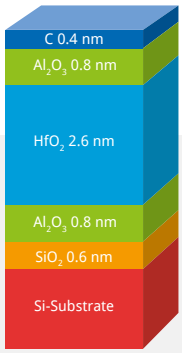
UPDATE Small spot < 10 µm

EnviroMETROS FAB

FULL WAFER XPS DEPTH PROFILING FOR THIN FILMS, MULTILAYERS AND ADVANCED DEVICES



Non-destructive characterization of multilayer stacks

KEY FEATURES

- Non-destructive depth profiling up to 30 nm
- Material-specific spectral response
- Nanoscale thickness accuracy
- Interface and transition detection
- Multilayer reconstruction

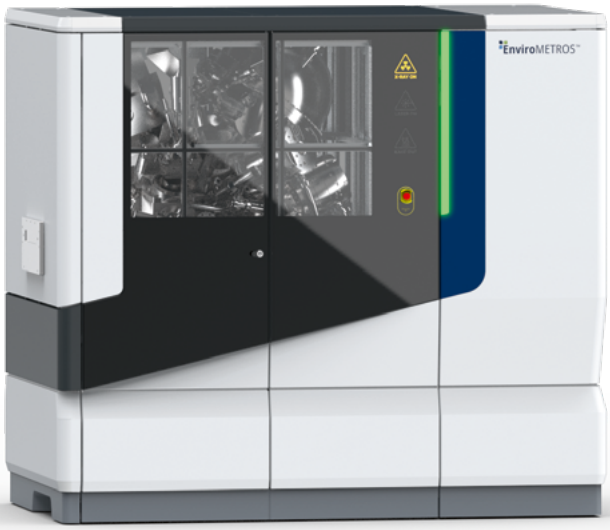


Enviro™

A member of SPECSGROUP

EnviroMETROS FAB

NON-DESTRUCTIVE ACCESS TO BURIED LAYERS AND INTERFACES



EnviroMETROS FAB.

All about the layers

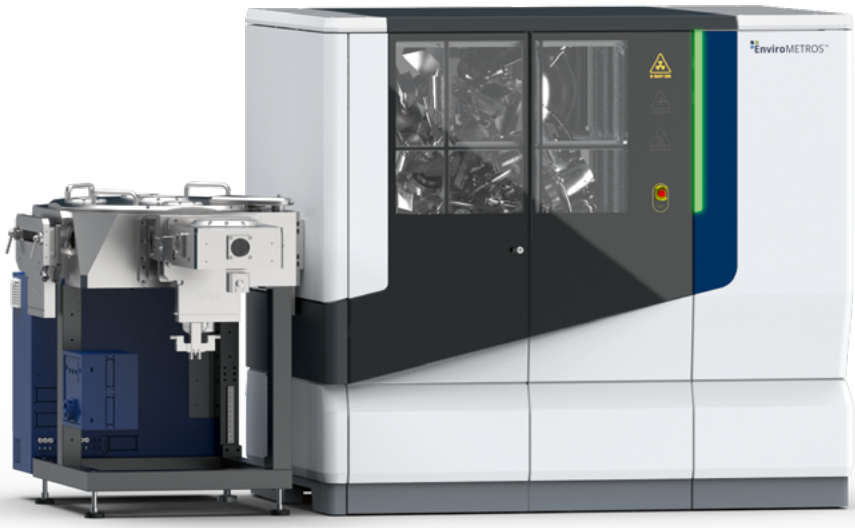
As semiconductor coatings and multilayer stacks become thinner and more complex, accurate characterization of layer thickness, composition and buried interfaces becomes increasingly important. Conventional sputter depth profiling can modify delicate structures through ion-induced damage, layer mixing or chemical changes. EnviroMETROS FAB addresses new challenges, enabling non-destructive depth profiling of ultrathin films and multilayer stacks. This preserves the original sample while providing reliable depth information for semiconductor research, process development and quality control.

Performance highlights

- Enables full characterization of FEOL blanket stacks without preparation or structural damage
- Distinguishes Si_3N_4, TiN, HfO_2, SiO_2, and Si with high chemical sensitivity, even in ultrathin layers
- Provides reliable quantification of critical films such as high-k dielectrics (1–4 nm) and metal gate layers (5–10 nm)
- Differentiates interfacial oxides, chemical gradients, and subtle variations in film quality
- Resolves complex FEOL stacks including hardmask, metal gate, high-k, interfacial oxide, pad oxide

PARXPS – the unique technique for advanced metrology

Advanced CMOS integration requires sub-nanometer control of complex stacks containing for example SiO_2, HfO_2, TiN and Si_3N_4. Common semiconductor metrology methods such as spectroscopic ellipsometry and optical reflectometry provide limited direct chemical-state sensitivity, while SIMS, sputter depth profiling and cross-sectional TEM require material removal or extensive sample preparation that may alter or destroy the region under investigation. Non-destructive Parallel Angle Resolved X-ray Photoelectron Spectroscopy (PARXPS) simultaneously measures electrons across multiple emission angles, providing information on layer thickness, composition, oxidation state, nitridation and interface chemistry. Combining PARXPS with multiple X-ray energies progressively increases the photoelectron information depth. Surface-sensitive XPS resolves the uppermost layers, while higher-energy HAXPES (Hard X-Ray Photoelectron Spectroscopy) probes through capping layers toward deeper films and buried FEOL interfaces, enabling a more complete chemical depth profile without sputtering.



EnviroMETROS FAB
with wafer handler.

Key applications

Gate-stack characterization prior to patterning
Thickness and material verification of TiN, HfO_2, and interfacial oxides in blanket deposition steps

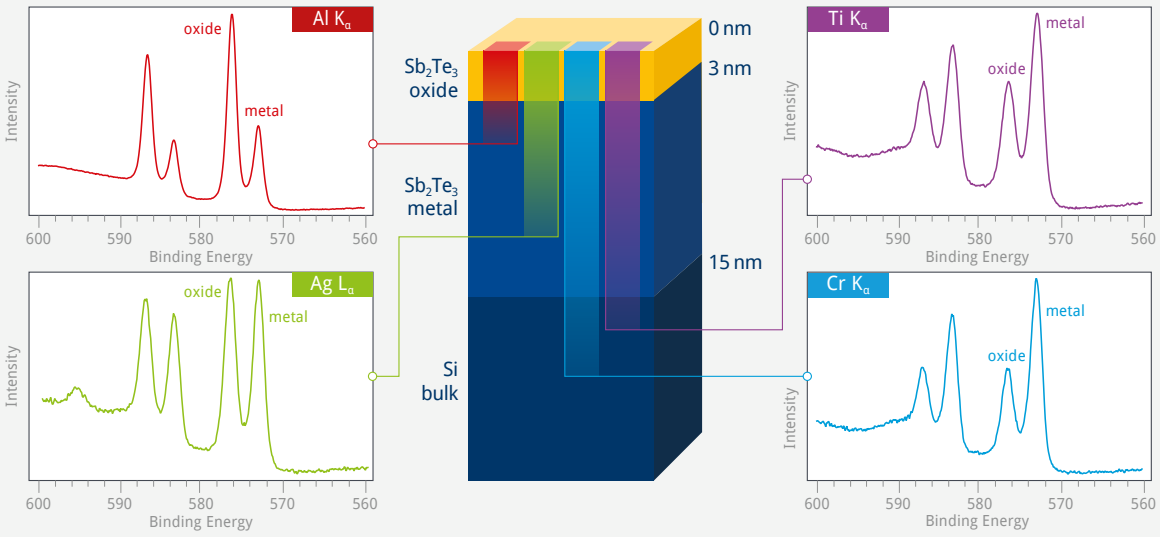
Spacer material evaluation (pre-pattern)
Characterization of Si_3N_4 and SiO_2 spacer films before structural definition

Hardmask quality control before lithography
Monitoring Si_3N_4/SiCN hardmask thickness and uniformity

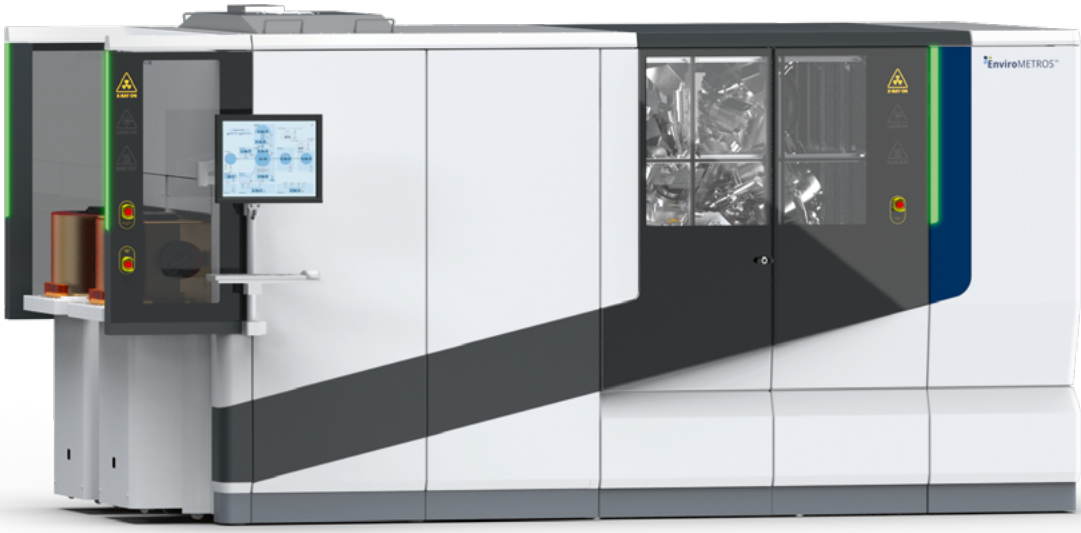
Silicide and epitaxy process window monitoring
Assessment of NiSi/$CoSi_2$ formation and SiGe/SiC consistency

High-k / metal-gate process development
Optimization of ALD cycles, annealing conditions, and work-function layers in R&D environments

FEOL process control
Rapid feedback for process optimization



High-resolution Te 3d core-level spectra of a Sb_2Te_3 sample on Si substrate, measured with Al K_α, Ag L_α, Ti K_α and Cr K_α excitation.

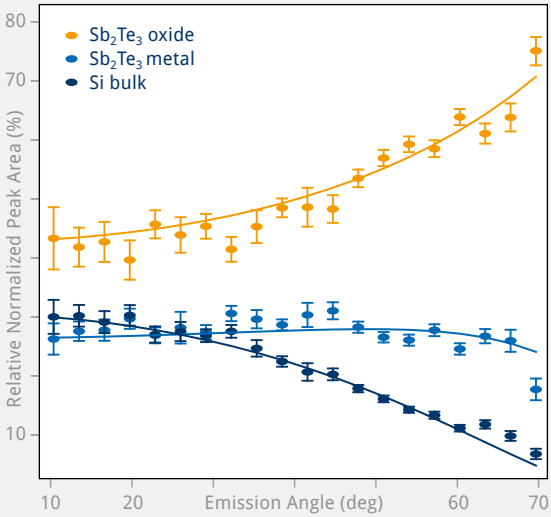


EnviroMETROS FAB
with FOUP/EFEM.

Multi-technique options

The system can be equipped with a range of complementary techniques, all controlled through a unified software interface, to provide a comprehensive analysis of complex materials. XPS and HAXPES reveal elemental composition, chemical states and bonding environments from the surface down to capped layers and buried interfaces. PARXPS provides non-destructive information on the depth distribution, composition and thickness of ultra-thin layers without sample sputtering or tilting. Sputter depth profiling enables analysis of thicker structures, while LEISS identifies the elemental composition and termination of the outermost atomic layer.

For electronic structure characterization, UPS measures work function, valence-band structure and occupied states, complemented by IPES for unoccupied states and conduction-band or LUMO positions. REELS provides bandgap related and dielectric information. IRRAS and Raman spectroscopy reveal functional groups, molecular vibrations, crystalline phases, defects, strain and material transformations. SEM and SAM add surface morphology, microstructure and spatially resolved elemental information, creating a comprehensive and directly correlated view of the sample.



Depth profile of the same Sb_2Te_3 sample on Si substrate (see on the previous page).

We invite you to contact us
for any demo measurement.

Model comparison

EnviroMETROS FAB

The EnviroMETROS FAB is equipped with a monochromatic four energy line X-ray source enabling fast acquisition of high-quality spectra from well-defined analysis areas.

EnviroMETROS µFAB

The EnviroMETROS µFAB is equipped with a monochromatic multi-color X-ray source with a scannable small spot size. This level of spatial resolution enables features that would be averaged out by a larger beam.

Technical data

EnviroMETROS FAB / µFAB	
System	• Fully automated surface metrology system • Clean room, CE, UL and SEMI compliant
Sample introduction	• Wafer handler system for standard wafer sizes 200 mm (8") or 300 mm (12") • FOUP loader / EFEM for standard wafer size 300 mm (12")
Vacuum	• UHV confirguration pressure < 5×10^{-9} mbar
NAP	• Near-ambient pressure option for pressure up 50 mbar (only for FAB version)
Electron Analyzer	• Hemispherical Electron Analyzer (150 mm) with wide angle lens (± 30°) for PARXPS • AD-CMOS Detector (< 1200 energy channels and < 12 angle channels)
X-Ray Sources	**FAB version** • Up to 4 switchable X-ray excitation lines (Al K_α, Ag L_α, Ti K_α, Cr K_α) • Spot sizes: Al K_α and Ag L_α: < 100 µm to 500 µm Ti K_α: < 150 µm to 500 µm Cr K_α: < 200 µm to 500 µm **µFAB version** • Up to 3 switchable X-ray excitation lines (Al K_α, Ag L_α or Ti K_α, Cr K_α) • Spot sizes: Al K_α and Ag L_α: < 10 µm to 300 µm Ti K_α and Cr K_α: < 25 µm to 300 µm • Scannable: 2 × 2 mm
Dimensions	• EnviroMETROS FAB: 1.2 m (W) × 2.2 m (L) × 2.0 m (H) • EnviroMETROS FAB with FOUP / EFEM: 1.2 m (W) × 4.7 m (L) × 2.0 m (H)

Technical alterations reserved.

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