operated in the skidless mode with an external reference datum. The cutoff length was 0.8 mm and the sampling rate was 1 point per µm over the traversing length of 4.0 mm. The stylus instrument was calibrated using an interferometrically measured step, and the stylus had a tip width of 2.0 ± 0.4 µm. The width is defined to be the distance between the two points of contact when the stylus tip profile is inscribed in a 150° angle.

The certified R_a and D values for this specimen are:

Roughness Average (R_a), µm	Surface Wavelength (D), µm
± 0.027	101.64 ± 0.24

The technical direction and physical measurements leading to certification were provided by T.V. Vorburger and C.H.W. Giauque of the Center for Manufacturing Engineering and J.F. Song, guest researcher.

Guidance on statistical analysis was provided by M.C. Croarkin of the NIST Statistical Engineering Division.

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.

Gaithersburg, MD 20899
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William P. Reed, Acting Chief
Office of Standard Reference Materials

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The specimens were machined by Pneumo Precision, Inc. of Keene, N.H. using a single-point, diamond tool in a facing operation with a numerically controlled tool path. The surface profile is sinusoidal to a high approximation but shows a fine-scale structure when the surface is scanned at high resolution, as is shown in Figure 1. The upper profile shown in Figure 1 was obtained with a stylus of width 4 μm. The lower profile was obtained with a stylus of width 0.5 μm. The fine-scale structure has a spacing of approximately 4.2 μm. This structure may be useful for monitoring the quality of fine stylus tips or for checking zero-crossing and peak-counting techniques in surface profile analysis.

The certified values represent average values of 18 profile traces taken in pairs at each of nine distributed positions on the specimen as shown in Figure 2. The certification is valid within the area defined by the extremes of these profile traces. Because of the curvature in the surface markings, the value for D outside the limits of the measured area is expected to increase.

The stylus force was approximately 4×10^{-4} N. This force should cause negligible damage to the hard metal surface; however, faint stylus traces may be visible on the surface. Repeated use with stylus instruments can slowly degrade roughness specimens; however, the specimen is expected to maintain its calibration value for at least five years provided that measurements are taken on clear, undamaged areas.

The uncertainties for R_a and D are sums of instrument calibration uncertainties and random uncertainties. Sources of calibration uncertainty for R_a include: (1) the uncertainty of the height of the calibrating step, (2) the uniformity of the calibrating step, (3) variations in the measured values caused by digital sampling processes and software computations, (4) nonlinearities in the transducer and interface hardware, and (5) uncertainty in the stylus width. The calibration uncertainty for R_a is 0.018 μm and the random uncertainty (3 standard deviations) is 0.009 μm.

Sources of calibration uncertainty for the interferometric measurement of D include the wavelength fitting procedure, changes in the laboratory environment, possible cosine errors in the specimen alignment, and a possible Abbe offset error. The calibration uncertainty for D is 0.03 μm and the random uncertainty (3 standard deviations) is 0.21 μm. The random uncertainties for R_a and D were obtained from prediction intervals, and they take into account instrumental variation and positional variation on the SRM.

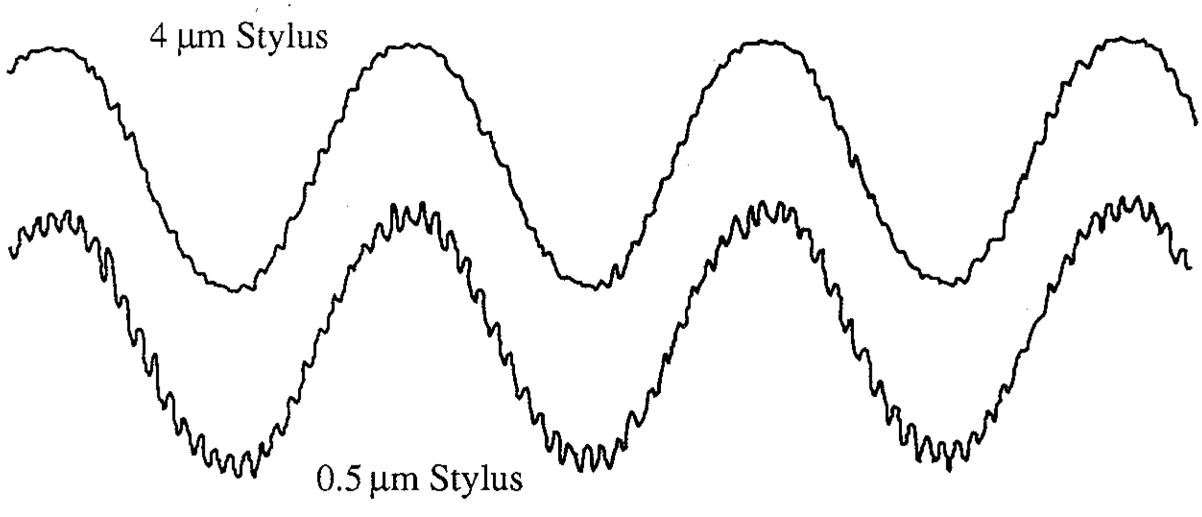

Figure 1. Representative surface profile traces of SRM 2072 using a 4 μm stylus (upper trace) and a 0.5 μm stylus (lower trace).

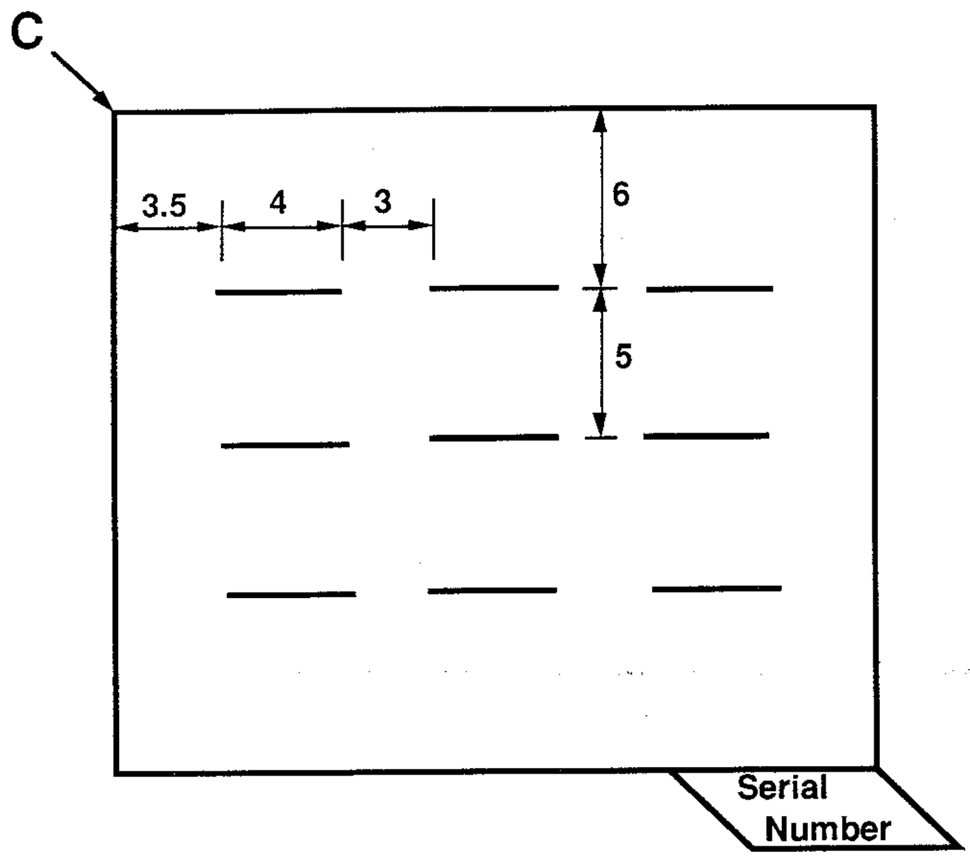

Figure 2. Measurement Positions for SRM 2072. Positions of traces in mm with respect to the upper left corner, C, of the roughness area.