

ION BEAM MILLING



RES 101



Ion beam preparation for thinning, cleaning
and in-situ-coating in one single system

Coating · Cryo Preparation
Ion Etching · Solid State Preparation
Accessories and more ...

KEY FEATURES INCLUDE:

- fully computer-controlled system
- variable milling angle from 0° to 90°
- „ALL-IN-ONE system“ with the highest level of flexibility for the user
- load-lock system for a permanent high vacuum
- variable ion energy for high and low energy sample milling
- external control of the milling process via LAN

ION BEAM MILLING



RES 101



2 new designed saddle-field ion sources
with variable ion energy for fast to
gentle milling results

ALL-IN-ONE

All ion beam preparation methods can be carried out within a single unit.

- Preparation of TEM samples with single or double-sided low angle milling of the sample down to 0°
- Preparation of samples for Scanning Electron and Light Microscopy
- Surface cleaning
- Surface milling for contrast enhancement
- Processing of samples of up to 25mm diameter
- 45° and 90° slope cutting for the investigation of the vertical structure
- In-situ coating of SEM and TEM samples with various target materials
- Various sample holders for different SEM, LM and TEM applications

UNIT DESCRIPTION:

The RES 101 is a compact bench unit, in which all the components are mounted in a single housing. Thanks to its high level of flexibility, it is ideally suited for the preparation of samples from a widely diversified range of materials, for

all Transmission Electron, Scanning Electron, and Light Microscopy.

Computer control

The RES 101 is fully computer controlled, and permits a very precise setting of the milling parameters thanks to the positioning motors used, which are fitted with incremental encoders. All parameters can be displayed in the menu. Settings can be changed via the touch screen.

After the start of the RES 101 program, the PC takes over the complete control of the milling process.

This includes:

- the vacuum system
- the regulation of the gas inlet and the high voltage for the ion sources
- all movements of the ion sources (milling angle) and of the sample holder (x-movement, tilting)
- the vacuum load-lock for the sample transfer

This results in the following possibilities:

- The ability to exactly set and control all process parameters through the user-friendly RES 101 program.

- Complete automation of the preparation process through:
 - the ability to create complete milling programs
 - a program library for the precise preparation of

Preparation of Multilayer Systems with highly variable sputter rates of the different materials.

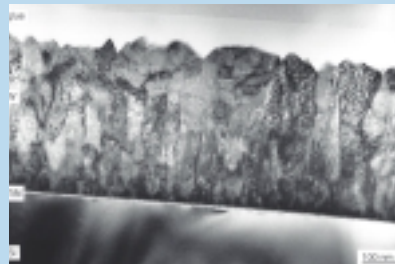


RES 101

Si-substrate with TiN-layer (approx. 5nm), W-layer (500 nm). Different hardness, atomic weight and milling rate of each layer makes a sample preparation more demanding. Conventional preparation with rotary sample holder and angle of incident at 10° would create steps between the different layers. In order to receive equal thinning of all the components, an angle of incident perpendicular to the glue-line and lower than 6° with simultaneous oscillation of the sample has to be chosen.



Set-up: Graphite holder with single sided low-angle milling, 7kV acceleration voltage (2kV final thinning), sample oscillation.



Images:
X-TEM images of W-layer deposited on TiN/Si

- recurring applications
- precise automatic termination feature with optical image processing
- sample control with CCD-camera and the storage of live images for the documentation of the milling progress
- external PC control of the milling process via a local network (LAN)

Reliable and stable operating system
based on Linux OS. Integrated
applications library

Video monitoring

With the help of a powerful CCD colour video camera, the sample can be observed during the milling process and the milling progress can thereby be assessed.

Optionally an additional microscope with an optical magnification between 4 and 20 is available. Live images can be stored at any time. Direct lighting and back lighting sources are available for the illumination of the sample.



Slope-Cutting of Semiconductor-Material



RES 101

Automation of the milling process

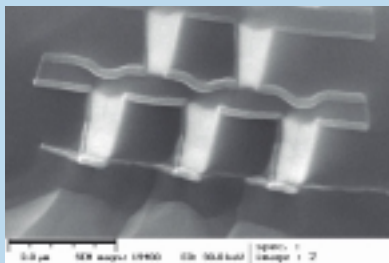
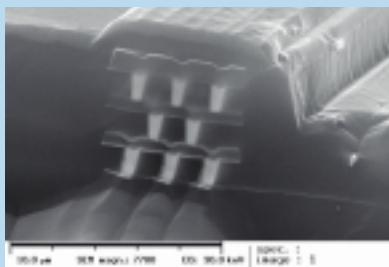
With the computer control, complete milling programs with different preparation steps can be created. These are stored, and can be reused for the same preparation problems. An extremely precise automatic switch-off routine, using optical image processing, even allows sample preparation when the user is not present. In this way, very time-consuming preparations can be carried out over-

night. A large number of possible settings, with regard to the switch-off sensitivity, permits a wide application range of sample materials. For materials that are completely transparent to light, a Faraday-cup can be used for the automatic switch-off of the milling process.

Network compatibility

With the use of an additional software, it is possible to monitor and control the milling process from another PC via a local network (LAN).

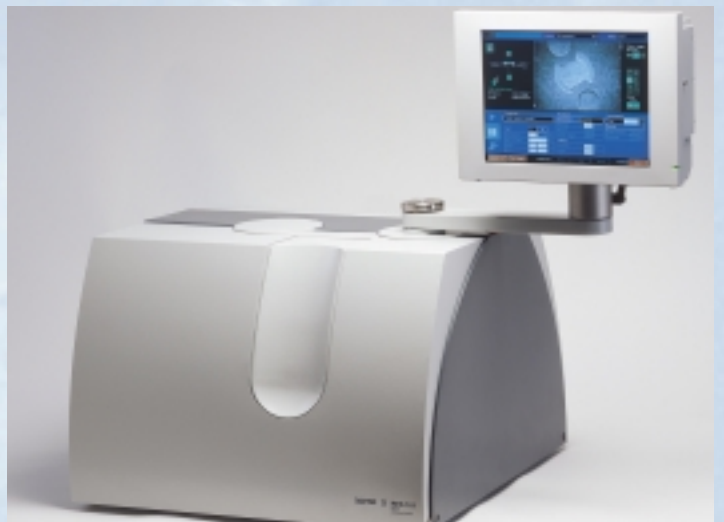
The vertical structure of microelectronic semiconductor material is of big interest to receive information on the entire system. In order to get information on the vertical structure, slope cutting for SEM is a fast (approx. 1 hour) and reliable alternative to the time consuming TEM-cross-sectional preparation. The interest in this application, was to receive information on vias and conducting layer structures. Slope cutting also enables to uncover and analyse the lateral structure on a lower level in the semiconductor system.



Set-up: 90° slope cutting holder, 6kV acceleration voltage, 45-60 min etching-time, sample oscillation (+/-60°).

Images:
90° slope cut through semiconductor material

The video camera has a motorised zoom objective with an optical magnification between 0.2 and 2.



Integrated CCD camera for excellent observation of the milling process and easy alignment of the ion beam

Motor control of all movements

All movements are realised using DC-motors with incremental encoders. As a result, a precise and reproducible set-up is possible. The accuracy of the settings is 0.1° for angles and 0.1mm for travel.

in the vacuum chamber within 1 minute via a vacuum load-lock.

Ion sources

Thanks to state-of-the-art technology, the saddle-field ion sources used, achieve a service life of well above 400 hours, whereby a water cooling system is unnecessary due

Large variability of the milling parameters

The RES 101 uses two ion sources arranged opposite one another, with which the samples can be processed either on one side or



Vacuum and gas inlet system

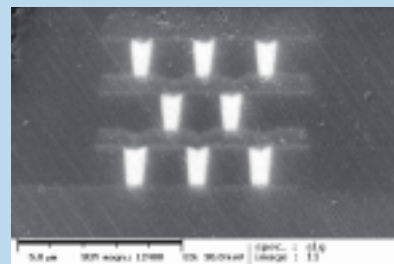
The two-stage vacuum system consisting of a diaphragm pump and a turbomolecular pump (70l/s) creates an oil-free ultimate vacuum of $<2 \times 10^{-6}$ mbar. The measurement is carried out using an ion gauge head. The innovative computer-controlled gas inlet system guarantees a stable operation of the ion sources at working pressures between 6×10^{-5} mbar and 4×10^{-4} mbar. The sample transfer takes place at vacuum conditions

to the good heat conduction. The ion energy can be varied between 1keV and 10keV with source currents of max. 3.5mA (per source). The FWHM value of the ion beam is dependent on the acceleration voltage. At 10kV, it is 0.8mm, and approximately 2.5mm at 2kV. In this way, the RES 101 can be used both, to achieve high milling rates and also to obtain a very gentle, low energy processing of samples for High Resolution Transmission Electron Microscopy (HRTEM).

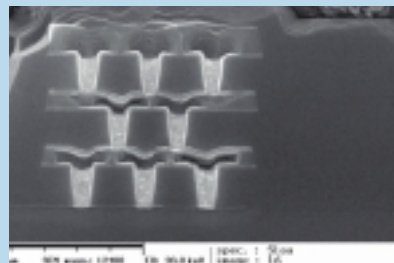
Cleaning and Contrast enhancement of grindings using ion milling



After conventional grinding of surfaces normally emerge scratches and remains of the substrate or the abrasive material. These artefacts are strongly depending on the substrate and will become only visible at high magnification in the SEM. Also the contrast of grindings is normally quite poor, which results in hard to recognise semiconductor structures. Ion-beam milling at different angles and with variable time and acceleration voltage, for cleaning and contrast enhancement is an interesting alternative to the more demanding and time consuming wet-chemical-etching method.



Set-up: 6kV acceleration voltage, 15° and 90° angle of incidence, variable etching-time, sample rotation.



Cross-sectional grindings:
 - After mechanical grinding
 - After ion milling (cleaning and contrast enhancement)

on both sides. The milling angle can be adjusted between 0° and 90°. With the wide range of settings for the milling angle and ion energy, practically all preparation problems for Scanning Electron, Transmission Electron and Light Microscopy can be processed.

Preparation-“recipes” or individual configuration of the milling parameters according to specific applications

ACCESSORIES

Various accessories are available for different applications.

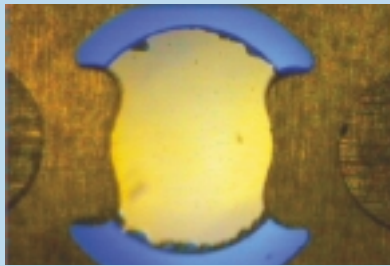
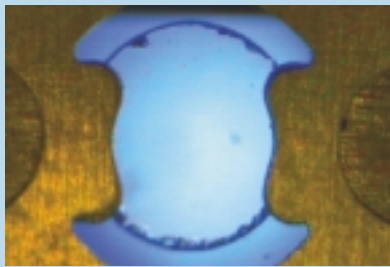
In-situ coating of SEM-, TEM- and LM-samples



RES 101

In order to improve electrical conductivity, to protect the prepared sample or to enhance the contrast of the sample surface under the SEM or TEM, a coating can be applied to the prepared sample. With the RES 101 this is possible subsequent to the ion-beam-preparation without sample-transfer. The coating is possible with different materials.

Set-up: 8kV acceleration voltage, 3.5mA ion-current, sputter rates: C = 2nm/min., Au =15nm/min.



Images:

- uncoated glass disc
- Au-coated glass disc

Quick Clamp holder

(Standard-TEM holder) for single and double-sided low angle milling down to 4°.

LZ 01631 VN



meter of 25mm is available on request.

LZ 00134 VN



Graphite holder

for single and double-sided low angle milling down to 0°.

LZ 00135 VN



45° and 90°

slope cutting holder

for the production of cross-sectional and angled sections for the investigation of the vertical structure of the sample on a Scanning Electron Microscope.

LZ 00132 VN /

LZ 02631 VN



Single-sided low angle

milling holder

for the preparation of temperature-sensitive samples. With a good heat contact to the sample, milling angles down to 0° can be achieved.

LZ 00131 VN



ALL IN ONE

The RES 101 unites all the above-mentioned preparation possibilities in a single unit. It can be used for the preparation of TEM, LM and SEM samples, allows an in-situ coating of the samples and, in addition to high-energy milling, can also be used for the very gentle sample processing with low ion energy.

Standard SEM sample holder

for the processing of SEM and LM samples up to 16mm diameter and 17mm height.

A holder for samples with a dia-

Large variety of different sample holders enable almost any application

TECHNICAL SPECIFICATIONS:

Basic unit RES 101 RES 101 GVN

Ion sources

Ion energy: 1keV to 10keV
 Ion current: >200mA (per ion source)
 Source current: up to 3.5mA (per ion source)
 Ion current density: 10mA/cm² (per ion source)
 FWHM: 0.8mm (at 10keV)
 2.5mm (at 2keV)
 Cathode service life: >400h
 Gas: Argon (other gases possible)
 Gas flow: <1sccm / ion source with automatic control

Angle settings

Gun tilting: Gun 1: ±45° (0.1° setting accuracy)
 Gun 2: ±45° (0.1° setting accuracy)
 Sample holder tilting: -5° to 210° (0.2° setting accuracy)
 Milling angle: 0° to 90° (dependent on the sample holder)

Specimen Bias

Positive high voltage (up to 3.5kV) on the sample holder in order to achieve an almost 0° ion incidence with regard to the surface of the samples, even with dimpled samples Option LZ 00128 VN

Sample holder

TEM:
 Quick Clamp holder (down to ±4°) LZ 01631 VN
 Graphite sample holder (down to 0°) Option LZ 00135 VN
 Sample holder for single-sided low angle milling Option LZ 00131 VN
 Mounting/centering device for Quick Clamp holder Option LZ 01632 VN
 SEM:
 Standard holder Option LZ 00134 VN
 Holder for 25mm samples Option on request
 45° slope cutting holder Option LZ 00132 VN
 90° slope cutting holder Option LZ 02631 VN
 Universal set-up jig for adjusting the sample table (for LZ 00135 VN, LZ 00131 VN, LZ 00134 VN, LZ 00132 VN, LZ 02631 VN) Option LZ 00056 VN

Sample holder movement

Rotation (0.5 to 3rpm)
 Oscillation (up to ±90°, in 1° steps)
 Zero point set-up in 1° steps
 Movement in the x-direction (±3mm; 0.1mm accuracy)
 Tilting: -5° to 210°

Sputter table

In-situ coating of TEM and SEM samples with various target materials Option on request

Motor drive

Computer-controlled DC-motors with incremental decoders for sample holder movement, milling angle setting, load-lock movements,

Lighting

Direct and back lighting

Computer

PC control unit with touch screen and BAL-TEC RES 101 software for the monitoring and control of the milling process.

LAN network capability for external operation and monitoring Option LZ 01679 VN

Video monitoring

CCD colour video camera with motorised zoom 0.2 to 2 optical magnification

Automatic switch-off

Automatic termination with optical image processing (adjustable sensitivity). Faraday cup (for completely light-transparent samples). Option on request

Vacuum system

Oil-free, two-stage system consisting of: Diaphragm pump and turbomolecular pump (70l/s) Computer-controlled gas inlet valves Vacuum load-lock for sample transfer within 1min and constant high vacuum in the vacuum chamber Ultimate vacuum: <2x10⁻⁶ mbar

Sample cooling

Liquid nitrogen cooling Option on request

Fully automatic vacuum-load-lock-system
 guarantees highest through-put and
 best efficiency.

COATING

• CARBON, GOLD HIGH RESOLUTION • CD/DVD MASTERING



SCD 050

CRITICAL POINT DRYING

• CRITICAL POINT DRYERS



CPD 030

CRYO PREPARATION

• FREEZE • DRY • ETCH • TRANSFER



VCT 100

ION BEAM MILLING

• ION MILLING/COATING FOR TEM, SEM AND LM



RES 101

MEMS PROCESSING

• CRITICAL POINT DRYERS FOR 4", 6" AND 8" WAFERS



CPD 400

CONSUMABLES

• FULL RANGE FOR SEM AND TEM



www.bal-tec.com

Coating - Cryo Preparation
Ion Etching - Solid State Preparation
Accessories and more...