Sample Certificate for Planotec Silicon Test Specimen S1932 #660-615-A through #660-615-5

SILICON TEST SPECIMEN S1932

CALIBRATED SPECIMEN NO: B548 **DATE: 2nd October 2013**

PURCHASER:

Ted Pella Inc
4595 Mountain Lakes Blvd
Redding
California 96003 -1448, ,
United States

Certificate of Calibration

This specimen has been calibrated by diffraction measurements taken from an area approximately 1mm diameter at the centre of the grating area.

The specimen was illuminated by a laser beam of wavelength 632.8nm, and the angular separation of the diffraction beams measured on a certified calibrated rotary table.

The line scribed on the face of the mount was first set horizontal so that rulings perpendicular to this diffracted the incident beam in a horizontal plane (orientation A).

The angular separation of the third to the sixth diffracted beams either side of the centre beam was measured.

The specimen was then rotated to bring the scribed line to the vertical position in order to measure the rulings at right angles (orientation B).

The complete series of readings were performed in duplicate.

The mean angular separation of each diffraction order was calculated. The relationship between the diffraction angle and the grating spacing is given by

$$n\lambda = 2d \sin\theta$$

where n = diffraction order
λ = illumination wavelength 632.8nm
d = grating spacing in nm
2θ = angle between corresponding diffraction orders on either side of the central beam

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Orientation A

		θ	Sinθ	d (μm)
Mean Diffraction angle for	3rd order	5° 26.7'	0.09489	10.00
	4th order	7° 16.3'	0.12657	10.00
	5th order	9° 6.0'	0.15816	10.00
	6th order	10° 56.5'	0.18981	10.00

Orientation A: Mean spacing = 10.00 micrometres.

The uncertainty in the measurement of the diffraction angle is estimated as ±1'.

Orientation B

		θ	Sinθ	d (μm)
Mean Diffraction angle for	3rd order	5° 26.8'	0.09492	10.00
	4th order	7° 16.5'	0.12664	9.99
	5th order	9° 6.3'	0.15825	10.00
	6th order	10° 56.8'	0.18989	10.00

Orientation B: Mean spacing = 10.00 micrometres.

The uncertainty in the measurement of the diffraction angle is estimated as ±1'.

Measurements obtained with the diffraction apparatus of Agar Scientific on a similar grating were compared with independent measurements on the same grating certified by the National Physical Laboratory (NPL).

The reference of the NPL certified grating is EO3120071/DR2/33.

The instruments used by the NPL for the calibration of this grating were a scanning electron microscope fitted with a Helium-Neon laser interferometer and an optical microscope which was also fitted with an interferometer.

The grating had a pitch of 10 micrometres and the uncertainty in the measurement of 10 pitches with the optical microscope was ±0.2 micrometres. The uncertainty in the measurement of individual pitches with the scanning electron microscope was ±0.05 micrometres. The measurements obtained with the diffraction technique of Agar Scientific were in agreement with the certified calibration of the NPL to within the tolerances quoted.

The calibration of a grating using the diffraction technique effectively integrates the pitch spacing over a number of lines and the resultant measurement uncertainty is estimated to be ± 0.02 micrometres.

S. Snell
Laboratory Manager

C. Noel
Laboratory Technician

Notes for User of Calibrated Specimen B548

It should be pointed out that the diffraction measurements integrate over a considerable number of rulings, and therefore give a mean spacing with a high degree of accuracy. The results of a study at the National Physical Laboratory (NPL) suggest that the specimens are in fact very consistent in spacing in different areas of the surface. However, the measurement uncertainty in attempting to measure a single line spacing does not permit us to assume that any individual line spacing is necessarily equal to the mean value. It is therefore prudent always to measure over at least 10 line spacings where possible, to reduce the potential for error.