

## Review on available calibration artefacts for dimensional measurements of microstructures

This tabulated synopsis contains currently available artefacts which may be used as calibration artefacts and which are suitable for the calibration of instruments used for dimensional measurements of microstructures.

No claim is put forward to the completeness of the list of manufacturers and products. The naming of certain companies and equipment does not imply that they are necessarily the only and/or best suited for calibration.

### References:

- 1) SiMetricS GmbH, Siliziumkomponenten für die Messtechnik, Am Südhang 5, 09212 Limbach-Oberfrohna and J. Fruehauf, S. Kroenert, U. Brand, R. Krueger-Sehm: Attainable precision of silicon dimensional standards. Proc. Euspen Conf. (2004), Contact: [joachim.fruehauf@e-technik.tu-chemnitz.de](mailto:joachim.fruehauf@e-technik.tu-chemnitz.de)
- 2) PTB Cu Depth Setting Standards, PTB, AG 5.11, Bundesallee 100, 38116 Braunschweig; < [www.ptb.de/de/org/5/51/511/index.htm](http://www.ptb.de/de/org/5/51/511/index.htm) > and U. Brand, G. Hinzmann, H. Schnädelbach, C. Feist, P. Stuht, R. Krüger-Sehm, V. Jäger: Rückführbare Präzisions-Tiefen-Einstellnormale für Messbereiche von 1 µm bis 1 mm (Traceable precision depth setting standards for measurement ranges from 1 µm to 1 mm). Technisches Messen 66, 12 (1999), 496-503. Contact: [uwe.brand@ptb.de](mailto:uwe.brand@ptb.de)
- 3) Neugebauer M, Jusko O, Neuschaefer-Rube U, Wäldele F: Darf's etwas kleiner sein? Quality Engineering, 9 (2004), 32. And: Neugebauer M, Neuschaefer-Rube U: A new micro artefact for testing of optical and tactile sensors. Proceedings of Euspen conference 2005. Contact: [michael.neugebauer@ptb.de](mailto:michael.neugebauer@ptb.de)
- 4) Brand, U; Neugebauer, M; Neuschaefer-Rube, U; Wilkening, G: Micro-Standards – State of the Art, Prospects and Limits. Proc. Sensor Conf., Vol. 2 (2005), 169-174. Contact: [ulrich.neuschaefer-rube@ptb.de](mailto:ulrich.neuschaefer-rube@ptb.de)
- 5) Fruehauf, J; Kroenert, S; Brand, U; Krueger-Sehm, R: Attainable precision of silicon dimensional standards. Proc. Euspen (2004), 217-218 Contact: [joachim.fruehauf@e-technik.tu-chemnitz.de](mailto:joachim.fruehauf@e-technik.tu-chemnitz.de)

Table 1a

z – calibration Single steps	Nominal step height	Type and shape	Meas. area	Substrate		Coating		Remarks
				Material	Dimens. (mm)	Material	Thickn. (nm)	
SiMetricS <sup>1)</sup> Depth Setting Standards VS Fig. 1	50 nm, ..., 1000 µm	grooves with rectangular profile and grooves with 54 ° slope, 100 µm wide, 6 mm length	(µm <sup>2</sup> )	Silicon	50 x 50			suitable for microscopes

\*) available on 200 Si wafer    \*\*) available on 200 and 300 mm wafer

Table 1b

z – calibration Multiple steps	Nominal step height	Type and shape	Meas. area	Substrate		Coating		Remarks
				Material	Dimens. (mm)	Material	Thickn. (µm)	
PTB Cu Depth Setting Standards <sup>2)</sup> Fig. 2	1, 5, 20, 50, 200, 450, 600, 900, 1000, 2000, 5000	grooves with 55 ° slope, distance between grooves: 400 µm, flat bottom (width 300 µm)	(µm <sup>2</sup> )	Copper	45 x 23, thickness: 10/12	Nickel	20	Type 900: 1...900 µm, Type 5: 5 µm...5 mm

**Table 2a**

<b>Lateral calibration 1 - dim.</b>	Nominal pitch	Type and shape	Measur. Area	Substrate		Coating		Remarks
	( $\mu\text{m}$ )		( $\mu\text{m}$ )	Material	Dimens. (mm)	Material	Thickn. (nm)	
SiMetricS <sup>1)</sup> Lateral Standard LS Fig. 3	10...250	line grating	250 ...62500	Si	75 x 20			ISO 5436-1 Type C3

**Table 3**

<b>Other calibration standards</b>	Nominal value	Type and shape	Meas. area	Substrate		Coating		Remarks
	(nm)		( $\text{mm}^2$ )	Material	Dimens. (mm)	Material	Thickn. (nm)	
<b>Flatness</b>								
SiMetricS <sup>1)</sup> Flatness Standard Type FtS Fig. 4	PV < 110/65	Flat ref. area	10 x 10/ 5 x 5	Si	15 x 15 x 6	SiO <sub>2</sub>		
<b>Tip radius, angle, parallelism</b>								groove-grating standards
SiMetricS <sup>5)</sup> Rectangle standard Type GrR Fig. 5	4, 8, 20, 40, 80, 200, 400, 800 $\mu\text{m}$ pitch	rectangle profile with different widths		Si	10 x 10	SiO <sub>2</sub>		
SiMetricS <sup>1)</sup> Triangle standard Type GrT70/109 Fig. 6	8, 25 $\mu\text{m}$ pitch	angle of surfaces: 70.52 °, 109,48°		Si	10 x 10	SiO <sub>2</sub>		

SiMetricS <sup>1)</sup> Trapezoidal standard Type GrTz 55 Fig. 7	8, 25 µm pitch	trapezoidal profile with surface angles of 54.7 °		Si	10 x 10	SiO <sub>2</sub>		
<b>Contour, Profile</b>								
PTB Micro contour artefact <sup>3)</sup> Fig. 8	100 µm, 250 µm, 500 µm, 1000 µm, 2000 µm	profile of cylindrical (180°), and prismatic elements (45°, 60°, 80°)	0.5 x 0.5 to 18 x 3	Steel	50 x 3 x 15			Test and comparison of optical and tactile micro sensors
<b>Diameter, Cylindricity</b>								
PTB Micro hole artefact <sup>4)</sup> Fig. 9	Ø 100 µm x 2.4 mm	cylinder		Steel	10 x 10			Test of tactile micro sensors
<b>Probing force</b>								
SiMetricS <sup>1)</sup> Probing force standard Type FC Fig. 10	0.005 – 1.0 mN/µm	cantilever for probing with stylus intruments, indenters etc.		Si	15 x 15	SiO <sub>2</sub>		
SiMetricS <sup>1)</sup> Probing force standard Type FB Fig. 11	0.3 – 5.5 mN/µm	cantilever fixed at both sides for probing with stylus intruments, indenters etc.		Si	15 x 15	SiO <sub>2</sub>		

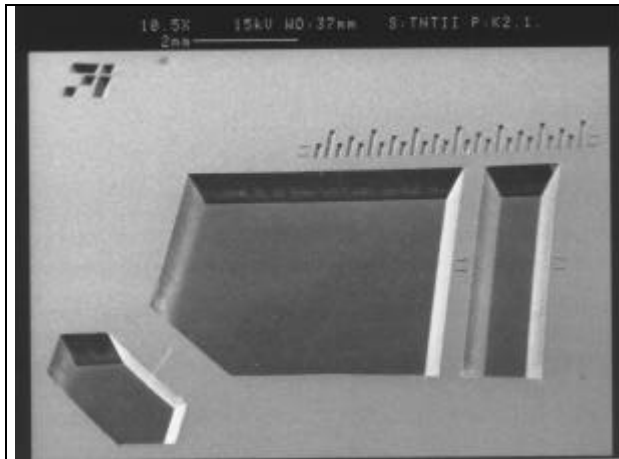


Fig. 1: SiMetricS depth setting standard, type VS

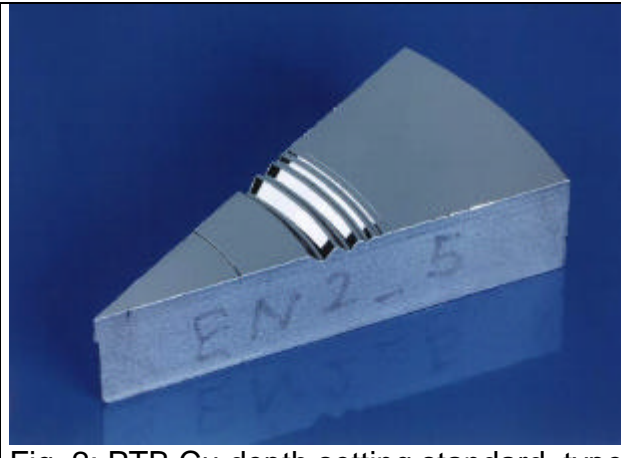


Fig. 2: PTB Cu depth setting standard, type 900 µm

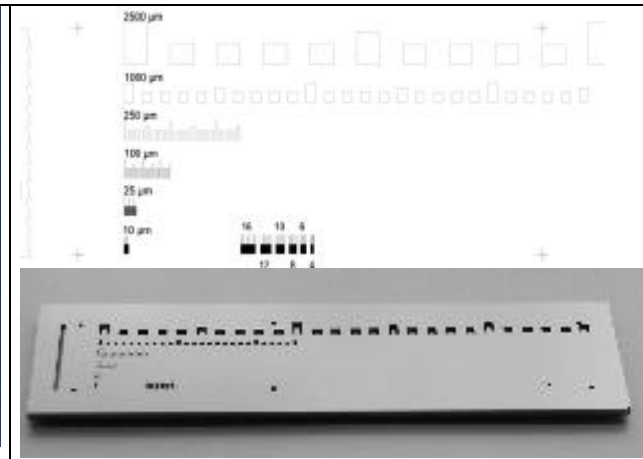


Fig. 3: SiMetricS lateral standard, type LS (top: sketch, bottom: photograph)

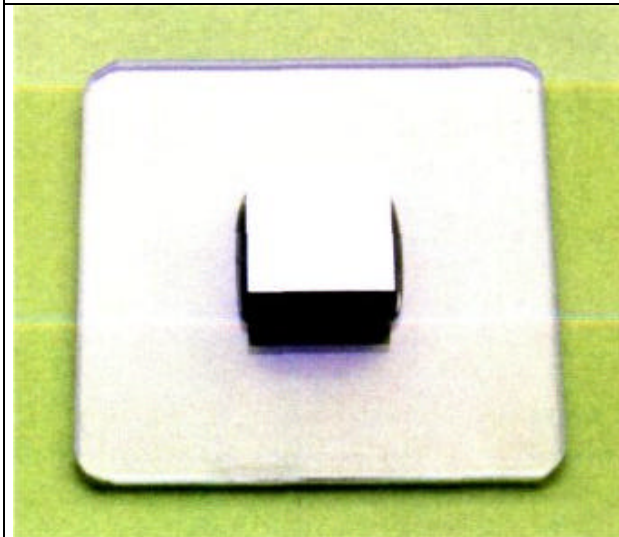


Fig. 4: SiMetricS flatness standard, type FtS

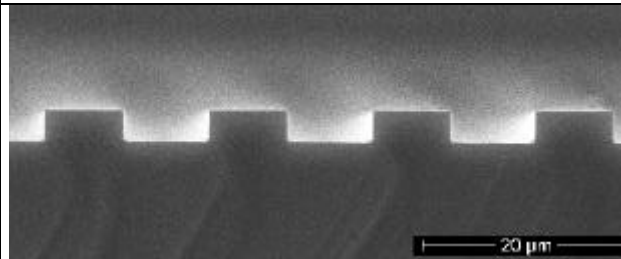


Fig. 5: SiMetricS rectangle standard, type GrR

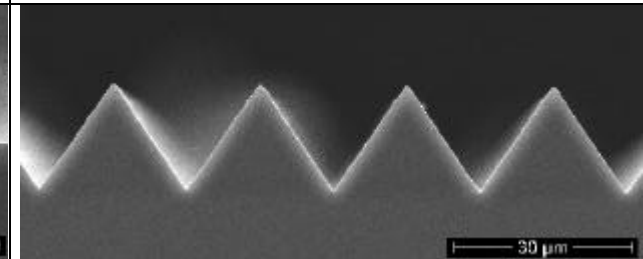


Fig. 6: SiMetricS triangle standard, type GrT 70 (surface angle 70.52 °)

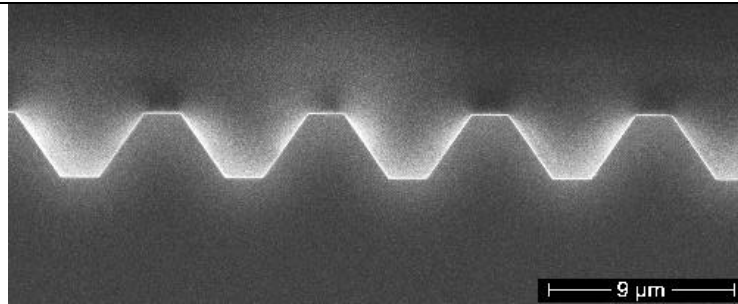


Fig. 7: SiMetricS trapezoidal standard, type GrTz 55

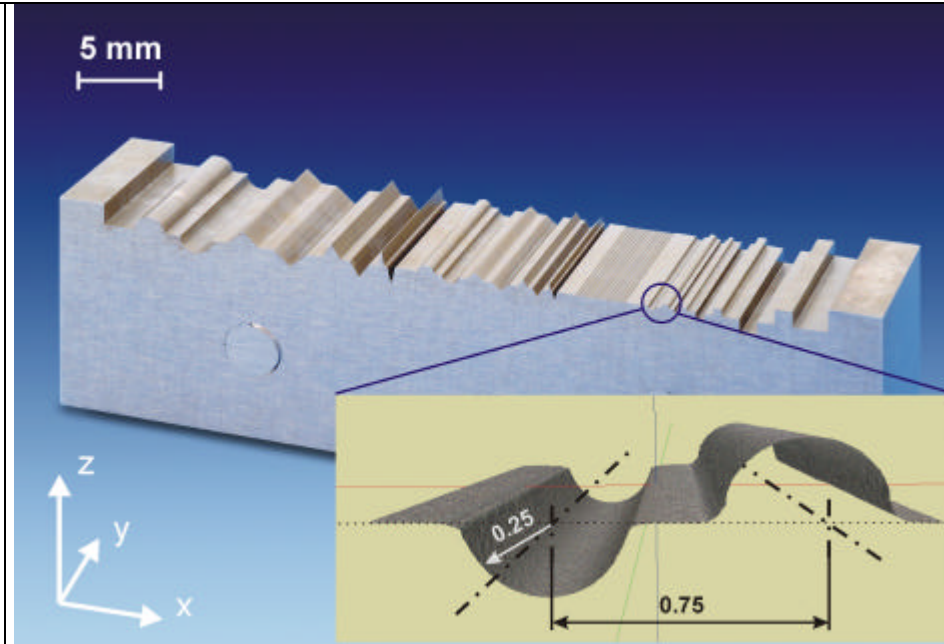


Fig. 8: PTB Micro contour artefact (stack of 3 artefacts)

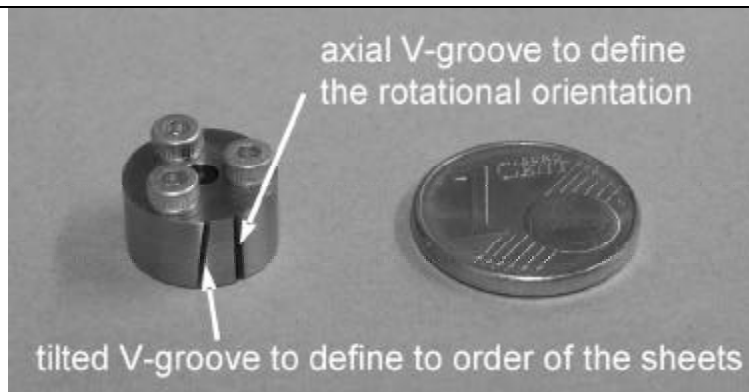


Fig. 9: PTB micro hole artefact

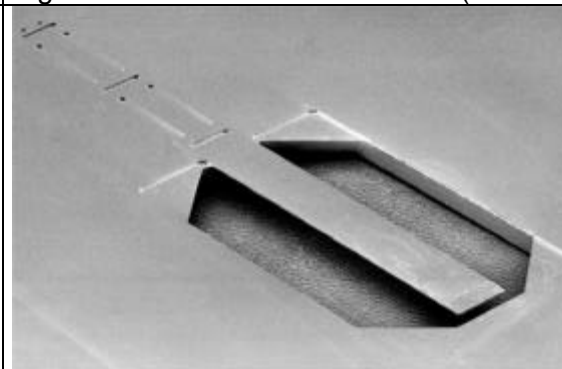


Fig. 10: SiMetricS probing force standard, type FC

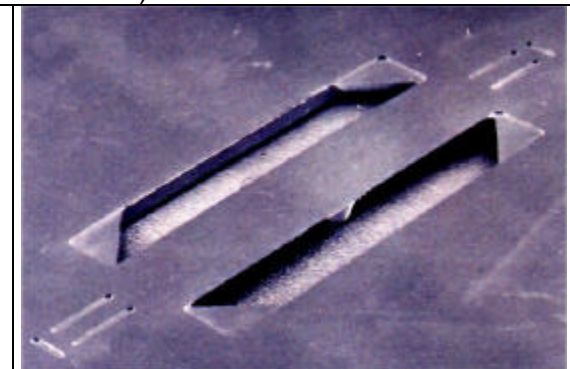


Fig. 11: SiMetricS probing force standard, type FB