

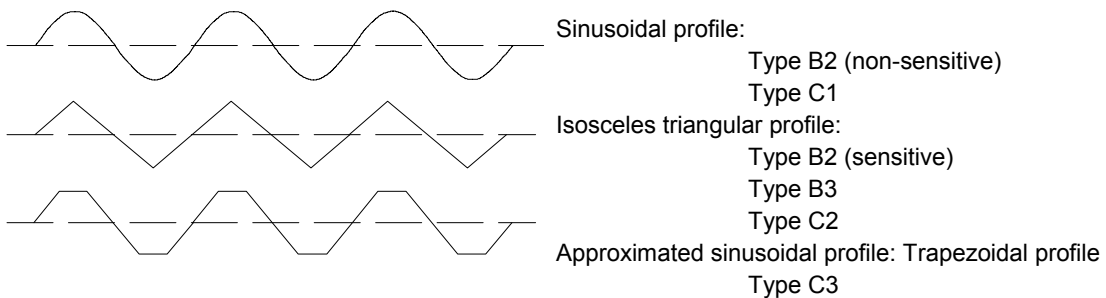
Grating Type Gr-P

1. General

The European Standard EN ISO 5436-1 (EN ISO 5436-1:2000-11 GPS-Surface texture: Profile method; Measurement standards-Part 1: Material measures) includes measures, among them type B „Standard for the assessment of the stylus tip“ and type C „Gratings“ for the calibration of the instruments with regards to their aptitude for the determination of RSm and Ra. In both cases the standards are linear gratings, whose cross sections are suitable for the respective application.

Type B distinguishes different cases, among them type B2 with two designs: “sensitive” gratings: these are triangular (isosceles) profiles with such lengths of periods (PSm) and peak angles α that the value of Ra is dependent on the radius of the stylus tip and “non-sensitive” gratings: these are approximately sinusoidal or arched profiles, whose RSm is so large, that the value of Ra is independent on the radius of the stylus tip. Type B3 is an edge with very small radius $R < 0.1 \mu\text{m}$ (razor blade).

Standards of type C are sinusoidal, arched or triangular profiles as well as approximated sinusoidal profile as trapezoidal and rounded triangular profiles.



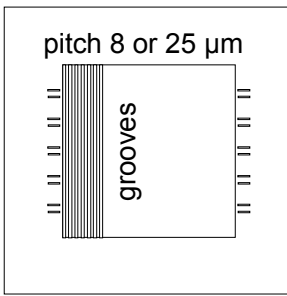
Gratings with such profiles can be technologically realized in silicon. In particular the demanded material properties are guaranteed.

J. Frühauf, S. Krönert: Linear Silicon Gratings with Different Profiles: Trapezoidal, Triangular, Rectangular, Arched, Proc. XI. Int. Colloquium on Surfaces, Chemnitz-Germany, 2005, Part II p. 75

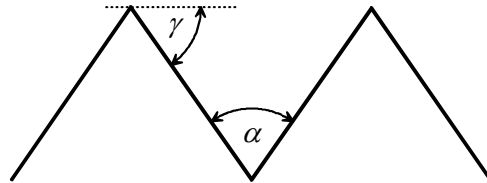
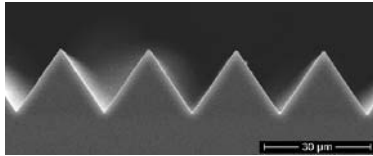
J. Frühauf, S. Krönert: Wet etching of Silicon Gratings with Triangular Profiles, Microsystem Techn., 2005, 11, p. 1287

M. Seifert et al.: Assessment of Tactile Profilers by Use of Regular Surface Artefacts with Periodically Triangular Cross Section, Proc. XII. Int. Colloquium on Surfaces, Chemnitz-Germany, 2008, p. 313

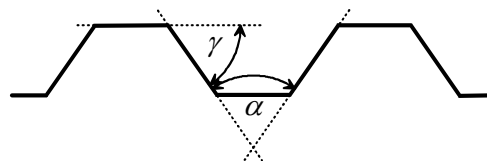
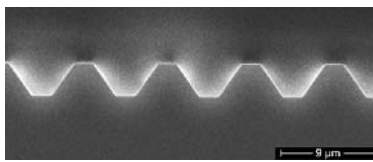
2. Structure



Triangular profile



Trapezoidal profile

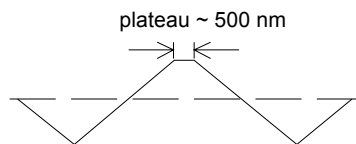


The grating of type Gr-P is available with a triangular or trapezoidal profile of the grooves. The field size of 6 mm x 6 mm lies inside a chip of 10 mm x 10 mm (thickness 525 μm). Right and left hand side of this field there are marks (double lines 300 μm x 30 μm) in positions of 1, 2, 3, 4 and 5 mm along the grooves.

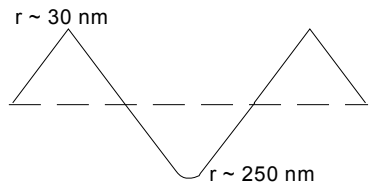
Depending on the crystallographic orientation of the used silicon wafer the sidewalls of the grooves have inclination angles $\gamma = 54.74^\circ$ or 35.26° . An opening angle of $\alpha = 180 - 2\gamma$ results. The grating with trapezoidal profile can be fabricated with $\alpha = 70.52^\circ$, the grating with triangular profile with $\alpha = 70.52^\circ$ or 109.48° . The available pitch lengths are 8 resp. 25 μm. The edges of the profiles are very sharp.

Two kinds of triangular profiles are available:

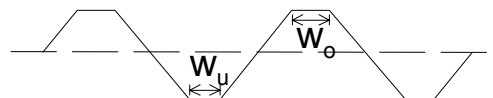
Triangular profile 1: blunting at the edges



Triangular profile 2: very sharp edge rounded etch ground



At the symmetric trapezoidal profile the widths of the horizontal regions can be different :



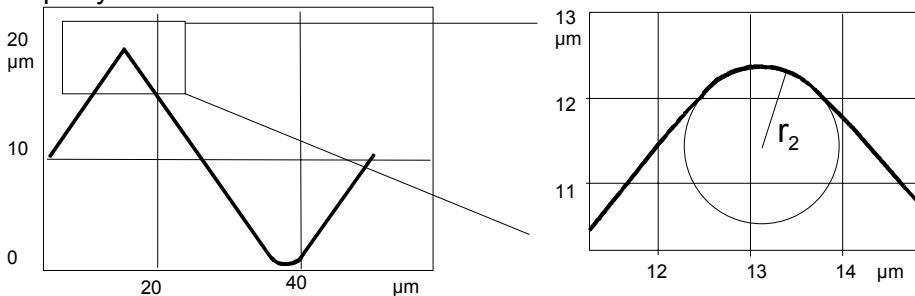
$w_o - w_u = 40 \dots 770$ nm
(depending on the period of the grating)

3. Use

The gratings Gr-P are preferentially intended for use according to the Standard EN ISO 5436-1. Other applications are possible. For instruments equipped with a stylus having a cone angle of 90° the gratings with an opening angle of $\alpha = 109.48^\circ$ are suitably, whereas both types of gratings can be used if the stylus has a cone angle of 60° .

• Inspection of the shape of the stylus tip

The inspection is performed by measuring the profile across a sharp edge with radius r_2 . The triangular profile 2 is the most suitable one for this test ($r_2 \approx 30 \text{ nm}$). The profile across the edge has the radius $r = r_1 + r_2$, r_1 is the radius of the stylus tip. If $r_2 \ll r_1$ the radius of the profile corresponds to the radius of the tip. The scan should be performed with minimum probing force and scan velocity. It should be paid attention to the uniformity of the most periods of the scan to exclude the influence of damages of the grating. For the determination of the radius of the stylus tip the measured profile must be equally scaled in vertical and horizontal directions.



• Assessment of the tactile profiling instrument

Calibration of the x-axis

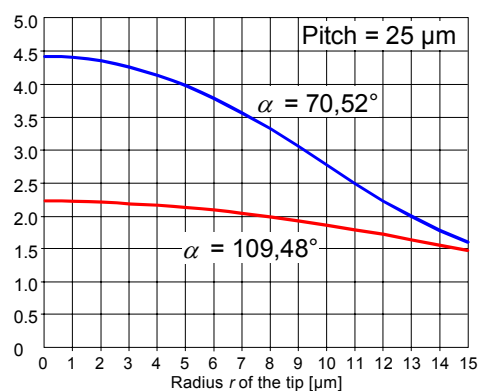
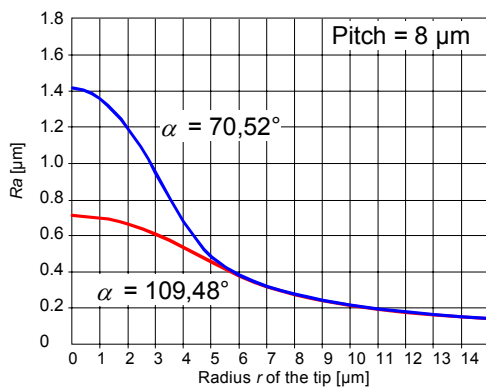
Each of the gratings Gr-P can be used as a line scale with a very precise pitch. Following, the value RSm or PSm determined by the software of the tactile instrument must be equal to the pitch if the x-axis is correctly scaled. The trapezoidal grating or the triangular grating with profile 1 are recommended for this application.

Verification of the z-axis

Using the trapezoidal grating the measured value of Pt (peak to valley) between two maxima of the profile must be equal to the depth of the grooves. The less sensitive trapezoidal grating with a pitch = $25 \mu\text{m}$ is recommended for this application.

Verification of the radius of the stylus tip r_1

Provided that the x- and z-axis are correctly scaled the tip radius can be derived from the value of Ra (Pa) measured at the sensitive triangular profiles 1 according to the graph in the Pa(r)-diagram. The plateau causes an uncertainty of r_1 in the range of 10%. A sufficient number of traces have to be measured.



For information about the possibilities of certification of the standard please contact SiMETRICS.

4. Packaging, Handling and Cleaning

For a better handling the chips with the grating are mounted on borosilicate glass with a size of 5 cm x 5 cm as substrate. Further sizes are possible on request. The chips are mounted by an epoxy resin adhesive.

The standards are stored in a membrane box. The grating for measuring and calibration does not come into contact with the membrane.

Do not touch the silicon chip especially the regions determined for measuring and calibration. Use suitable (plastic) tweezers for handling.

For cleaning the grating the following procedures are recommended:

- Removing of particles of dust: blowing off by pure nitrogen or by compressed air.
- Removing of tightly sticking particles: ultrasonic cleaning in deionised water, rinsing with deionised water, blowing dryly by pure nitrogen or by compressed air.
- Removing of organic deposits: rinsing with ethanol (analytic-grade), rinsing with deionised water, blowing dryly by pure nitrogen or by compressed air.

If none of these methods is successful please contact SiMETRICS for a cleaning process.

5. Assortment and Specification

Type	Profile	Inclination angle of the sidewalls [°]	Pitch [µm]	Pt nominal [µm]	Radius of edge [nm]
Gr-P 25-55t Gr-P 25-55t s	triangular 1 triangular 2 (sharp edge)	54.74	25.0	18	250* 30
Gr-P 25-35t Gr-P 25-35t s	triangular 1 triangular 2 (sharp edge)	35.26	25.0	9	250* 30
Gr-P 8-55t Gr-P 8-55t s	triangular 1 triangular 2 (sharp edge)	54.74	8.0	5	250* 30
Gr-P 8-35t Gr-P 8-35t s	triangular 1 triangular 2 (sharp edge)	35.26	8.0	2.8	250* 30
Gr-P 25-55tz	trapezoidal (symmetric)	54.74	25.0	10**	100
Gr-P 8-55tz	trapezoidal (symmetric)	54.74	8.0	3.2**	100

* half width of plateau

** on request with other Pt – values (asymmetric profile)