National Institute of Standards & Technology

Certificate

Standard Reference Material 2071a

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 measured with a stylus instrument using procedures in ANSI Standard B46.1. 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 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 stylus instrument was interfaced to a minicomputer and a laser interferometer and its vertical motion was calibrated using an interferometrically measured step. The instrument was operated in the skidless mode with an external reference datum.

The certified R_a and D values for this specimen are:

Roughness Average (R_a), μm	Surface Wavelength (D), μm

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 Standard Reference Materials Program by R.L. McKenzie.

Gaithersburg, MD 20899
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W.P. Reed, Acting Chief
Standard Reference Materials Program

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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 approximately sinusoidal but shows a fine-scale structure as well (figure 1).

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 certification is valid within the area defined by the extremes of the profile traces shown in figure 2. The certified value for R_a is the average of 12 profile traces taken at six positions indicated as "R_a" in figure 2.

The uncertainty for R_a is the sum of the instrument calibration uncertainty, the random uncertainty, and a systematic uncertainty due to the specimen. 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 0.0096 μm. The random uncertainty for R_a (3 standard deviation prediction limits) is 0.0028 μm. This quantity takes into account instrumental variations in the measured values. The systematic uncertainty for R_a is due to a monotonic variation in roughness over the specimen from left to right when viewing the specimen as illustrated in figure 2. The value of 0.0025 μm is the largest bias expected for a measurement taken at any unflawed position within the certified area.

The certified value for D represents an average of the 18 profile traces taken in pairs at all nine distributed positions on the specimen as shown in figure 2. Unlike the measurements of R_a, the measurements of D did not disclose systematic variation over the specimen surface. The certified value represents a grand average of the results for D calculated for the entire set of these standard reference materials.

The uncertainty for D is the sum of the calibration uncertainty and the random uncertainty. The calibration uncertainty for D is based on several sources of uncertainty in the interferometric measurement of displacement including the interpolation procedure for calculating wavelength, variation 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. The random uncertainty for D (3 standard deviation prediction limits) is 0.28 μm. This value applies to a measurement at any unflawed position within the certified area and takes into account both instrumental and positional variations.

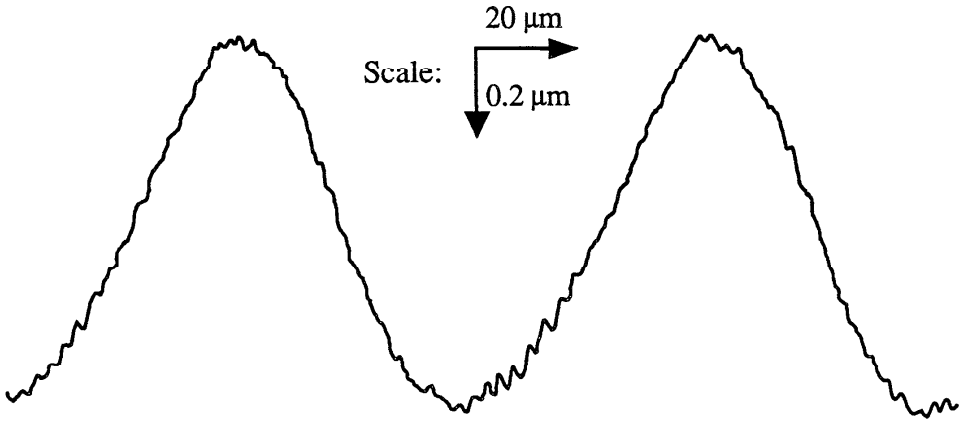

Figure 1. Representative surface profile trace of SRM 2071a. Dimensions are approximate

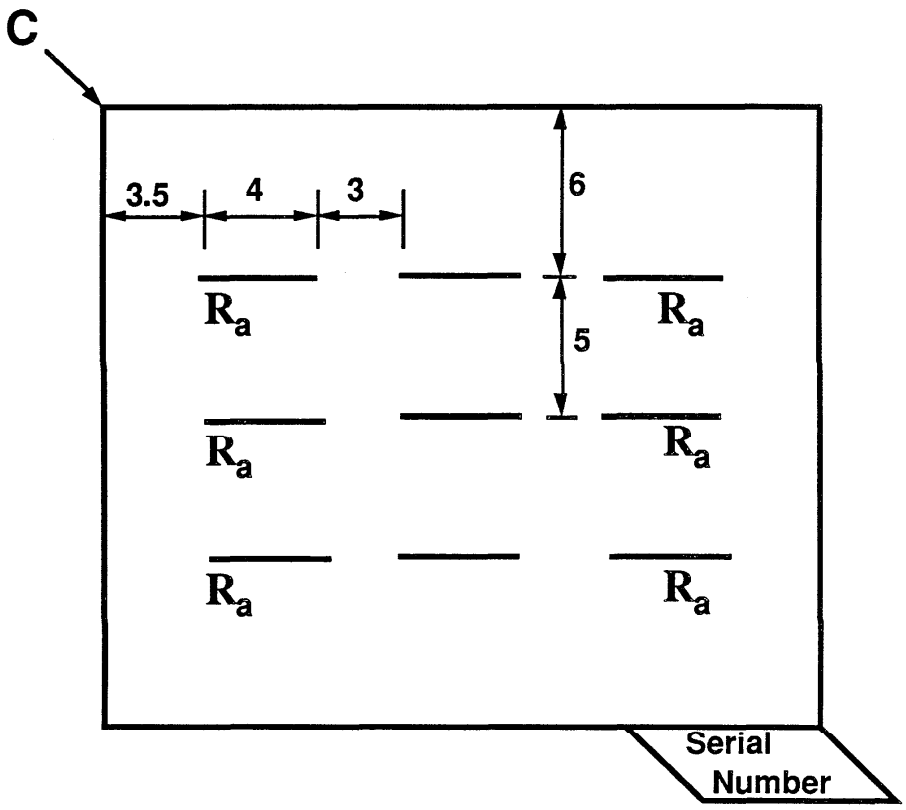

Figure 2. Measurement Positions for SRM 2071a. Positions of traces in mm with respect to the upper left corner, C, of the roughness area.