

Microscopy and Microstructure Analysis

Fraunhofer Institute for Silicate Research ISC – Project Group Materials Recycling and Resource Strategies IWKS

Head of the department Analytics: Dipl.-Ing. Konrad Güth

High Resolution Field Emission Scanning Elektron Microscopy (SEM)



Detectors

Topography: In-Lens (IL)
Secondary electrons (SE)
Phase contrast: Angle and energy selective back scattered electrons (ASB, ESB)
Chemical analysis: Energy dispersive (EDX) und wavelength dispersive (WDX)
X-ray spectroscopy

Additional equipment

- Cryo stage
- Airlock for cryo-/vacuum-transfer unit
- Charge-compensator & plasma cleaner

Applications:

- High resolution imaging: lateral resolution below 10 nm
- Morphology investigation: surface and ion etched or crack-line cross sections
- Determination of the chemical composition: nano-, micro-, macro-structures
- Phase identification and quantification (point, line and surface mapping)
- Determination of particle size and distribution, layer thickness in cross section

Focused Ion Beam / Scanning Electron Dual Beam Microscopy (FIB/SEM)



Detectors

SESI, IL, ESB, STEM, EDX, EBSD

High resolution ion source

Ga-LMIS, 0.5-30 kV, 10-10⁵ pA

two gas injection sources

Deposition of platinum and carbon, electron or ion beam induced

Tomography with simultaneous EDX and EBSD investigation

3D-Option by serial serial sectioning, imaging and/or mapping

Micro manipulator, charge-compensator, plasma cleaner

Applications:

- Preparation of cross sections, TEM-lamellae and specimen for 3DAP
- Characterization of layer thicknesses in multi-layer systems, protection of near-surface features by FIB or electron beam induced deposition
- Phase identification and –quantification, combination of FIB sectioning, SEM imaging, EDX und EBSD provides 3D investigation of the microstructure

3D Local Electrode Atom Probe Microscopy (3-DAP)

3D element specific microstructure

Chemical characterization and 3D element specific morphology investigation of solids

Reflectron mass spectrometer

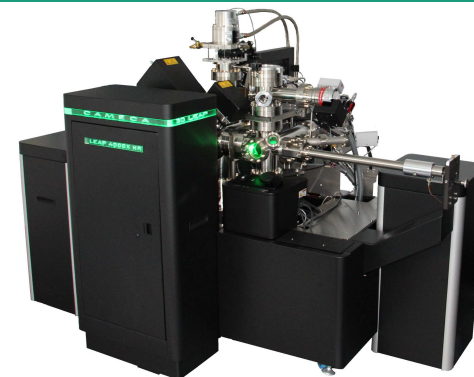
For high mass resolving power
 $\Delta m/m$ (FWHM) ~ 1000

Laser and voltage pulse mode

Analysis of metals, semiconductors and insulators

Helium Cryostat

Adjustable sample temperature, 25 - 300 K



Applications:

- Nanoscale 3D analysis of the chemical composition, resolution ~0.2 nm
- Grain boundary morphology, diffusion profiles and thin layer characterization of semiconductor, optoelectronic devices and nanostructured materials
- Metals, alloys, semiconductors, insulators and composites from powder or compact samples, sensitivity ~5 ppm, all elements

Sample preparation and transfer with oxygen-free workflow

Mechanical pre-preparation EM TXP

Cutting, grinding, polishing with μm precision
Microscope with image and video capture

Sputter Coater EM ACE600

Various targets: carbon, copper, platinum, tungsten
Cryo-stage and airlock for vacuum-/cryo-transport

Argon broad ion milling EM TIC 3X

Cross section and surface preparatio in vacuum

Cryo-/ vacuum transport unit VCT100

Sample transfer under vacuum on cryo-stage



Applications:

- Leica's workflow system allows fast and precise sample preparation
- Transfer excluding oxygen and other contaminations for clean surfaces and exact determination of composition and morphology
- Samples can be prepared and transferred between sputter coater, ion milling and electron microscope at cryogenic temperatures and contamination free