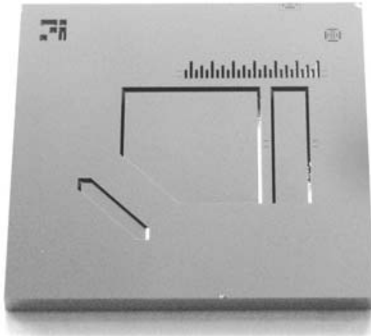
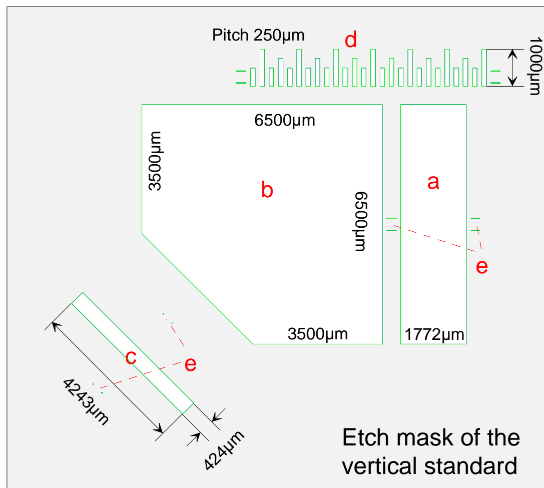


Vertical Standard
VS

1. Structure



Etch mask of the vertical standard

The standard contains following structures:

- (a) Groove as step in depth for calibration
- (b) Large deepening for interferometric calibration or for building a step in height by combination with groove (a)
- (c) Groove for the calibration of optical instruments and for tracing of steep stylus tips
- (d) Scale with 25 periods each of them having a length of 250 µm to support the positioning operation; also preferably used as steps in the case of submicron depths
- (e) Grooves to mark the positions for calibration

According to the preparation method 3 types of vertical standards can be differentiated:
1) Depth range **0.05 – 0.45 µm**
2) Depth range **1 – 10 µm**
3) Depth range **20 – 1000 µm**

All grooves have the same depth (exception: grooves of scale d at depths > 50 µm, at these depths they have a V-profile). The chip size is 16 mm x 16 mm.

The standards belonging to group 1 are prepared by a special technology (oxidation). Here the sidewalls are not crystallographically defined. These standards have the low uncertainty of depth of a few nm.

The vertical standards of group 2 and 3 are prepared by the means of orientation dependent wet etching. The shape of the grooves which rise during this process are dependent on the orientation and depth of the structures. At the edges which run horizontally and vertically (in grooves a and b) 54.7° inclined sidewalls (111-faces) are built. Because of that the bottom of the grooves narrow with increasing etch depth.

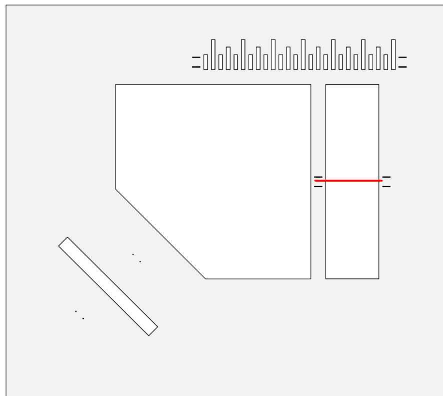
At the edges which run diagonally vertical sidewalls are created (in grooves c and b).

The roughness on the plateau regions (Ra < 5 nm) is in accordance with the roughness of the polished wafer surface.

The roughness at the bottom of the grooves is different in group 2 and 3: in group 2 this roughness is influenced by the etching process. The values increase with increasing etch depth ranging from Ra = 5 nm to 40 nm. Small inhomogeneities of the etching process produce a weakly curved etch ground depending on its width and depth. This effect creates a contribution to the uncertainty of the depth measurement which can be minimized (0.1 up to 0.5‰ of the depth) by a defined reduction of the evaluated section of the profile.

The standards belonging to group 3 which are prepared by a modified technology have a low uncertainty of depth (< 70 nm), a maximum flatness and a minimum roughness (Ra < 5 nm) also at the etch ground.

2. Calibration Process



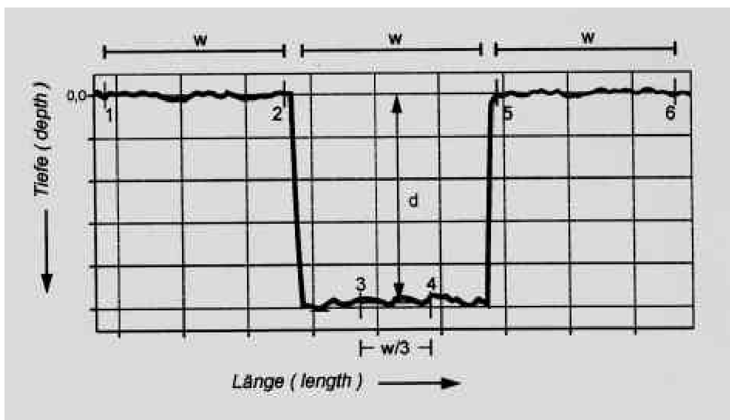
Measuring line

The certification takes place according to the European Standard EN ISO 5436-1 (Type A1). Groove a or c for standards of group 2 and 3 or the 1st groove of scale d for standards of group 1 is measured 3 times in 5 parallel profile sections between the marks. The evaluation of the profiles for the determination of the groove depth is as follows:

- Limitation of the profile length to be evaluated to a length that includes one groove width w before and after the groove.
- Levelling of the profile in such a way that the marks 2 and 5 lie on the same height.
- The groove depth results from averaging of the profile values between marks 3 and 4. The distance between these marks should be 1/3 w.

Together with the groove depth d the expanded uncertainty of measurement U is given.

The standard is available either with a PTB calibration certificate (PTB: Physikalisch-Technische Bundesanstalt, the national metrology institute of Germany) or a calibration certificate (traceable to the PTB) by SiMETRICS. The groove for certification can be chosen.



J. Frühauf, S. Krönert, U. Brand:Tiefen- und Längennormale aus Silizium, tm – Technisches Messen 68, 7-8, 2001, p. 326
J. Frühauf, H. Trumpold: Silicon Standards for Assessment and Calibration of Stylus Probes, Annals of the CIRP, Vol. 51/1/2002, p. 475
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3. Packaging, Handling and Cleaning

For a better handling the standards are mounted on borosilicate glass with a size of 5 cm x 5 cm as substrate. Further sizes and materials are possible on request. The chips are mounted by an epoxy resin adhesive.
The standards are stored in a membrane box. The grooves for measuring and calibration do 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 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.

4. Assortment and Specification

Type	Nominal depth (µm)	Possible deviation from nominal depth (µm)	Certified uncertainty (nm)	groove	P_t etched ground (nm)	P_t middle third (nm)
VS 0.05	0.05	± 0.01	± 7	d	10	6
VS 0.10	0.10	± 0.01	± 7	d	10	6
VS 0.23	0.23	± 0.01	± 7	d	10	6
VS 0.45	0.45	± 0.02	± 7	d	10	6
VS 1	1	± 0.01	± 25	a	20 - 200	60 - 80
VS 2	2	± 0,02	± 25	a	20 - 200	12 - 60
VS 5	5	± 0.02	± 25	a	20 - 200	12 - 60
VS 10	10	± 0.04	± 25	a	20 - 200	12 - 60
VS 20	20	± 0.06	± 25	a	60 - 80	20 - 40
VS 50	50	± 0.08	± 25	a	60 - 80	20 - 40
VS 100	100	± 1.0	± 25	a	60 - 80	20 - 40
VS 200	200	± 10	± 70	a	60 - 80	20 - 40
VS 400	400	± 5	± 70	a	60 - 80	20 - 40
VS 500	500	± 10	± 70	a	60 - 80	20 - 40
VS 525	525	± 10	± 70	a	60 - 80	20 - 40
VS 600	600	± 10	± 70	a	60 - 80	20 - 40
VS 900	900	± 10	± 70	a	60 - 80	20 - 40
VS 1000	1000	± 10	± 70	a	60 - 80	20 - 40