Leibniz Institute
for high
performance
microelectronics

Analytical Methods

Auger Electron Spectroscopy (AES)

Technical Parameters

Auger Electron Spectrometer:

Physical Electronics PHI 670 Nanoprobe

Ion source: Ar^{+} Ions (Energy 1-5 keV)

Primary Beam: focused electron beam (1 - 25 keV) – Field emitter

Signal Detected: Auger electrons, Secondary electrons

Elements Detected: Li-U; Chemical bonding information

Application areas

- Surface analysis
- Particle analysis
- Small-area depth profiling
- Defect analysis
- Thin film composition analysis

Contact person

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Focused Ion Beam (FIB)

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Technical parameters

FIB-SEM system:

NVision 40 (Carl Zeiss Microscopy GmbH)

Primary beams:

SEM (Zeiss Gemini): e^- 1 - 30 kV

FIB (Seiko Zeta): Ga^+ 2 - 30 kV

Lateral resolution: SEM: 1.1 nm @ 20 kV
2.5 nm @ 1 kV

FIB: 4.0 nm @ 0.1 pA

Signals detected:

Secondary electrons

Backscattered electrons

(SE, In lens, EsB, STEM detectors)

Application areas

- High resolution cross-section images of small sample features
- SEM and STEM imaging
- TEM sample preparation
- „on-chip“ circuit modification (FIB cuts,

  deposition of C, W, Pt, SiO_2)
- Surface patterning

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Scanning Electron Microscopy (SEM)

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Technical Parameters

SEM System:

Zeiss MERLIN Gemini 2

Primary Beam: Electrons 1 - 25 kV

Signal Detectors:

- secondary electron detector (SE , In-Lens)
- energy-selective backscattered electron detector (ESB , In-Lens)
- backscattered electron detector (BSD)

Lateral Resolution:

Application areas

- high resolution SEM images

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Transmission Electron Microscopy (TEM)

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Technical Parameters

TEM System:

FEI Tecnai Osiris

Super-X windowless silicon drift detector

Primary Beam: Electrons 200 keV

Signal Detected:

- Transmitted electrons
- Scattered electrons
- X-rays

Elements Detected: B-U (EDX)

Lateral Resolution: TEM: 0.26 nm

STEM: 0.18 nm
EDX: 5 nm

Detection Limits: EDX: 0.1 - 1 at%

Application areas

- Cross-section and plan-view (S)TEM analysis
- Failure analysis of integrated circuits
- Determination of crystallographic phases
- Crystal defect characterization
- Ultra small area elemental analysis by EDX and EELS

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Secondary Ion Mass Spectrometry (SIMS)

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Technical Parameters

Magnetic Sector SIMS System:

CAMECA IMS WF

Primary Beam: O and Cs Ion Sources

Signal Detected: Secondary Ions

Elements Detected: H – U

Lateral Resolution: 10 µm

Depth Resolution: 1 – 3 nm

Detection Limits: 10^{13} - 10^{16} at/cm³

B / HE:	$5 \cdot 10^{13}$ at/cm³
B / LE:	$2 \cdot 10^{15}$ at/cm³
As / HE (HMR):	$5 \cdot 10^{13}$ at/cm³

Application areas

- Dopant and impurity depth profiling
- Composition and impurity measurements of thin films
- High-precision matching of process tools, such as ion implanters and CVD etc.

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Time-of-Flight Secondary Ion Mass Spectrometry (TOF-SIMS)

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Technical Parameters

Time-of-flight mass spectrometer:

ION-TOF 5

Primary Beam:

Analysis Gun:

Liquid Metal Ion Gun (LMIG)

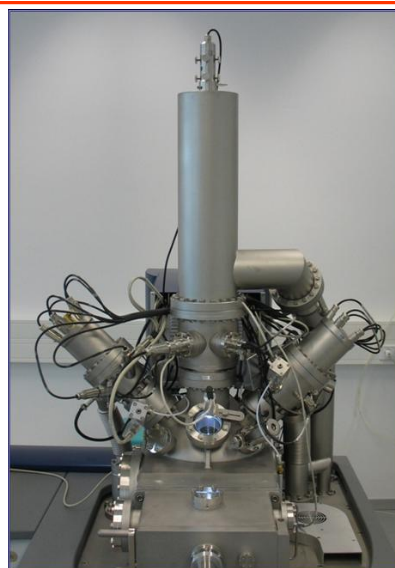
Bi_1, Bi_3 und Bi_3^{++} Ions/Clusters

Sputter Gun: O und Cs

Signal Detected: Secondary Ions

Elements Detected: H – U

Lateral Resolution: 90 nm (Imaging)



Application areas

- Surface microanalysis of organic and inorganic materials
- High resolution ion imaging of surfaces
- Dopant and impurity depth profiling
- Composition and impurity measurements of thin films
- In situ sample cooling and heating (-130°C to +600°C)
- Sample (5 – 20mm) and wafer (200mm) analysis

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X-Ray Photoelectron Spectroscopy (XPS)

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Technical Parameters

Photoelectron Spectrometer:

PHI VersaProbe II

X-Ray Source: Aluminium anode (Al Kα, photon energy 1486,6 eV)

Ion Source: Ar^{+} Ions (Energy 0.25-5 keV)

Primary Beam: mono chromatised

AlKα - 1486,6 eV

Signal Detected: Photoelectrons

Elements Detected: Li – U Chemical bonding information

Lateral Resolution: 10 µm – 100 µm

Application areas

- Surface analysis of organic and inorganic materials
- Determining composition and chemical state information from surfaces
- Depth profiling for thin film composition
- Thin film oxide thickness measurements

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Vapour Phase Decomposition (VPD) + Inductively Coupled Plasma Mass Spectrometry (ICP-MS)

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Technical Parameters

WSPS2 - VPD automation system:

- Open cassette stations
- **Robotic system:** Fully automatic wafer handling and processing
- **PAD-Fume:** Etching of surface and bulk Si
- **PAD-Scan:** scanning of liquefied wafer surface
- **Scan options:** Bevel scan (for wafer edges) and Hydrophilic surface scan

Element2:

- **High range of elements:** >33
- **Detection limit:** $1{\cdot}10^8$ at/cm^2
- **High dynamic range:** >$1{\cdot}10^9$ cps
- **High range of linearity:** $1{\cdot}10^8$ at/cm^2 - $1{\cdot}10^{12}$ at/cm^2
- **High mass resolution (HR):** MRP>10000

Application areas

- Sinks by blank monitor wafer
- Cleanliness of chemicals, UPW and DI Water
- CVD tools for TEOS-Oxide, SiN and SiON for layer cleanliness
- Implanters for baseline contamination (Ar-implant in thin Oxide)
- Metrology tools (bare silicon wafers)
- Cleanliness of cleanroom environments with monitor wafers (bare wafers)

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