

Example Certificate Of Calibration

#79502

Certificate of Calibration

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

A laser beam of wavelength 632.8 nm illuminated the specimen, 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 center 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 spacings is given by :

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

Where n = diffraction order

λ = Illumination wavelength 632.8 nm

d = Grating spacings in nm

2θ = angle between corresponding diffraction orders on either side of the central beam

Silicon Test Specimen

Orientation A

Mean Diffraction angle for:	()	Sin()	d μ
3 rd order	5° 26.4'	0.09481	10.00
4 th order	7° 16.3'	0.12657	10.00
5 th order	9° 6.1'	0.15819	10.00
6 th order	10° 56.4'	0.18978	10.00

Orientation A: Mean spacing = 10.00micrometers.

The uncertainty in the measurement of the diffraction angle is estimated as $\pm 1'$.

Orientation B

Mean Diffraction angle for:	()	Sin()	d μ
3 rd order	5° 26.5'	0.09484	10.00
4 th order	7° 16.2'	0.12654	10.00
5 th order	9° 6.3'	0.15825	10.00
6 th order	10° 56.5'	0.18981	10.00

Orientation B: Mean spacings = 10.00 micrometer.

The uncertainty in the measurement of the diffraction angle is estimated as $\pm 1'$.

Measurement obtained with the diffraction apparatus of EMS 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 08A032/97017/ML73/103.

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 micrometers and the uncertainty in the measurement of 10 pitches with the optical microscope was ± 0.2 micrometer. The uncertainty in the measurement of individual pitches with the scanning electron microscope was ± 0.05 nm. The measurements obtained with the diffraction technique of EMS 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 micrometers.

Notes for User

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 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.

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