OMICRON

INSTRUMENTS FOR SURFACE SCIENCE

# SPECTALEED Optics

# and Electron Gun

# User's Guide

Version 3.3

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Idsteiner Straße 78, D-65232 Taunusstein, Germany

Tel.: +49 (0)6128 987-0, Fax: +49 (0)6128 987 185

M3351

Fred Henr 412-831-2262
Fax 412-831-9828.

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**Please note:** Some components described in this manual may be optional. The delivery volume depends on the ordered configuration.



**Please note:** This documentation is available in English only.

**Attention:** Please read the safety information on pages 8 to 10 before using the instrument.

| Related Manuals |
|---|
| NG LEED / NG LEED S |
| DAT 100 |
| Auger Electron Spectroscopy with 4-Grid SPECTALEED |

Table 1 Related manuals.

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# Conditions of CE Compliance

OMICRON instruments are designed for use in an indoor laboratory environment. For further specification of environmental requirements and proper use please refer to your quotation and the product related documentation (i.e. **all** manuals, see individual packing list).

The SPECTALEED Optics complies with CE directives as stated in your individual delivery documentation if used unaltered and according to the guidelines on page 6 in conjunction with a CE labelled UHV system and CE labelled OMICRON power supplies.

### Limits of CE Compliance

This compliance stays valid if repair work is performed according to the guidelines in the relevant manual and using original OMICRON spare parts and replacements.

This compliance also stays valid if original OMICRON upgrades or extensions are installed to original OMICRON systems following the attached installation guidelines.

### Exceptions

Omicron **cannot** guarantee compliance with CE directives for **components** in case of

- changes to the instrument **not explicitly agreed by OMICRON**, e.g. modifications, add-on's, or the addition of circuit boards or interfaces to computers supplied by OMICRON.

The customer is responsible for CE compliance of entire **experimental setups** according to the relevant CE directives in case of

- installation of OMICRON components to an on-site system or device (e.g. vacuum vessel),
- installation of OMICRON supplied circuit boards to an on-site computer,
- alterations and additions to the experimental setup not explicitly approved by OMICRON

**even if** performed by an OMICRON service representative.

### Spare Parts

Omicron spare parts, accessories and replacements are not CE labelled individually since they can only be used in conjunction with other pieces of equipment.

# 1. Introduction

The OMICRON SPECTALEED is a rear view LEED optics which combines four unique features in a single analytical instrument:

1 Rear view LEED: no need for a second opposite viewport.

2. Internal retraction mechanism(optional): more space for the sample (holder) movements.

3. Four grid version for retarding field Auger analysis (optional): integrated electron energy spectrometer.

4. Integral electron gun for up to 3.5 keV: no external excitation source required for AES.

5. Weight ≈ 15 kg, for dimensions see figure 1 below.

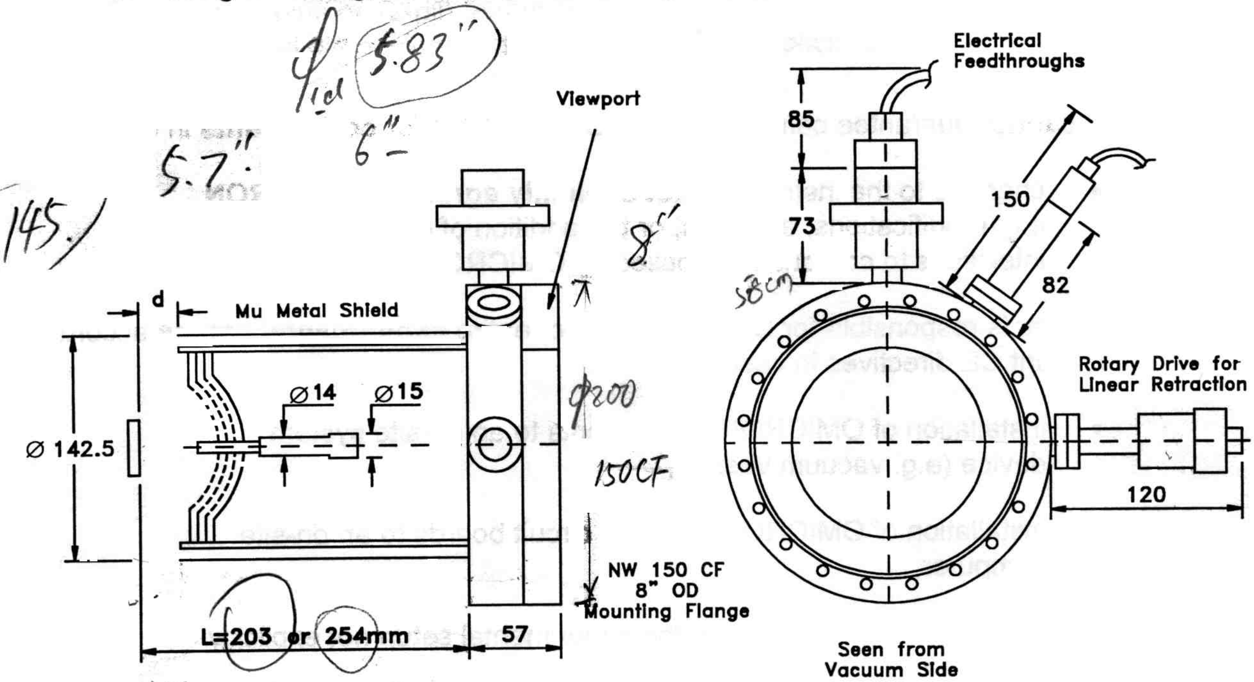


Figure 1. The SPECTALEED optics, schematic diagram. d =30 mm for 2-grid version, 26 mm for 3-grid version and 22 mm for 4-grid version.

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OMICRON INSTRUMENTS FOR SURFACE SCIENCE

## NORMAL USE

The OMICRON SPECTALEED rear view LEED optics is intended for viewing a diffraction pattern from the back as well as from the front of the optics. It can also be used for retarding field Auger analysis.

The SPECTALEED rear view LEED optics shall always be used as part of one of the following packages

| |
|---|
| **1. SPECTALEED optics** |
| **2. NG LEED: SPECTALEED control unit** |

or

| |
|---|
| **1. SPECTALEED optics** |
| **2. NG LEED S: LEED/Auger package** |
| **3. PC PEN LEED including DAT 100 data acquisition softtware and LIAC control software** |

The **SPECTALEED rear view LEED optics** shall always be used

- with original cable sets which are explicitly specified for this purpose
- inside a vacuum chamber (explicitly specified for this purpose)
- in UHV (baked)
- with all cabling connected and secured, if applicable
- with all electronics equipment switched on
- in an indoor research laboratory environment
- by personnel qualified for operation of delicate scientific equipment
- in accordance with all related manuals.

**Please note:** CE compliance for a combination of certified products can only be guaranteed with respect to the lowest level of certification. Example: when combining a CE-compliant instrument with a CE 96-compliant set of electronics, the combination can only be guaranteed CE 96 compliance.

**Warning: Lethal Voltages!!**

Adjustments and fault finding measurements as well as **installation procedures and repair work** may only be carried out by authorised personnel qualified to handle lethal voltages.

Please read the safety information in the relevant manual(s) before using the instrument

# 2. Safety Information

## Important:

- **Please read this manual and the safety information in all related manuals before installing or using the instrument.**
- The safety notes and regulations given in this and related documentation have to be observed at all times.
- Check for correct mains voltage before connecting any equipment.
- Do not cover any ventilation slits/holes so as to avoid overheating.
- The SPECTALEED may only be handled by authorised personnel.

## Warning: Lethal Voltages!!

Adjustments and fault finding measurements may only be carried out by authorised personnel qualified to handle lethal voltages.

- Lethal voltages are present at the electron gun, the screen and at the power supply unit during operation.

## Always

- **All connectors which were originally supplied with fixing screws must always be used with their fixing screws attached and tightly secured.**
- **Always disconnect the mains supplies of all electrically connected units before**

  - opening the vacuum chamber or a control unit case,
  - before touching any cable cores or open connectors,
  - before touching any part of the in-vacuum components.

- Leave for a few minutes after switching off for any stored energy to discharge.

## ⚠ Viewports

- Always handle viewports carefully. Improper installation and handling may cause implosion.
- Protect viewports with a safety cover and vent the UHV system whenever handling tools or workpieces in the vicinity of a viewport.
- One accidental smack with a tool or the application of a strong laser beam may already damage the viewport sufficiently to cause cracking during pump-down or under UHV conditions later on.
- Eye protection should be worn when near to a viewport, even if using protective covers.
- If viewports are used on instruments with X-ray generative sources, lead glass covers with sufficient X-ray absorption must be used.

## ⚠ Never

- Never exceed a pressure of 1.2 bar inside the vacuum chamber.
- Never have in-vacuum components connected to their electronics in the corona pressure region, i.e. between 10 mbar and $10^{-3}$ mbar, so as to avoid damage due to corona discharge.

## ⚠ Storage

- **Store the optics in a dark place.** Do not expose to sunlight as this may start chemical reactions on the luminescence screen and destroy it.

## ⚠ $LaB_6$ Crystal

- **$LaB_6$ crystals are extremely hygroscopic** - even more than silica gel which is normally used in dessicators. $LaB_6$ filaments must therefore be kept under vacuum conditions if stored for more than about two weeks. If the optics has to be stored in air for a longer period of time remove the filament and store it in vacuum.

## ⚠ Grids and Screen

- **Grids and screen must be kept free of dust!** Low energy electrons are easily deflected by charged dust particles on the grids, showing up as dark spots. Also field emission could appear, noticeable as bright spots on the screen. Leave the polythene bag on the optics as long as possible for protection against dust. When removing the optics from the vacuum system immediately cover it with a polythene bag or aluminium foil. When venting the vacuum system care should be taken not to introduce dust. Always vent with dry nitrogen or at least a dust filter for air. In some cases dust may be removable by gently blowing clean.
- **Do not touch the grids or the screen** or their spherical shape may be changed irreversibly. This causes a severe loss in performance of the SPECTALEED optics and can only be cured by replacing the damaged grid.

## ⚠ No Acetone !

- **Do not use acetone for cleaning** specimens or other in-vacuum components. Acetone deactivates the $LaB_6$ filament. Isopropanol is preferable as a final rinse.

## ⚠ This product is only to be used:

- within a dedicated UHV system
- under ultra-high-vacuum conditions
- indoors, in laboratories meeting the following requirements:

  altitude up to 2000 m,

  temperatures between 5°C / 41°F and 40°C / 104°F (specifications guaranteed between 20°C / 68°F and 25°C / 77°F)

  relative humidity less than 80% for temperatures up to 31°C / 88°F (decreasing linearly to 50% relative humidity at 40°C / 104°F)

  pollution degree 1 or better (according to IEC 664),

  overvoltage category II or better (according to IEC 664)

  mains supply voltage fluctuations not to exceed ±10% of the nominal voltage

# 3. Filaments

## Thoriated Tungsten Filament

The thoriated tungsten filament (WTh) can be used in a broad vacuum range. Its main advantage is the rather high operating pressure: the thoriated tungsten filament can be used with pressures up to $5\times10^{-6}$ hPa.

| | |
|---|---|
| wire diameter | 0.1 mm |
| work function | 2.6 eV |
| recommended operating temperature | 1900 K |
| max. chamber pressure | $5\times10^{-6}$ hPa |
| filament resistance | 1 Ω |
| filament current | ≈1.6 A |

Table 2. Thoriated tungsten filament specifications.

## Lanthanum-Hexaboride Filament

The $LaB_6$ (lanthanum-hexaboride) filament has good emission characteristics at low power inputs. It yields a higher emission current than the thoriated tungsten filament and is therefore recommended for Auger work. Its low operating temperature results in a very low stray light level, essential for VideoLEED work. For specifications see table 3 below.

| | |
|---|---|
| crystal orientation | <100> truncated |
| diameter | 100 µm |
| work function | 2.6 eV |
| recommended operating temperature | 1700 K |
| max. chamber pressure | $2\times10^{-7}$ hPa |
| filament resistance | cold: 10Ω<br>hot: 6Ω |
| filament current | <1.4 A |

Table 3. $LaB_6$ filament specifications.

Although a long filament lifetime is expected under normal conditions these filaments are very sensitive to misuse. Forced operation at too high pressures, even for a short time, may be fatal. Particularly oxygen and acetone are poisoning for the $LaB_6$ filament, see figures 9 and 10 in the appendix.

**Attention: Never use acetone** for parts that share the vacuum chamber with a $LaB_6$ filament, see page 10 and figure 10.

- The SPECTALEED optics should never be operated with a system pressure above $2 \times 10^{-7}$ hPa, otherwise lifetime of the $LaB_6$ filament can be reduced markedly.
- The $LaB_6$ filament runs at a filament current below 1.4 A corresponding to a filament temperature below 1700 K.
- The resistance of the filament changes from about 10Ω (cold) to about 6Ω (hot) during operation.

# 4. Installation

> **Attention: Installation procedures** may only be carried out by authorised personnel qualified to handle lethal voltages.
>
> Switch off all units and wait for a few minutes (for discharge of the power supplies) before connecting or disconnecting any cables.
>
> Make sure all high voltage plugs are secured before switching any one of the electronics units on.

The SPECTALEED optics is mounted to a double sided flange NW 150 CF (200 mm o.d.) and should be carried only by handling this base flange.

> **Please note:** The SPECTALEED optics is shielded with a Mu-metal cylinder. For installation within a Mu-metal chamber this should be replaced by a stainless steel cylinder. In this case please contact OMICRON for further information.

- Make sure that the interior diameter of the chamber flange to which the SPECTALEED optics shall be bolted is large enough and the space needed is unobstructed.
- Remove the plastic cover.
- Use a new copper gasket and 20 bolts (M8, about 45 mm long).
- If the SPECTALEED optics is mounted in a horizontal position the electrical feedthrough should preferably show upwards. It may, however, be installed to the vacuum system in any orientation.
- Keep all packaging, boxes and the plastic transport cylinder in case the optics has to be shipped or transported, see also page 30.

The SPECTALEED optics is bakeable up to 220°C.

> **Attention:** After bakeout the assembly should be allowed a sufficient amount of time to cool down (about 5 hours) before switching on. ($T < 60°C$).

All FT 12 connections have fixing screws which prevent accidental disconnection. The plugs must always be used with their fixing screw(s) tightened, i.e. plug secured. These screws, see figure 2, also prevent connecting a plug to the wrong FT 12 feedthrough and hence should not be removed when disconnecting the plug.

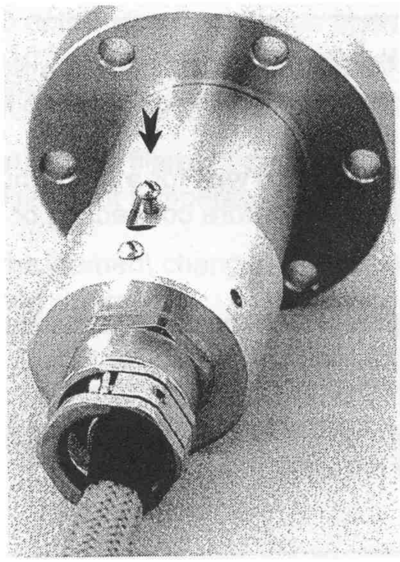


Figure 2. FT 12 connectors: always tighten the fixing screw.

The pin-assignment of the electrical feedthrough is shown in figure 3.

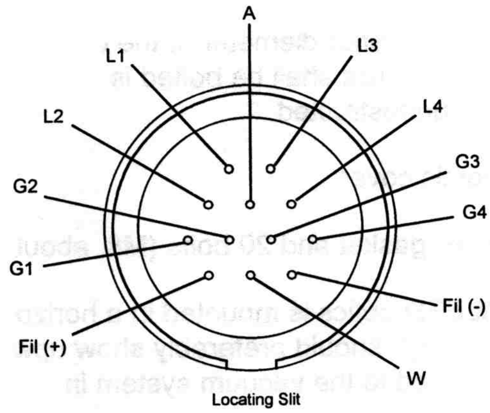
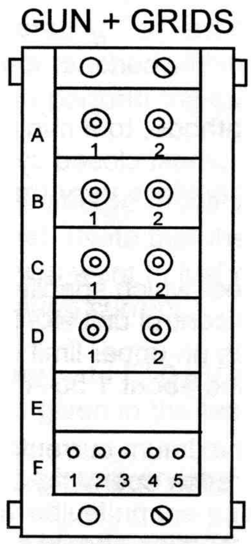



Figure 3. The 12-pin feedthrough as seen from the atmospheric side, schematic diagram. A: anode, $L_{1-4}$: lenses, G1 - G4: grids, Fil: filament, W: Wehnelt.

| | |
|---|---|
| Two Grid Optics | G3, G4 |
| Three Grid Optics | G1, G3, G4 |
| Four Grid Optics | G1, G2, G3, G4 |

Table 4. Used grid pins of 12-pin feedthrough.

The integral electron gun and grids of the SPECTALEED Optics are connected with a supplied multi-lead cable that fits to the 13-pin socket on the rear of the NG LEED and the 12-pin feedthrough on the SPECTALEED Optics.




| | |
|---|---|
| 1A | Filament + |
| 2A | Filament - |
| 1B | Wehnelt |
| 2B | Anode |
| 1C | Lens 1/3 |
| 2C | Lens 2 |
| 1D | Grid 2 |
| 2D | Grid 3 |
| 1F | 0 V (Lens 4) |
| 2F | Grid 1; Grid 4 |
| 3F | Earth/Ground |
| 4F | securty switch |
| 5F | security switch |

Figure 4. Gun and grids 13-pin socket, connection to electron gun and grids of the SPECTALEED optics.

# 5. Operation

## Filament

In order to reduce the stray light, emitted by the cathode, to a minimum, the Wehnelt cylinder and back cap are constructed to form an almost closed cylinder. This, however, also reduces pumping speed considerably. **It is therefore very important to degas the electron gun properly.**

Each SPECTALEED is accompanied by a test sheet which specifies the operating conditions during test at the factory using a LEED control unit NG LEED. The maximum filament current value should be strictly followed as an upper limit during operation. As a guide this will be about 1.7 A for a $LaB_6$ filament and about 1.55 A for a WTh filament.

Filament currents must be increased slowly and maximum currents observed or damage to the filament may occur. The minimum time to reach operating current is 1 minute.

The following degassing procedure for cathode activation should be performed on each switch-on. Before adjusting or reading voltage or current values make sure that appropriate push button is selected for the panel meter.

### Filament Switch On

1. Make sure the system base pressure has come below $5x10^{-6}$ hPa ($5x10^{-8}$ hPa for $LaB_6$ filament)

2. Turn the potentiometers for the FILAMENT CURRENT and the SCREEN high-voltage to OFF, i.e. fully counter clockwise.

3. Turn the EMISSION potentiometer fully clockwise.

4. Set BEAM ENERGY to 0 V (potentiometer fully counter clockwise) and switch the control unit on.

5. Switch the digital panel meter to "Wehnelt" and set WEHNELT to 0 V. The emission current $I_E$ is the current emitted by the filament onto the anode aperture. The anode voltage is fixed to about +400 V with respect to the filament. On their way to the anode the electrons have to pass the Wehnelt aperture. Setting the Wehnelt to 0 V ensures a correct measurement of the filament emission current.

6. Switch the digital panel meter to filament current $I_{Fil}$.

7. Always watch the system pressure. If at any time the pressure exceeds $5\times10^{-6}$ hPa ($2\times10^{-7}$ hPa for $LaB_6$): reduce the filament current and wait until the pressure has recovered, then proceed.

8. **Slowly** (i.e. within 1 minute) increase the filament current until it reaches the "operating current" given in the test sheet. (The "maximum allowable filament current" mentioned in the test sheet refers to the forming procedure of the filament, only). FILAMENT is a 10-turn potentiometer, so one full turn gives about 0.2 A.

9. Watch emission current $I_E$ by switching the digital panel meter accordingly from time to time and wait until it has reached a value between 0.1 mA and 0.3 mA (0.3 mA to 0.5 mA for $LaB_6$). In order to quickly reach this value you may **temporarily** exceed the nominal operating filament current by 0.2 A. If the desired emission current is not reached within 30 minutes with a $LaB_6$ filament it is necessary to perform the cathode forming procedure as described on page 23.

10. Set Wehnelt voltage to the value indicated as "for good focus" on the test sheet. (Note that the "Wehnelt" has mainly a focusing function. If you want to just reduce the beam current $I_0$, reduce the filament heating current.).

11. Turn the energy to E=0 eV and turn the offset-pots for $L_{1/3}$ and $L_2$ to the voltages given in the test sheet.

12. Then turn the beam energy to 1000 eV and set the indicated lens-voltages by adjusting the gain potentiometers. This will reduce the emission current $I_E$ to 0.001-0.01 mA. Note that minor changes of this value may occur after several hours of operation.

13. After 15 minutes of operation the emission current should be readjusted for correction of thermal drift by setting Wehnelt to 0 V and checking $I_E$.

14. Finally it is recommended to reduce the filament current as far as possible in order to operate the cathode at lower temperatures. This generally improves the total beam current $I_0$ due to the smaller space charge. It also improves the system pressure, enables smaller spot sizes and extends cathode lifetime.

### Filament Switch Off

1. Set Wehnelt to 0 V.

2. Slowly decrease the filament current $I_{Fil}$, it should take about one minute for $I_{Fil}$ to reach 0 A.

3. Now you may switch off the power supply.

> ⚠ **Attention:** Before venting the system switch off the filament and leave it for at least half an hour to cool down to room temperature.

## Optimising the Sample Position

Nominal operating position of SPECTALEED optics with internal retraction facility is given by the most extended position (at stop). In both LEED and Auger operation the correct sample position is essential for highest performance and ultimate energetic resolution.

- The surface of the sample should be placed in the centre of the spherical curvature of screen and grids.
- The geometrical dimensions for 2-grid, 3-grid and 4-grid versions of SPECTALEED are given in table 5 and figure 5.

Make sure the sample is connected to ground. When the gun is ready for operation,

- turn the screen switch to 6 kV and
- move the sample into measuring position

To check and/or correct the sample position you may

Set the electron energy to 1 keV to have a nearly evenly illuminated screen.

- Turn SUPPRESSOR close to 0 V until a dark ring appears on the screen.
- Change the sample distance to find a position where the screen is most evenly illuminated.
- Reset suppressor voltage to about 50V.

| | Spherical Radius | Circular Radius | Full Angle of Acceptance |
|---|---|---|---|
| **Screen** | 66 mm | 104 mm | 102° |
| **Grid 1** | 60 mm | 99 mm | 110° |
| **Grid 2** | 57 mm | 97 mm | 115° |
| **Grid 3** | 54 mm | 95 mm | 122° |
| **Grid 4** | 51 mm | 93 mm | 128° |

Table 5. Geometrical dimensions of the SPECTALEED Optics. Grid numbering starts with the grid closest to the screen.

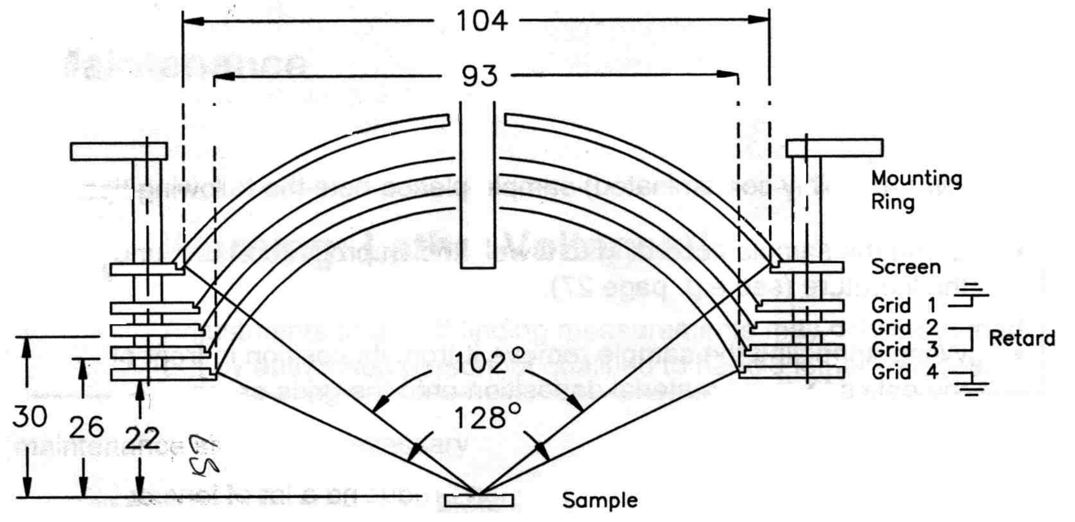



Figure 5. Geometrical dimensions of the SPECTALEED Optics. Grid numbering starts with the grid closest to the screen. Grid 1 is grounded via the power supply. Grid 4 is grounded inside the optics.

> **Please note:** For your camera or video system you have to take into account that you need a depth of focus of 26 mm (= height of the screen).

## Optimising the Lens Settings

On the test sheet you find a set of voltages for operating the gun in LEED mode. These enable sharp spots for as broad an energy range as possible. For special applications there may be different settings necessary, depending on the special energy range needed or for having the beam current constant over the scan range. The voltage values on the test sheet are intended as start values to be optimised for special requirements.

## Looking for LEED Spots

- Set the proper energy, Wehnelt and lens voltages.
- Vary the beam energy on the LEED power supply to discern possible spots from a possible background. A good starting energy range is about 40 eV to 300 eV.
- Move or turn the sample to find a good area.
- If necessary readjust the voltage settings for the electron gun. The offset should be adjusted at low electron energies (10 eV to 40 eV), the gain should be adjusted at high electron energies (100 eV to 300 eV).
- The lens voltages should be about beam energy ($L_2$) and twice the beam energy($L_{1/3}$).
- For very low energies (< 15 eV) the offset needs to be adjusted.

# Hints and Tips

## Sample Preparation

For an unknown (possibly contaminated) sample please note the following tips:

- Clean the sample according to a well-known procedure as found in the literature (see e.g. page 27).
- When annealing the sample remove it from its position in front of the optics to avoid material deposition onto the grids or the luminescence screen.
- Turn off the screen high voltage when producing a lot of ions or electrons somewhere in the system.

## Taking Photographs of a LEED Screen

- Choose aperture 8 with a 100 ASA film.

  Focus on the back side of the screen with room lighting on.

  Make sure to eliminate all stray light during exposure.
  (Mind the LEDs !)

  Choose an exposure of 15 to 30 s depending on beam current $I_0$.

# 6. Maintenance

> **Warning: Lethal Voltages!!**
>
> Adjustments and fault finding measurements may only be carried out by authorised personnel qualified to handle lethal voltages.

If any maintenance should be necessary

OMICRON highly recommends to do all maintenance work in a dust free environment or at least protecting grids and screen with a dust cover.

- Any work on the vacuum side of the SPECTALEED optics should be carried out wearing suitable gloves and using degreased, nonmagnetic tools.

For easy access remove the Mu-metal cylinder first.

- Locate the 3 screws holding the Mu-metal cylinder at the mounting ring underneath the screen.
- Slacken them (2 turns) and rotate the Mu-metal cylinder until it comes free to be pulled off.

## Changing Filament of Internal Electron Gun

For filament exchange only it is possible to leave the SPECTALEED bolted to the vacuum chamber, just removing the viewport at the back.

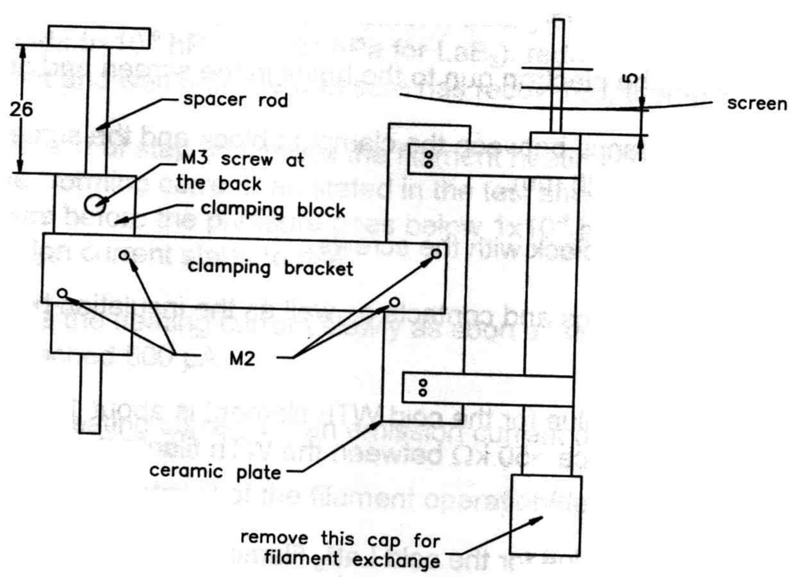



Figure 6. Electron gun assembly.

> ⚠ **Attention:** During filament exchange the electron gun **must not** be allowed to change its position relative to the screen and grids.

The electron gun is mounted to one of the supporting rods by means of a clamping block, see figure6.

1 Remove the cap at the rear end of the electron gun. It is mounted with a spring loaded bayonet fitting. Push and twist end cap clockwise to unlock. (See in detail figure7.)

2. Unplug both connectors of the filament wires.

3. Pull off the spring and remove the filament base, gently pulling on its wire connectors.

4. (Pre 13-9-1989 guns only: remove the ceramic distance ring in front of the filament base, if present. Ensure that the metal aperture plate is kept in position when inserting the new filament.)

5. Push in the new filament to the stop. For low filament heating current consumption and good emission performance it is important to have the correct distance between filament/Wehnelt assembly and anode. This can only be achieved when the filament /Wehnelt assembly is completely at the stop.

6. Re-assemble the parts in reverse order and lock the back cap.

7 Make sure that the insulations of the filament wires are not damaged or generating a short to either the back cap (Wehnelt) or each other.

After replacing the filament adjust the electron gun if it is necessary.

- Loosen the screws holding the clamping block to the support rod.

  Centre-align the electron gun to the holes in the screen and grids.

  Adjust the distance between the clamping block and the screen mounting ring to 26 mm.

  Fix the clamping block with the screws.

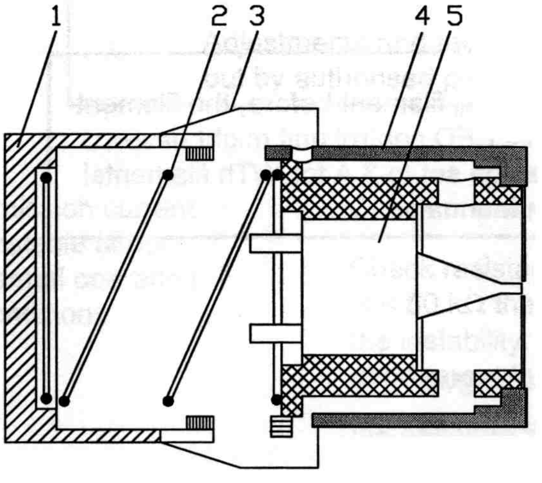
Check all electrical connections and contacts as well as the insulation between the lens elements.

The resistance value for the cold WTh filament is about 1 Ω. There is a finite resistance >50 kΩ between the WTh filament and the Wehnelt.

The resistance value for the cold $LaB_6$ filament is about 10 Ω. There is a finite resistance >50 kΩ between the $LaB_6$ filament and the Wehnelt.

With a replacement filament the optimum voltage settings for electron gun focusing elements may have changed because of a minor change in distance between the filament and the first aperture.

At operating current the Wehnelt cutoff is given by the voltage at which the emission current $I_E$ is reduced to 0.001 mA. This is typically of the order of -50 V. If Wehnelt cutoff is between 0 and -20 V the replaced filament is not correctly positioned. In this case dismantle and readjust the filament following the steps above.




| numbering: | / part name & function: |
|---|---|
| 1&3 | end cap (bayonet fitted) |
| 2 | spring |
| 4 | housing |
| 5 | filament/Wehnelt assemly |

Figure 7. Mounting the filament assembly.

## Forming a Replacement Filament ($LaB_6$ only)

Each filament shipped together with a SPECTALEED optics has been formed at the factory. Therefore a reforming is only necessary after a long time of exposure to air. $LaB_6$ replacement filaments, however, **always** require a forming procedure.

- Go through steps 1 to 8 of the normal degassing procedure (see page 16).
- Always watch the system pressure. If at any time the pressure exceeds $5\times10^{-6}$ hPa ($2\times10^{-7}$ hPa for $LaB_6$): reduce the filament current and wait until the pressure has recovered, then proceed.
- At the end of step 8 increase the filament heating current slowly up to the "forming current" as stated in the test sheet. It may take up to 2 hours before the pressure goes below $1\text{x}10^{-7}$ hPa and the emission current starts to rise.
- Reduce the heating current slowly as soon as emission current $I_E$ has reached 500 µA.
- Set the heating current for an emission current of 300 µA.
- Continue with step 9 of the filament operation/degassing procedure (page 16ff).

# Degassing a WTh Replacement Filament

For WTh filaments a forming procedure is not necessary. However, degassing of the filament may take some time, depending on the required final chamber pressure.

Slowly increase the filament current to about 2.3 A to 2.6 A (0.5 A within 5 min) until the emission current goes up.

> ⚠ **Attention:** If having used a $LaB_6$ filament before, the filament current limit within the SPECTALEED control unit might have been set to 2.2 A. This limit can be set to 3 A for WTh filaments! See also NG LEED Instruction Manual.

# Electron Gun

Figure8 shows the outline of the employed electron gun.

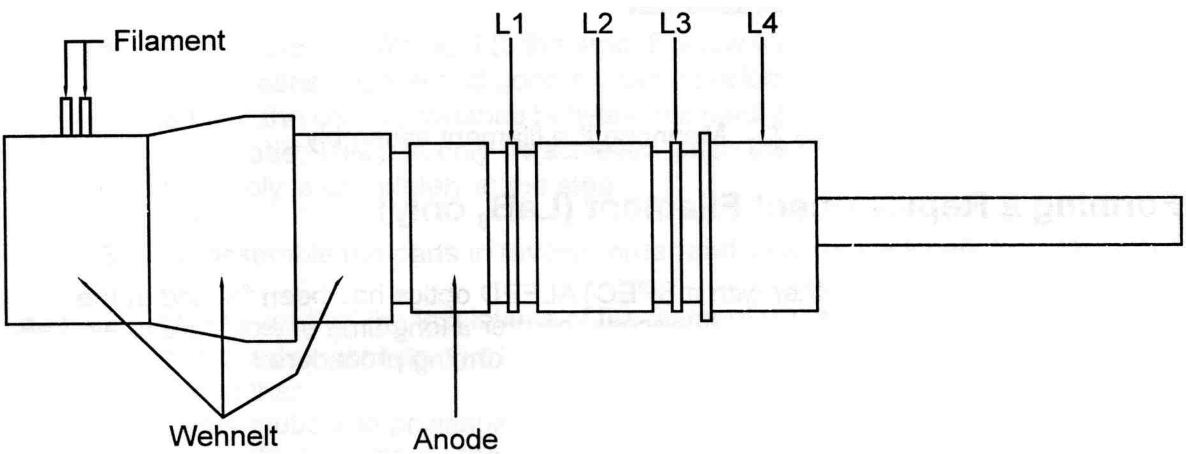



Figure 8. The LEED gun, schematic diagram.

# 7. Trouble Shooting

> **Warning: Lethal Voltages!!**
>
> Adjustments and fault finding measurements may only be carried out by authorised personnel qualified to handle lethal voltages.

| | |
|---|---|
| Emission current unstable under normal operating conditions | Check mains voltage stability is within ±10%. |
| | Check resistance R between Wehnelt and filament. If R < 50 kΩ the Wehnelt voltage supply might be the source of the instability. In this case contact OMICRON service department for detailed instructions. |
| | Increase the filament current to avoid contamination of the cathode. Stable emission current is not only desirable for constant operating conditions during measurement, but also indicates an equilibrium between desorption of contaminants and adsorption from residual gas molecules. |
| No beam current $I_0$ and no pattern on the screen | Check the lens settings and beam energy. |
| | Check the emission current $I_E$ (Wehnelt set to 0 V). |
| | If there is no $I_E$ current the connection to the anode may be interrupted, the anode supply failed or the filament is misaligned. |
| | Check the connections to the lens elements, see figure 8. |
| No pattern on the screen | Check the beam current $I_0$. |
| | Check the screen high voltage (i.e. fuses within the spectrometer control unit). |
| | Check the resistance between screen and earth (this should be infinite). |
| | Check sample preparation and grounding of the sample. |
| Light streaks on the screen shifting with time and energy | There is something charging up. |
| | Check the grounding of the sample. |
| | Check if you look at an edge of the sample. This may produce streaks as well. |
| | Check the sample holder and surroundings for ceramics and something that could charge up. |

# Appendix

## Literature

### LEED

Lagally, M.G., Martin, J.A.: Instrumentation for low-energy electron diffraction, Rev. Sci. Instr. 54 (1983) 1273-1288

Saloner, D. et al: Determination of terrace size and edge roughness in vicinal Si(100) surfaces by surface sensitive diffraction, J. Appl. Phys. 61 (1987) 2884

Van Hove, M.A., Tong, S.Y.: Surface Crystallography by LEED, Springer Series in Chem. Phys. 2 (a bibliography of papers dealing with LEED-patterns for different crystals)

Henzler, M.: Quantitive Evaluation of Random Distributed Steps at Interfaces and Surfaces, Surface Science 73 (1978) 240-251

Henzler, M.: Electron Diffraction and Surface Defect Structure, Topics in Current Physics vol. 4, Springen-Verlag, (1977) 117-149

Henzler, M., Göpel, W.: Oberflächenphysik des Festkörpers, Teubner Studienbücher, B.G. Teubner Stuttgart (1991)

Cunningham: Rev. Sci. Instrum. 49,6 (1978) 751-755

Mroz, S.:J. Phys. E (Scientific Instruments) 16 (1983) 858

### I(E) Curves

Wei, P.S.P.: Low-Energy Electron Diffraction Study of Tungsten (100) Surface, J. Chem. Phys, 53, (1970) 2939

Regina Rochow: Untersuchung von Struktur und magnetischen Eigenschaften dünner. Dissertation, Kernforschungsanlage Jülich Jül-2150, August 1987, ISSN 0366-0885.

### Auger:

Taylor, N.J.:Auger Electron Spectrometer, Rev. Sci. Instr. 40, (1969) 792-804

Davis,L.E., MacDonald, N.C., Palmberg, P.W., Riach,G.E., Weber, R.E.: Handbook of Auger Electron Spectroscopy, A Reference Book of Standard Data for Identification and Interpretation of Auger Electron Spectroscopy Data, Physical Electronics Industries Minnesota, 1972, 1976

### Loss-Spectra and Secondary Electrons

Avery, N.R.: Instrumental effects in the electron spectra from surfaces due to the use of LEED optics, J. Phys. E9 (1976) 676-679

Wei, P.S., Cho, A.Y., Caldwell, C.W.: Instrumental Effects of the Retarding Grids in a LEED Apparatus, Rev. Sci. Instr. 40 (1969) 1075

Dierschke, P.: Energieverteilung emittierter Sekundärelektronen, Dissertation, Essen 1988.

### Surface Resonances

Price, G. L.: Techniques for very low energy electron diffraction, Rev. Sci. Instrum. 51(5) 1980, 605-609

### Sample Cleaning

Musket, R.G. et al: Preparation of atomically clean surfaces of selected elements: a reviev; Appl. Surf.Sci. 10 (1982) 143-207).

Another method of having clean samples is evaporating metals on to a substrate. Ask for details of the OMICRON Evaporator EFM.

## Lanthanum-Boride Evaporation Rate and Current Densities

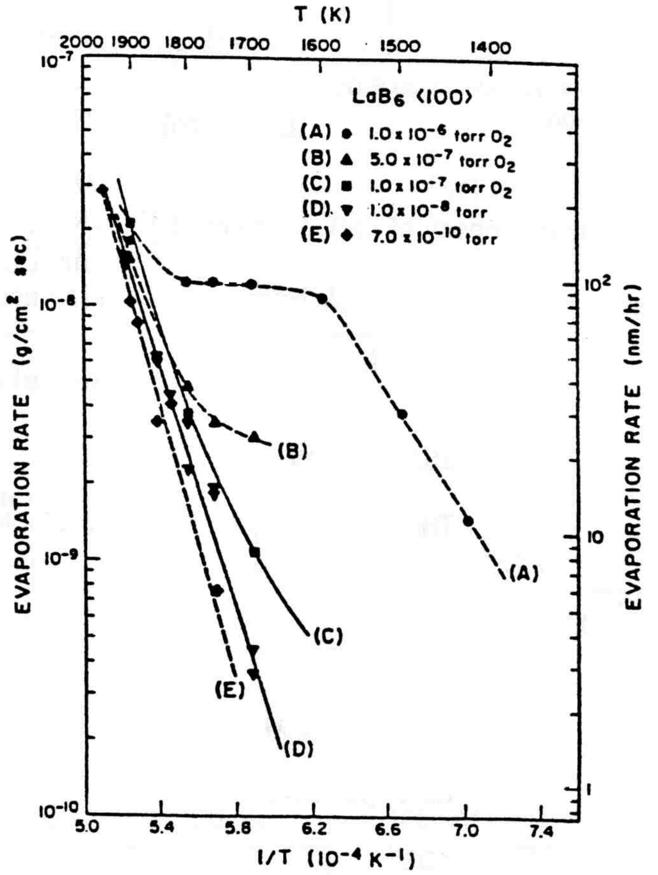



Figure 9. $LaB_6$ filament evaporation rate versus temperature for different oxygen pressures. Curves D and E were obtained with no added oxygen in non-baked and baked systems, respectively.

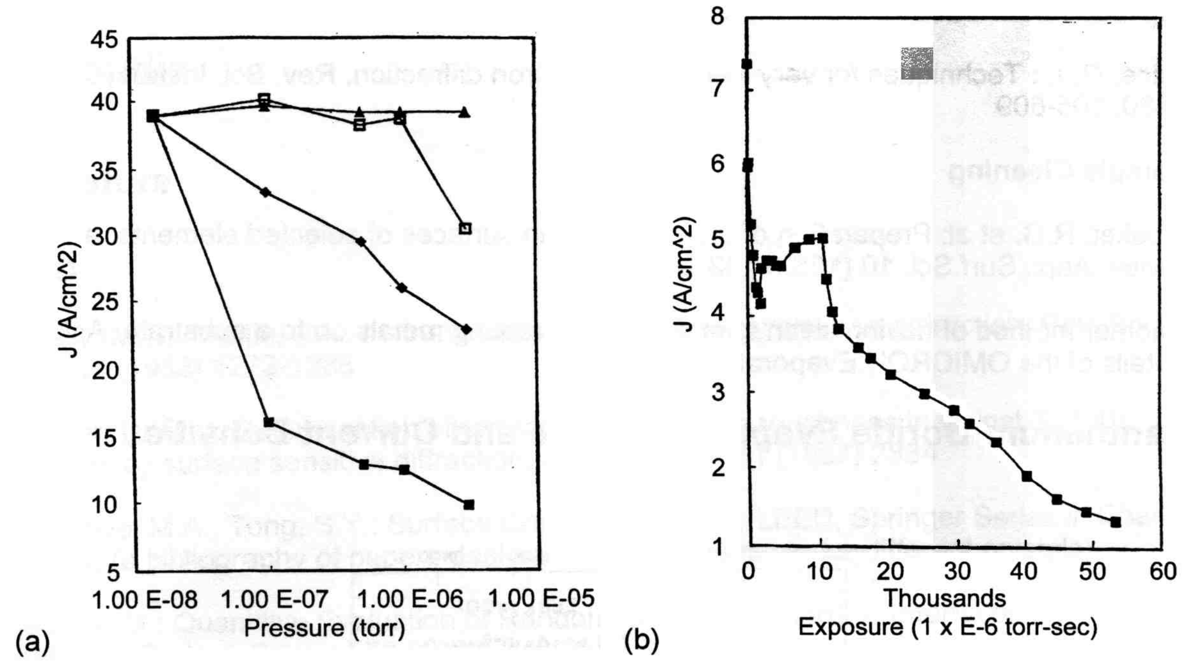



Figure 10. (a) Current density of $LaB_6$ filament at 1700 K for different environments (■ = oxygen, ◆ = CO, ▲ = methane, □ = nitrogen). (b) Current density of $LaB_6$ filament exposed to acetone.

## Technical Data

| | |
|---|---|
| Gun Energy Range: | 15 - 3500 eV |
| Filament Type: | Thoriated tungsten (optional: single crystal $LaB_6$) |
| Maximum Beam Current: | > 30 µA |
| Gun Diameter: | 15 mm |
| Grid Construction: | Gold Plated Molybdenum |
| Grid Transmission: | 82 % per Grid |
| Screen Viewing Angle: | 102° |
| Fluorescence Colour at Screen: | Green |
| Wavelength at Peak: | 530 nm |
| Line Width: | 72 nm |
| Weight | ≈ 15 kg |

# TESTSHEET

## Operating Data for SPECTALEED-Optics

Customer: ............................................ Serial number:

Dist. flange to sample (mm): ................Retraction length (mm): ...

Number of grids: ........................ .Date: ..

Measurements taken at system pressure:

**1. Set filament emission:**

filament operating current: ....................A Beam Energy: 0 eV

| Wehnelt | $I_E$ (mA) | - | Comment |
|---|---|---|---|
| 0 V | | - | set $I_{FIL}$ for $I_E$ = 300 µA |
| V | 0.001 | - | check for cutoff (typ. -50 V) |
| V | | - | setting for good focus |

**2. Set gun electron lenses:**

| Energy | $L_2$ | L1/3 | Comment |
|---|---|---|---|
| 0 eV | V | V | set "offset" potentiometers |
| 1000 eV | V | V | set " gain" 0 V potentiometers |

**3. Check beam current $I_0$:**

| Energy | 50 eV | 100 eV | 200 eV | 500 eV |
|---|---|---|---|---|
| $I_0$ (µA) | | | | |

**4. Maximum allowable filament current for forming:** **A**

**5. Set screen operating voltage:** **kV (Test: 7 kV)**

tested by:

# Service Procedure

Should your equipment **require service**

Please **contact OMICRON** headquarters or your local OMICRON representative to discuss the problem. Preferably use the provided FAX form below to make sure all necessary information is supplied and because the required service engineer may not be available immediately.

The service department may also be contacted via e-mail.

CompuServe: "ccmail:service at omihqger"
Internet: "service@omihqger.ccmail.compuserve.com"

Always **note the serial number** of your instrument or have it at hand when calling.

If you have to **send any equipment back to OMICRON**

Please contact **OMICRON headquarters** before shipping any equipment.

- Place the instrument it in a polythene bag.

**Use the original packaging and transport locks.**

Take out a **transport insurance policy**.

**For UHV equipment only:**

Make sure the **plastic transport cylinder is clean** and no dust or packaging materials can contaminate the instrument.

Wear suitable cotton or polythene gloves.

**Re-insert all transport locks** (if applicable).

- Cover the instrument with aluminium foil and/or place it in a polythene bag.
- **Fix the instrument into its plastic cylinder** (if applicable).

Include a filled-in and signed copy of the "Declaration of Decontamination" at the back of the related manual.

**No repair of UHV equipment will be carried out without a legally binding signed decontamination declaration !**

# FAX

**To**
**OMICRON Vakuumphysik GmbH**

Test and Service Department
Idsteiner Straße 78
D - 65232 Taunusstein
Germany

Tel: +49 - 61 28 - 987-0
**FAX: +49 - 61 28 - 987 193**

**From**

.............................................

.............................................

.............................................

.............................................

.............................................

.............................................

Tel: .............................................

FAX: .............................................

**Type of Instrument** .............................................

**Serial Number** .............................................

**Purchasing Date** .............................................

**(Last Service Date** ............................................. **)**

**Problem:**

**Date:** **Signature:**

# Decontamination Declaration

**If performing repair or maintenance work on instruments which have come into contact with substances detrimental to health, please observe the relevant regulations.**

**If returning instruments to us for repair or maintenance work, please follow the instructions below:**

- ***Contaminated units*** (radioactively, chemically etc.) must be decontaminated in accordance with the radiation protection regulations before they are returned.

  ***Units returned*** for repair or maintenance must bear a clearly visible note "free from harmful substances". This note must also be provided on the delivery note and accompanying letter.

  Please use the attached attestation declaration at the end of this manual.

- "***Harmful substances***" are defined in European Community Countries as **"materials and preparations in accordance with the EEC Specification dated 18 September 1979, Article 2"** and in the USA as **"materials in accordance with the Code of Federal Regulations (CFR) 40 Part 173.240 Definition and Preparation"**.

**No repair will be carried out without a legally binding signed declaration !**

# Declaration of Decontamination of Vacuum Equipment and Components

The repair and/or service of vacuum equipment/components can only be carried out if a correctly completed declaration has been submitted. **Non-completion will result in delay.** The manufacturer reserves the right to refuse acceptance of consignments submitted for repair or maintenance work where the declaration has been omitted.

**This declaration may only be completed and signed by authorised and qualified staff.**

**1. Description of components**

Type:______________________________ Serial No:______________________________

**2. Reason for return** ______________________________

**3. Equipment condition**

**Has the equipment ever come into contact with the following** (e.g. gases, liquids, evaporation products, sputtering products…)

- toxic substances? Yes ☐ No ☐
- corrosive substances ? Yes ☐ No ☐
- microbiological substances (incl. sample material)? Yes ☐ No ☐
- radioactive substances (incl. sample material)? Yes ☐ No ☐
- ionising particles/radiation ($\alpha,\beta,\gamma$, neutrons, …)? Yes ☐ No ☐

**For all harmful substances, gases and dangerous by-products which have come into contact with the vacuum equipment/components please list the following information on (a) separate sheet(s):** trade name, product name, manufacturer, chemical name and symbol, danger class, precautions associated with substance, first aid measures in the event of an accident.

**Is the equipment free from potentially harmful substances?** Yes ☐ **No** ☐

**The manufacturer reserves the right to refuse any contaminated equipment / component without written evidence that such equipment/component has been decontaminated in the prescribed manner.**

**4. Decontamination Procedure**

Please list **all harmful substances, gases and by-products** which have come into contact with the vacuum equipment/components together with the decontamination method used.

| SUBSTANCE | DECONTAMINATION METHOD |
|---|---|
| | |
| | |

(continue on a separate sheet if necessary)

**5. Legally Binding Declaration**

**Organisation:** ______________________________

**Address:** ______________________________

______________________________

**Tel.:** ______________________________ **Fax:** ______________________________

**Name:**______________________________ **Job title:** ______________________________

**I hereby declare that the information supplied on this form is complete and accurate.**

**Date:**______________ **Signature:** ______________ **Company stamp:**

# Useful OMICRON Addresses

**Headquarters:** OMICRON VAKUUMPHYSIK GmbH
Idsteiner Straße 78
D-65232 Taunusstein
Germany
Tel. +49 (0) 61 28 987-0
Fax. +49 (0) 61 28 987 185
Sales Telephone: +49 (0) 61 28 987 210
Internet: omicron@omihqger.ccmail.compuserve.com
CompuServe: ccmail:omicron at omihqger
Service Telephone: +49 (0) 61 28 987 230
Fax. +49 (0) 61 28 987 193
Internet: service@omihqger.ccmail.compuserve.com
CompuServe: ccmail:service at omihqger

**UK:**

OMICRON Surface Science Ltd.
Leeds House, Amberly Court,
Whitworth Rd, Crawley
West Sussex RH11 7XL
Tel. 01293 428300
Fax. 01293 428303
e-mail: 106112.633@compuseıve.com

**USA:**

OMICRON ASSOCIATES
1738 N. Highland Road
Suite G101
Pittsburgh, PA 15241
Tel. (412) 831-2262
Fax. (412) 831-9828
e-mail: omiassoc@aol.com

**FRANCE:**

OMICRON EURL
Espace Liberté
33, bd de la Liberté
13001 Marseille
Tel. 91 28 38 00
Fax. 91 28 38 28

**JAPAN:**

MATSUSHITA RESEARCH
INSTITUTE TOKYO, INC.
3-10-1 Higashimita, Tama-Ku
Kawasaki 214
Tel. 044-911-6331
Fax. 044-911-7046
e-mail: omicron@mrit.mei.co.jp

**SWEDEN:**

CRYSIS TECHNOLOGY AB
Science Park Mjärdevi
Teknikringen 1
583 30 Linköping
Tel. 013 212151
Fax. 013 212147
e-mail: kristian.flodstrom@crysis.lejonet.se

**SOUTH KOREA:**

WOO SIN ENTERPRISE, INC.
Daesung Building, 4th floor
1530-18 Seocho-Dong
Seocho-Ku
Seoul 137-070
Tel. (02) 598-3693
Fax. (02) 597-5615

**TAIWAN:**

OMEGA SCIENTIFIC TAIWAN LTD.
1 Fl., No. 461
Kuang Fu South Road
Taipei
Tel. (02) 703-2255
Fax. (02) 755-3615
e-mail: omega001@ms3.hinet.net

**ITALY:**

OMICRON VAKUUMPHYSIK GmbH
Ufficio di Rappresentanza - Roma
Via della Giuliana 74, Int. 2
00195 Roma
Tel./Fax. (06) 39 72 13 00
e-mail: holmesb@compuserve.com

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