



THÉLIAS TECH
SCIENTIFIC INSTRUMENTS

uSTEP 300 PROFILOMETER

A LOT OF NONDESTRUCTIVE TESTING METHODS ON A SINGLE PLATFORM
FOR COMPREHENSIVE ANALYSIS OF Ø300 MM WAFERS

SEMICONDUCTOR WAFER INDUSTRY

The development of semiconductor wafer industry requires to control reliably geometric, mechanical, chemical, and electrophysical parameters at the production steps. The testing, the detection and the elimination of defects on time are necessary to accelerate the manufacturing process.

The combination of various analysis methods within a single device leads to the entire production process optimization. Despite the variety of inspection methods, profilometry remains the very popular one.

PROFILOMETRY

Profilometry is a technique used to measure the surface profile. It yields information on surface morphology, step heights and surface roughness. In general, profilometry techniques are divided into contact and optical ones, both of them have some benefits.

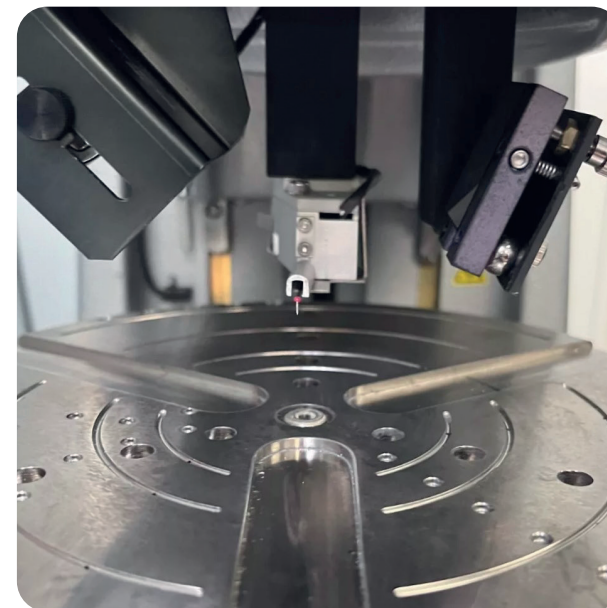
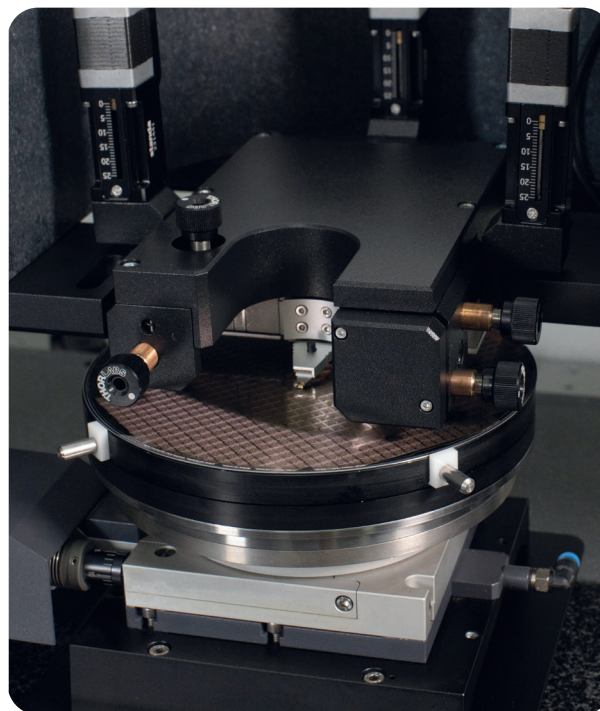
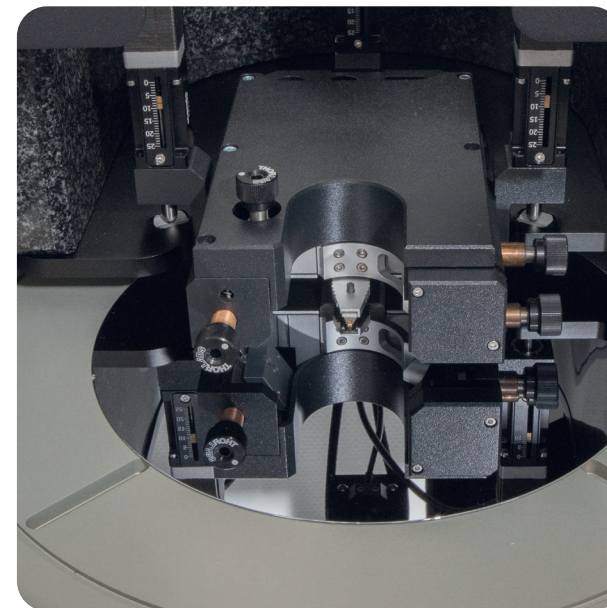
uSTEP 300 CAPABILITIES

The **uSTEP 300** is a universal platform with functional modules combining different profilometry regimes inside one instrument. Based on the uSTEP 300 both contact and non-contact methods of roughness analysis, and analysis of electrical, physical and chemical surface properties for large samples (up to 300 mm in diameter) with various roughness can be realized.

The uSTEP 300 is equipped with a scanning stage with the lateral positioning accuracy up to 25 nm, allowing 3D maps to be acquired automatically from the defined areas.

The unique design of the uSTEP 300 profilometer allows to work with samples up to 20 mm in thick and 25 - 300 mm in diameter. Vacuum wafer fixation and built-in vibration isolation by pneumatic supports reduce the influence of mechanical noise.

Monolithic design of the profilometer base reduces the parasitic noise by 30 dB in the frequency bandwidth above 200 Hz. For additional vibration impact minimization, the system can be equipped with an active vibration isolation module operating in the frequency range of 1-200 Hz with a response time of about 0.5 ms.



uSTEP 300 SOFTWARE

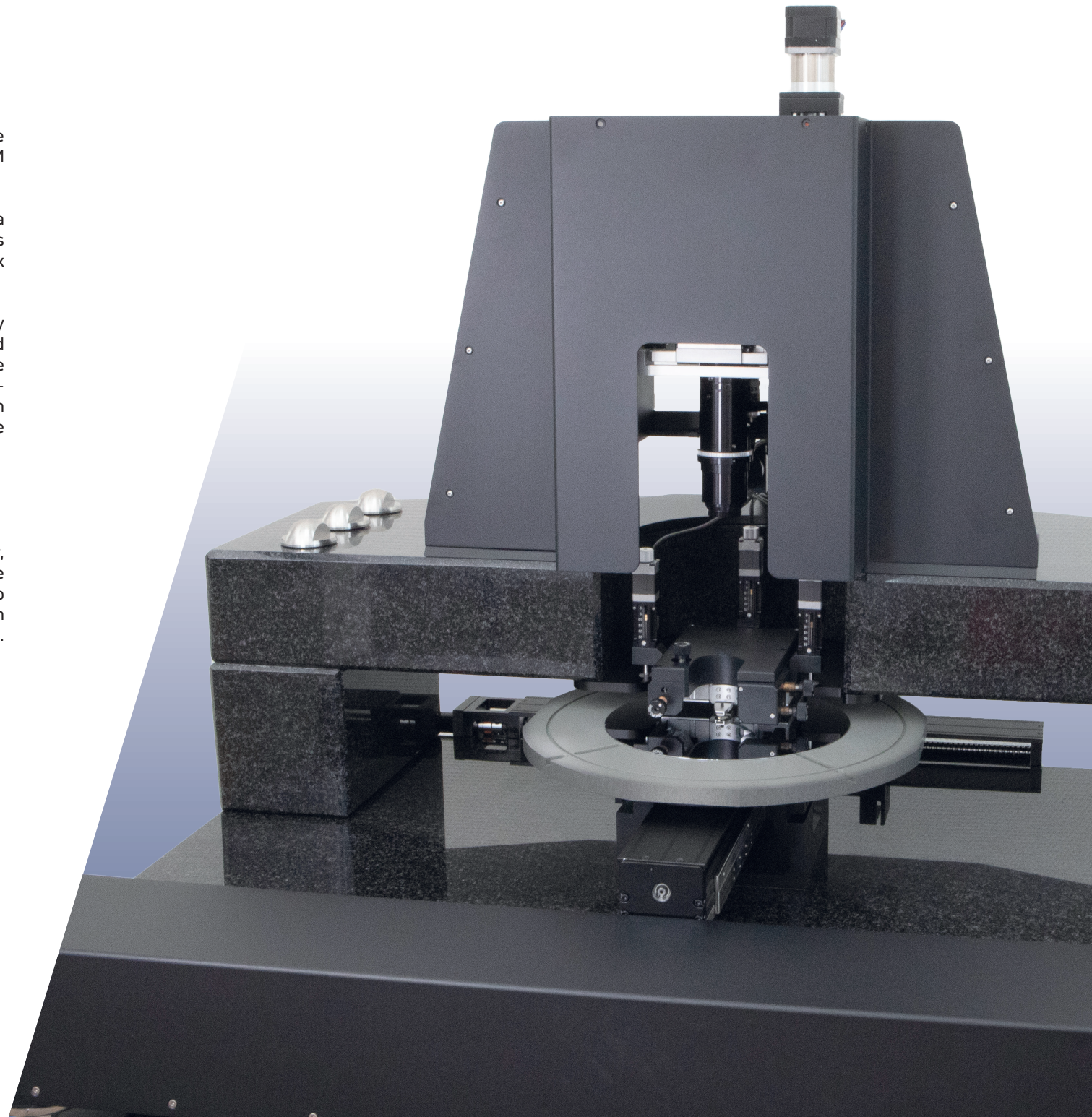
The software automatically acquires and analyzes the data obtained. uSTEP 300 is controlled by the Nova SPM program installed on Windows 10, 11.

The intuitive software design allows to work both in a simplified mode for quick surface roughness analysis and in an advanced mode for more detailed and complex research of the sample features automatically.

Built-in data processing package makes available a variety of useful operations, including the wafer curvature and roughness characterization, and 3D mapping of the sample surface. The data obtained can be processed by third-party software packages (MS Excel, Origin). Users can additionally utilize their own script procedures for the unique tasks.

FACTORY USE

Due to the modular design of the uSTEP 300 profilometer, its separate units can be successfully used in the microelectronics fab lines. The development of fab modules with uSTEP 300 integrated in is possible also in cooperation with the leading industry and research teams.

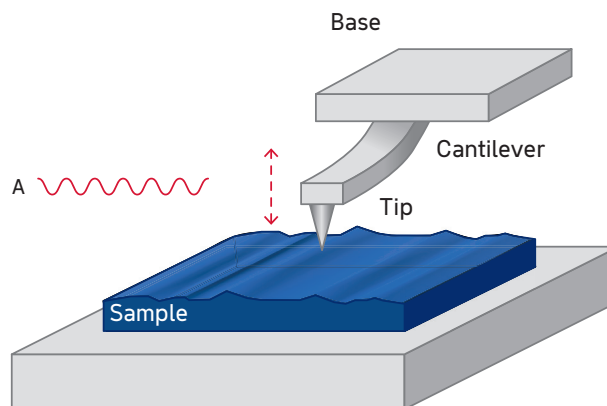
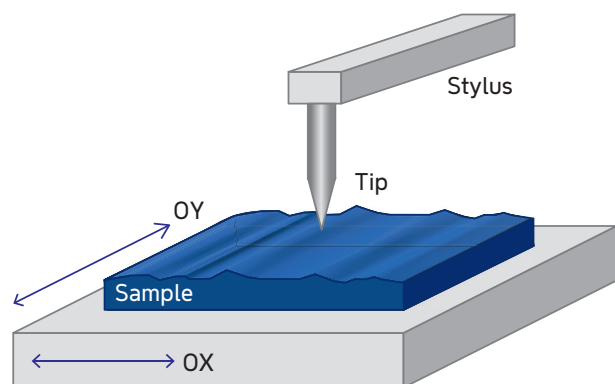


STYLUS PROFILOMETER

The principle of stylus profilometer operation is based on keeping constant force applied to the sample surface by the stylus (probe). Passing over the surface, the stylus deflection restores its profile.

With a number of consecutively measured profiles, it is possible to reconstruct the surface 3D image. By choosing the probe (the probe curvature radius can be from tens of micrometers to submicrometers), it is possible to control the precision of measurements.

This method of analysis provides fast routine measurements of materials with a low-roughness surface.



ATOMIC-FORCE PROFILOMETER

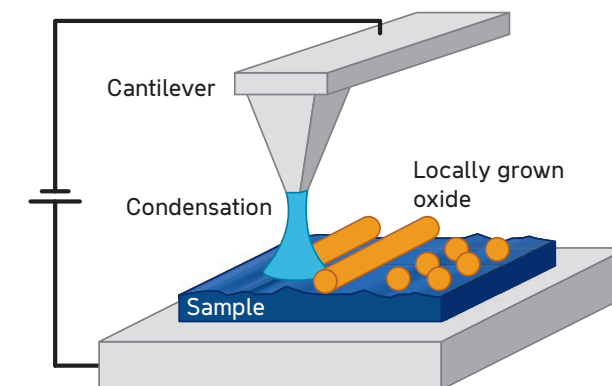
An Atomic-Force Microscope (AFM) and a profilometer both use sharp tips to study the surface morphology.

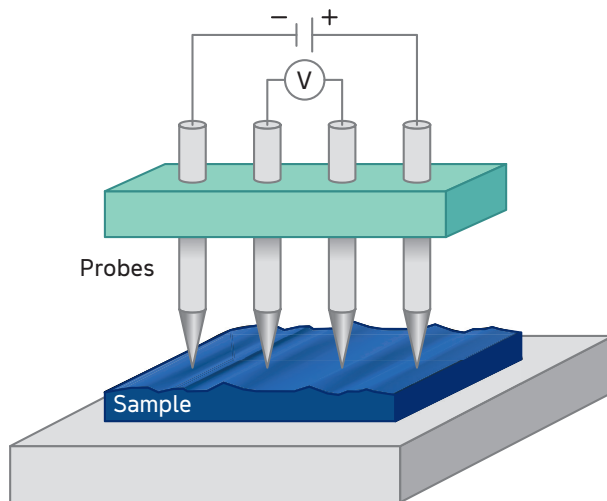
However, the AFM tip curvature radius is of a nanometer scale, which allows to study the sample in more detail. In addition, the use of semi-contact AFM mode significantly reduces mechanical interaction between the probe and the sample, preventing the possible deformation of them.

Different AFM modes in combination supply additional information of local mechanical (stiffness, adhesion, Young's modulus, etc.), electrical (conductivity, capacitance, surface potential, etc.), and magnetic features of the sample surface.

ATOMIC FORCE NANO-LITHOGRAPH

Based on scanning probe microscopy techniques, the atomic force nano-lithograph enables to create pre-designed structures with spatial resolution up to 10 nm without using masks. The software supports both raster and vector lithography capabilities. The lithography templates can be either generated manually using software tools or uploaded from outside. AFNL supports various types of lithography: mechanical, electrical, etc.





PROBE PROFILOMETER

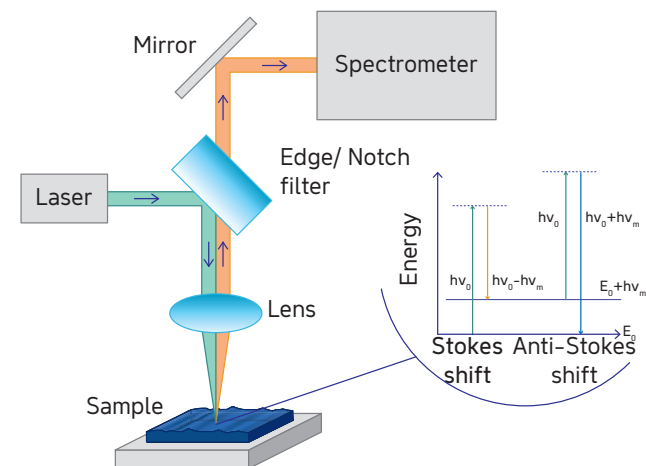
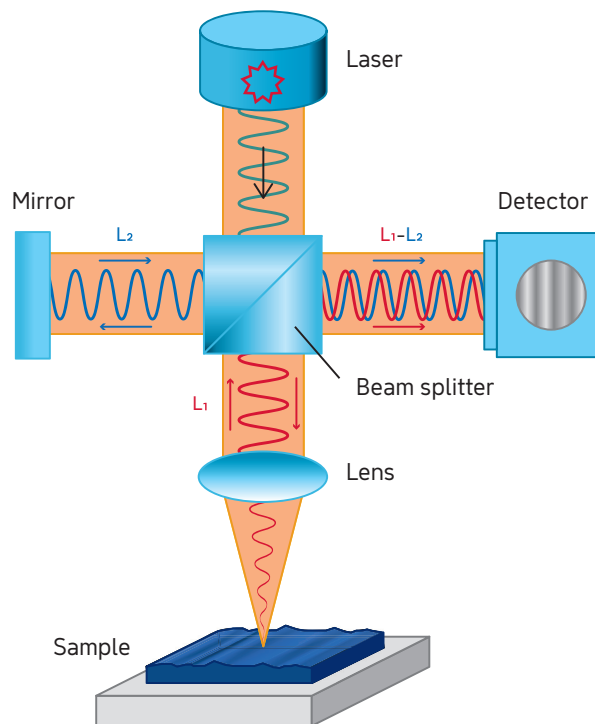
To characterize the sample surface better in terms of its electrophysical properties, the uSTEP 300 profilometer uses traditional four-probe method of measuring surface resistance, which can be especially useful while studying various conductive materials.

OPTICAL PROFILOMETER

Non-contact methods for surface roughness investigation include optical profilometry, which uses optical "probe" instead of a mechanical probe.

The optical interferometer head inside uSTEP 300 includes a beamsplitter and a mirror to create an interferometric pattern, which is captured by a photo detector to control the beam path difference and, consequently, the head position height above the surface under investigation.

The main advantages of this method are: fast measurements, no mechanical contact with the surface, no sample material damage.



LASER SPECTRAL ANALYZER "RAMAN-PROBE"

Using the uSTEP 300 profilometer, the surface roughness mapping and the chemical composition analysis can be done simultaneously by combining mechanical probe and optical analysis.

The instrument is equipped with a spectrometer, enabling fast local measurements of Raman spectra, PL spectra, light scattering, etc.

The "Raman-probe" configuration can use lasers with different wavelengths: 405, 532, 633, and 785 nm.

CCD VIDEO CAMERA

VIDEO MICROSCOPE XY
POSITIONER

Z POSITIONERS

MONOLITHIC
BASE MADE OF
GABBRO-DIABASE

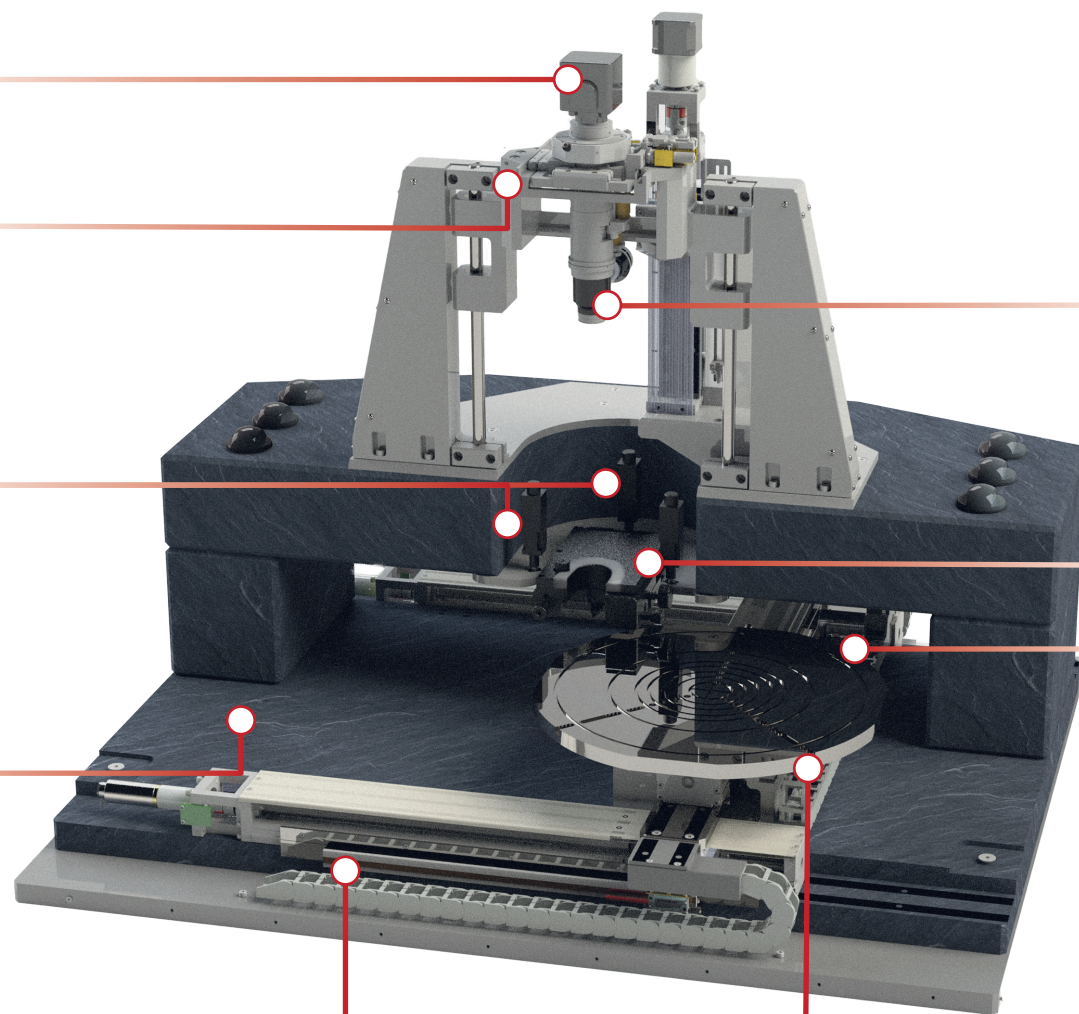
X POSITIONER

OBJECTIVE LENS

SCANNING AFM HEAD

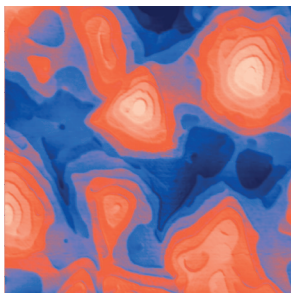
Y POSITIONER

VACUUM CHUCK

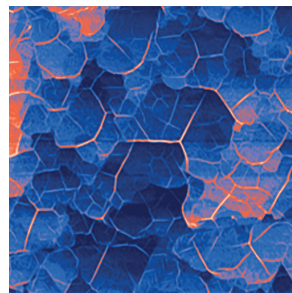


APPLICATIONS OF THE uSTEP 300

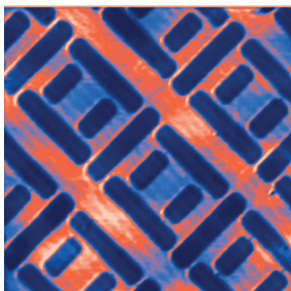
- Surface roughness measurement
- Wafer defects inspection
- Local electrical properties measurement
- Thin films and coating thicknesses measurement
- Elastic properties study
- Etching depth control



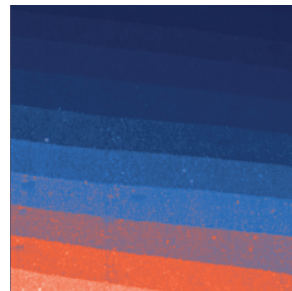
BiSbTeSe₂ epitaxial film on Si.
AFM image.
Scan size: 2x2 µm



Carbon sample.
Kelvin probe mode with amplitude modulation.
Scan size: 10x10 µm



Si microstructure.
AFM imaging. Phase contrast.
Scan size: 50x50 µm



SiC steps with a height of 1.5 nm.
Semi-contact AFM.
Scan size: 3x3 µm

TECHNICAL DATA

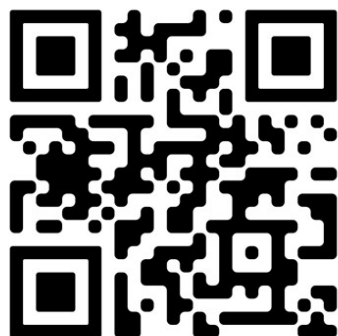
XY sample positioning	Positioning sensors resolution	25 nm
	Positioning rate	4 mm/s
Sample stage with vacuum holder	Sample size	ø 25 – 300 mm ø 1 – 12"
AFM scanning head with piezo scanner	Scan range	60 × 60 × 7 µm
AFM deflector	Laser wavelength	650 nm/ 830 nm
	Photodetector	Four-sectional
Optical microscopy head	Objectives	10x, 50x
Raman spectra analyzer (option)	"Raman-probe", fiber type Excitation laser $\lambda = 405/532/633/785$ nm Monochromator with focal length 620 mm, spectral resolution $\leq 1 \text{ cm}^{-1}$ CCD camera	
Base frame with passive vibration isolation	Material	Gabbro-diabase
Active* vibration isolation	Frequency bandwidth	1 – 200 Hz
	Vibration isolation performance	– 40 dB at 70 Hz
Thermal stability	Active temperature control	PID
	Internal temperature stability at the ambient temperature variation by 1°C	< 0.05 °C

* - depending on the system configuration, active vibration protection can be provided by Park Systems Accurion Vario Basic 90 or Herzan AVI-200XL platform.

uSTEP 300 KEY FEATURES

- Ability to analyze samples with various height differences from monoatomic steps to advanced micrometer topography.
- A new generation of low-noise electronics providing roughness examination with an accuracy of 2.7 Å.
- The large size motorized positioner allows examination of samples with up to 300 mm diameters.
- XY positioning accuracy is 25 nm.
- Monolithic construction of the profilometer base reduces the influence of parasitic noise in the frequency band above 200 Hz by 30 dB.
- Convenient and easy-to-use software for fast routine measurements and for processes control.
- Low sample load of 0.03 – 10 mg, allowing delicate materials handling without surface damage.
- Integrated optics include motorized control of focus, magnification and XY movement.
- The system can be equipped with a thermostabilizing chamber to reduce drift and thermal noise.

FLAXIBLE. VERSATILE. INNOVATIVE.



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