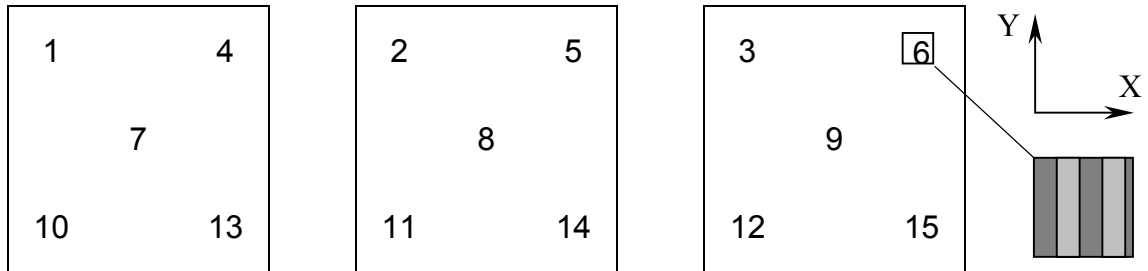


Calibration procedure of TGZ gratings

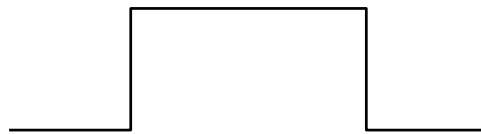
Two gratings to be calibrated are placed on each side of the test grating certified at National Institute of Standards and Technology (Gaithersburg, MD, USA). Measurements are made in tapping mode in accordance with procedure described in ISO 5436.

Areas to be scanned are selected in the following succession



Then the stage with gratings is turned by 180° and measurements are performed the same way.

Each area includes 2-3 periods. 256×256 height values are measured in every area. This array is then averaged over X-coordinate and a fraction $n_x \times n_y$ of step-like profile (one period) is considered thereafter:



These scans are processed by TGZpro routine which computes height difference at points in low-high-low regions and yields (relative) height of the step H_i (or H_j^{NIST}), the mean of n_y scans in the area measured and standard deviation over these scans.

If standard deviation exceeds acceptable value (0.5 nm for TGZ01, 0.7 nm for TGZ02 and 1 nm for TGZ03), apparently inconsistent n scans are thrown away, and height value derived from the rest $n_y - n$ scans is used.

As all 30 areas are measured, 20 scaling factors K_i are calculated according to the following scheme:

$$K_i = \frac{H_i}{H_{i+1}^{NIST}}, \text{ if left and test gratings are considered, and}$$

$$K_i = \frac{H_i}{H_{i-1}^{NIST}} \text{ if right and test gratings are considered } (i = 1, 3, 4, 6 \dots 28, 30)$$

Then standard deviation for 10 factors corresponding to each grating is calculated. If standard deviation exceeds acceptable value, measurements over the area with apparently suspect value of K_i is repeated using both test grating and grating to be calibrated. If it doesn't help the grating is regarded as useless.

Then values of K_i are processed using the following algorithm:

$$1) K = \frac{\sum_{i=N} K_i}{N}$$

$$2) U(K) = \sqrt{\frac{N \sum_{i=N} K_i^2 - \left(\sum_{i=N} K_i \right)^2}{N^2}}$$

$$3) H = H_{NIST} \cdot K,$$

where values H_{NIST} of 523.6 nm, 97.97 nm and 21.49 nm for TGZ03,02,01 correspondingly are taken from NIST certificate for test gratings

$$4) U(H) = \sqrt{H_{NIST}^2 \cdot U(K)^2 + K^2 \cdot U(H_{NIST})^2},$$

where values $U(H_{NIST})$ of 2.05 nm, 0.225 nm, 0.125 nm for TGZ03,02,01 correspondingly are taken from NIST certificate for test gratings

$$5) D_f = \frac{U(H)^4}{\frac{H_{NIST}^4 \cdot U(K)^4}{D_f(U(K))} + \frac{K^4 \cdot U(H_{NIST})^4}{D_f(H_{NIST})}}$$

where $D_f(U(K))=9$, and $D_f(H_{NIST})=17$ for TGZ01,02 and 8 for TGZ03 are taken from NIST certificate for test gratings

$$6) \Delta_{\text{exp}} = U(H) \cdot \bar{S}(D_f, 0.05),$$

where $\bar{S}(D_f, 0.05)$ is inverse Student's distribution for degrees of freedom D_f and probability 0.05

The values of H and confidence interval Δ_{exp} are specified in certificate.