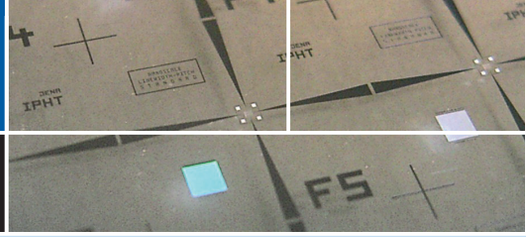
Tip characterizer



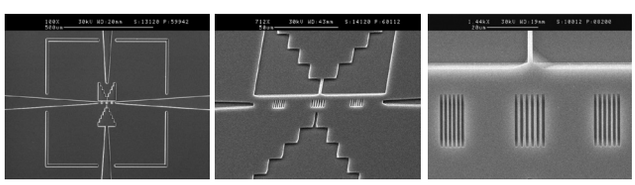
AFM

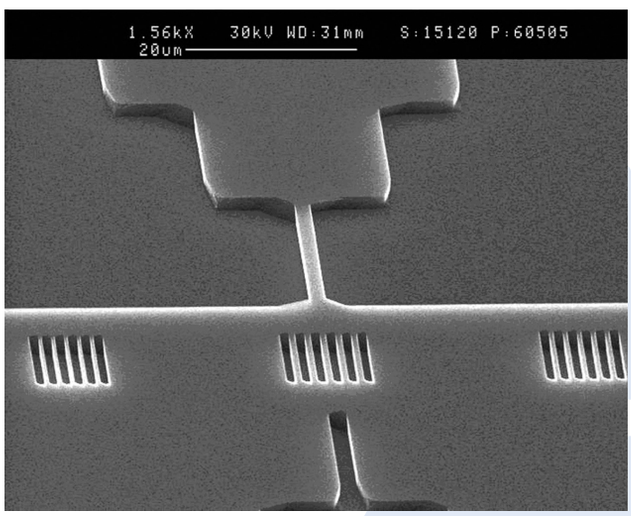
APPLICATION

The AFM-tip characterizer contains patterns for an in-situ determination of the AFM-tip shape.

DESCRIPTION

The structures for the AFM-tip characterizer offer a series of very smooth and sharp etched line-space structures in silicon with vertical side-walls. Each calibration chip has a size of 8 x 8 mm². In the centre of the calibration chip, where the two-stage finding structure ends, 3 groups of 5 line-space structures with different nominal widths (300, 500 and 800 nm) are arranged. The space between the lines is about 1µm. Each group is nominally 20 µm long. The structures are sharp-edged with edge radii of less than 2 nm. The edge roughness is well below 5 nm (3σ).





SEM-Micrograph of the calibration pattern
(groups with different CD-widths from 300 nm to 800 nm).

SPECIFICATIONS

Substrate	· Material: <110> Si · Chip dimension: 8 x 8 mm² · Surface roughness: < 1 nm
Finding structures	· Grooves in the Si-substrate · Depth (in general): 1 µm
Types of grating	· 1-dim
Size of grating	· Normally 10 x 10 µm²
Linewidths (CD)	· Nominal: 300 nm, 500 nm, 800 nm · Linewidth variation along the lines (within a central part of 10 µm): < 5 nm 1σ

Pitches	· 1µm + CD value · Uncertainty of mean pitch: 3 nm 1σ
Structure depth	· in general: 1µm
Edge radius	· < 2 nm
Edge roughness	· ± 4 nm (3σ)
Sidewall angle	· 89°
Traceability	· CD, pitch and depth-calibration made by the PTB Braunschweig on request.

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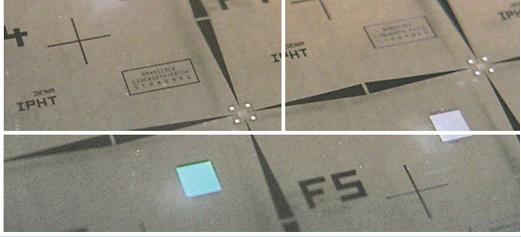
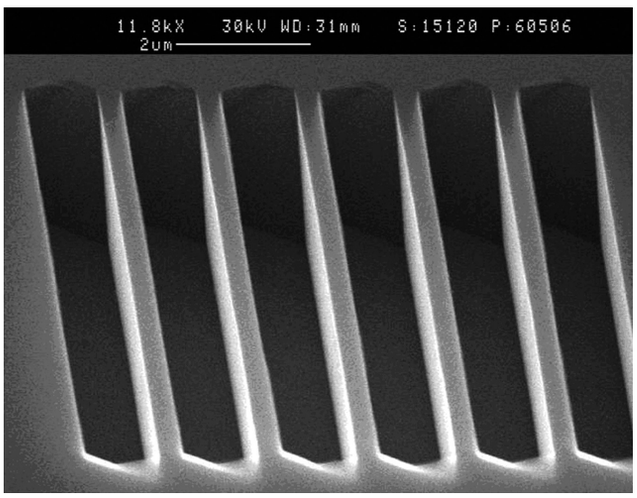
Tip characterizer

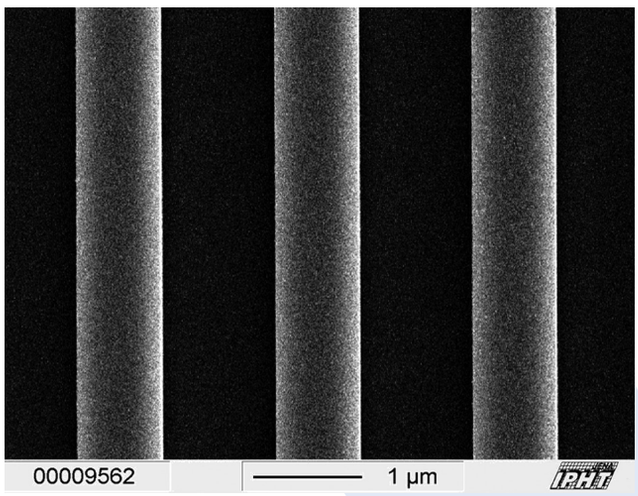


AFM

STRUCTURE DETAILS

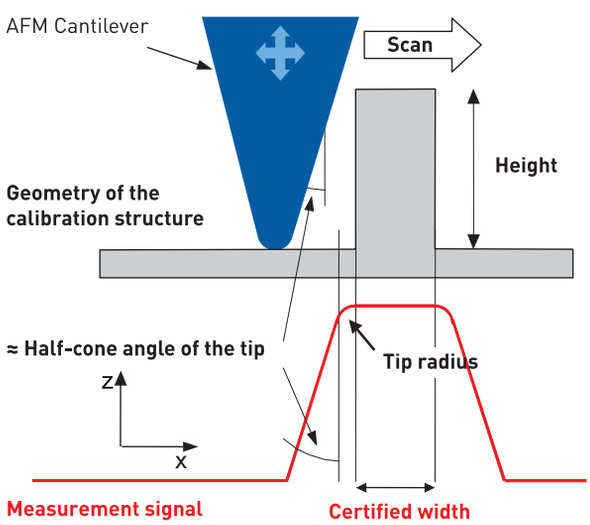


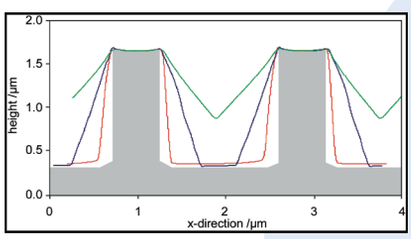
SEM-picture of the 300 nm calibration group with very small edge roughness (tilt view 60°)

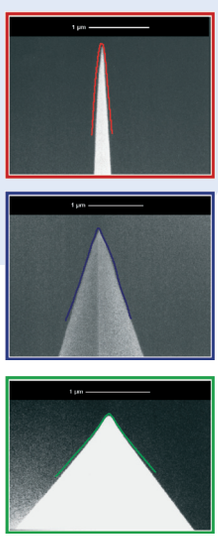


Details of the very smooth, highly parallel and sharp etched silicon structures (SEM-micrograph of the 800 nm group, tilt 0°)

PRINCIPLE OF DETECTION OF THE AFM-TIP SHAPE AND TIP RADIUS







AFM-measurements of the calibration structures with three different tip shapes (the cross section of the calibration structure is shaded). The extracted tip shapes are visualized on the SEM-images of the tips.

red: high aspect ratio tip (NanoSensors AR5-NCHR)
blue: silicon tip (NanoSensors NCH)
green: silicon nitride tip

AFM-pictures: Courtesy of Th. Sulzbach, Nanoworld GmbH

The method of the in-situ characterization is based on the AFM-measurement of a well-known line-space structure and the calculation of the tip shape from the measurement result (see figure). The sidewalls of the calibration structures are steeper than the half-cone angle of the tip. Therefore, the measured sidewalls reflect the shape of the tip. If, in addition to that, the edge radius of the calibration structures can be neglected, compared to the tip radius, then the measured radii also represent the tip radius. By means of these standards the shape and the radius of the tip can be quickly quantified before and after the AFM measuring process.

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