E-Beam Heater For Tunnelling Tips (Tip Preparation Tool)

Version 2.2

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PN02282

Preface

This document has been compiled with great care and is believed to be correct at the date of print. The information in this document is subject to change without notice and does not represent a commitment on the part of Omicron NanoTechnology GmbH.

Notice

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

Notice

This documentation is available in English only.

Caution

Please read the safety information on pages 5 to 6 before using the instrument.

Copyright

Warranty

Omicron acknowledges a warranty period of 12 months from the date of delivery (if not otherwise stated) on parts and labour, excluding consumables such as filaments, sensors, etc.

No liability or warranty claims shall be accepted for any damages resulting from non-observance of operational and safety instructions, natural wear of the components or unauthorised repair attempts.

Waste Electric and Electronic Equipment

In compliance with the WEEE directive (2002/96/EC) OMICRON ensures that all products supplied by OMICRON which are de-commissioned and which are labelled with an WEEE Registration Number will be taken back by OMICRON free of charge.

All costs of packing, transport, duty, etc. to the destination of the nearest OMICRON Returned-WEEE-Centre shall be borne by the customer. The customer is required:

- to declare the returned material is free of contamination or hazardous materials from usage (include Decontamination Declaration sheet),

- to request a valid Return Material Authorisation (RMA) available from the OMICRON service department,
- to ship all returned goods to the advised destination "OMICRON Returned-WEEE-Centre, DDP (INCOTERMS)"

Otherwise OMICRON will not accept any shipment

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 OMICRON **E-Beam Heater for Tunnelling Tips** complies with CE directives as stated in your individual delivery documentation if used unaltered and according to the guidelines in the relevant manuals.

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 authorised 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 individually CE labelled since they can only be used in conjunction with other pieces of equipment.

Notice

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.

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1. Safety Information

Caution

Important:

- Please read this manual and the safety information in all related manuals before installing or using the instrument or electronics equipment.
- 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 E-Beam Heater for Tunnelling Tips may only be handled by authorised personnel.

Caution

Warning: Lethal Voltages!!

- Adjustments and fault finding measurements may only be carried out by authorised personnel qualified to handle lethal voltages.
- Lethal voltages may present at parts of the instrument during operation.
- Lethal voltages are present inside the control unit and computer.

Caution

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.

Caution

Always

- All connectors which were originally supplied with fixing screws must always be used with their fixing screws attached and tightly secured.
- All connectors which were originally supplied with a short circuit plug must either be connected to the electronics or fitted with their short circuit plug.
- Always disconnect the mains supplies of all electrically connected units before
  - ⇨ venting, pumping down or opening the vacuum chamber
  - ⇨ opening a control unit case,
  - ⇨ touching any cable cores or open connectors,
  - ⇨ touching any part of the in-vacuum components (except for tip and sample exchange as described in this manual).
- Leave for a few minutes after switching off for any stored energy to discharge.

Caution

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
- Condensation of humidity, particularly on water-cooled equipment, must be avoided.

2. Function Principle

The tip preparation tool allows cleaning SPM tunnelling tips from etching remains or oxides. This process requires a high temperature (above 1000°C) on the tip in order to remove those remains.

A thoriated tungsten filament is used to emit electrons (emission current up to 3 mA). The tip is sitting at a short distance (up to 1mm or even less) right opposite the filament and is biased up to 1 kV. In the high electric field (up to 1 kV) the electrons are accelerated onto the apex of the tip.

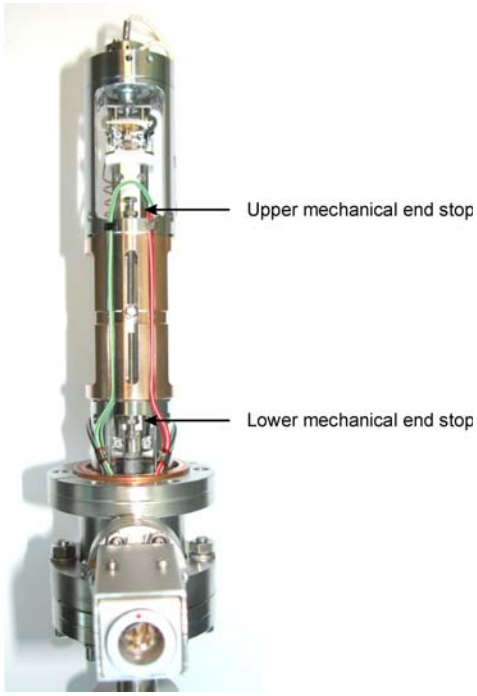

Figure 1. Tip Prep Tool, in-vacuum part shown.

Due to its shape the tunnelling tip is heated up by electron bombardment mostly at the very front and less further away. While 80% of the deposited energy goes into tip heating, about 20% is lost to thermal conduction while radiation losses are neglectable (less than 1%). Note that the heating cleans the tip of deposits, it does not sharpen it. On the contrary: if the temperature goes too high, the radius of the tip apex becomes larger due to a melting process.

Notice

The upper and lower mechanical end stops are set individually and limit the Z-travel of the tip holder.

Caution

Never fit or remove tips when control unit is switched on !!!

The tip preparation tool must only be operated under vacuum conditions. Never try to set it up under ambient conditions.

3. Setting-up the Tip Preparation Tool

Caution

The tip preparation tool must only be operated under vacuum conditions. Never try to set it up under ambient conditions.

Notice

The maximum bakeout temperature of the tip preparation tool is 170°C. Note that your system bakeout temperature may be limited to lower temperatures by other components.

The tip preparation tool has two electrical feedthroughs. Via the SHV-connector a high voltage is applied to the tip and the tip holder. The 4-way Fisher connector connects to the filament and the Wehnelt cylinder.

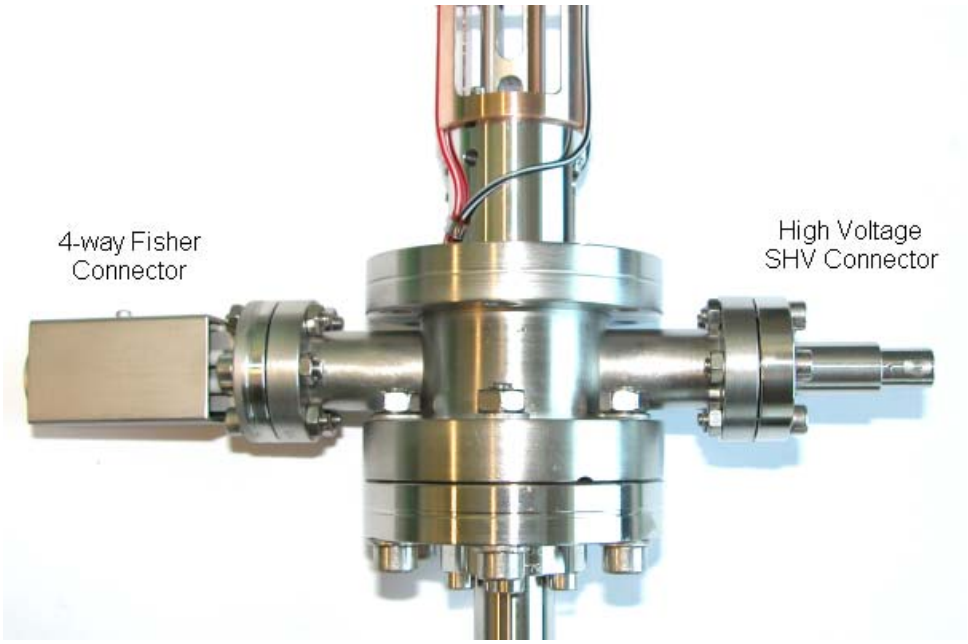

Figure 2. Electrical connectors of the tip preparation tool.

Wiring Instructions

Caution

Always use the provided power supplies.

Never apply a high voltage to the 4-way Fisher connector.

- Connect one end of the grey cable to the 4-way Fisher connector of the TPT. Connect the other end of this cable to the HV-power supply, see also figure 8 on page 13.
- Connect red, yellow, green, blue, and green/yellow to their respective sockets.
- Connect the SHV plug of the power supply to the SHV connector of the tip preparation tool. High voltage must only be applied to the SHV connector using the provided power supply.

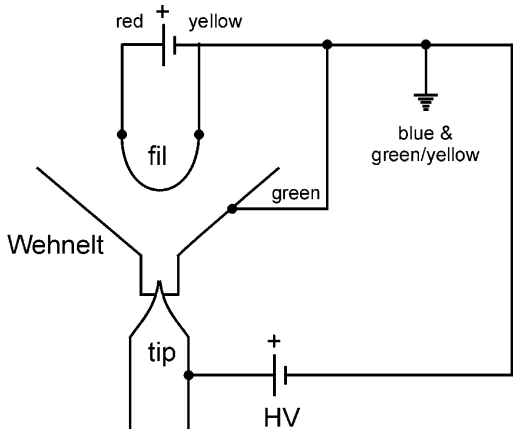

Figure 3. Wiring diagram, schematically.

- Connect the Wehnelt cylinder (green) to system ground. (This is important because otherwise the Wehnelt cylinder is charged up by electrons emitted from the filament.) Optional: Negative potential with respect to the filament will repel emitted electrons. Note that this option needs an additional power supply.
- Connect the blue and green/yellow cables to ground.
- Connect the HV to the tip.

Before operating the tip preparation tool make sure the z-drive is fully retracted, i.e. tip position indicator, see figure 4 on page 10, is at its minimum position.

Figure 4. Z-scale and tip position indicator.

Outgassing

The outgassing procedure is performed similarly to the normal operation procedure.

- Use an old tip that is not intended to be used anymore
- With the wobblestick place the tip carrier plate with the old tip in the acceptor of the TPT.
- Start the filament and slowly ramp it up to 2.0 A
- Apply the high voltage up to 1 kV
- Use the z-shift to approach the tip towards the filament until it reaches the mechanical end stop. In case of shortings retract the tip until the emission current is about 2-3 mA.
- Keep it there for about 1 hour. Note that the system pressure will increase when the tip carrier plate and Wehnelt cylinder start degassing.
- Once the pressure has decreased significantly again, indicating that the degassing process has been successful: use the Z-shift to retract the tip away from the filament until it reaches the other mechanical end stop.
- Turn the high voltage down.
- Ramp the filament down.
- Take the tip carrier plate with the old tip out of the acceptor.
- Remove it from the system via the load lock chamber (FEL).

4. Operation

- Make sure the Z-drive is fully retracted to its lower mechanical end stop, see also figure 1 on page 7. Make sure not to put to much stress onto one of the mechanical end stops.

- Carefully slide a tip carrier plate with a tip into the holder.

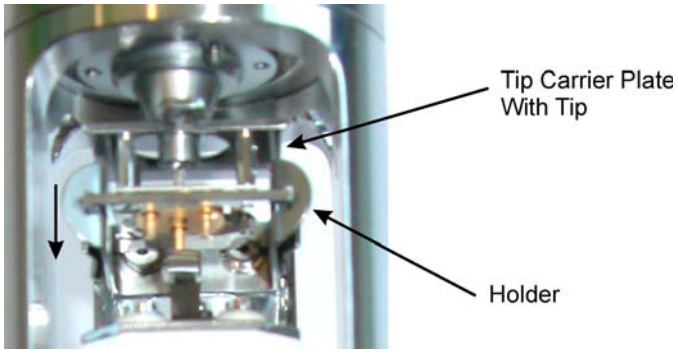

Figure 5. Mounting a tip carrier plate.

- Make sure the filament current and HV are set to zero by turning the 10-turn potentiometer counter-clockwise.

- Switch on the filament power supply and slowly increase the current up to about 1.8 A to 2.0 A (depending on the filament).

- Slowly increase the high voltage up to 1000 V.

- Move the tip assembly towards the filament watching the emission current on the control ammeter, see also figure 9 on page 14.

Caution

The upper mechanical end stop is intended to prevent the tip from touching the filament. However, a very long tip may still touch the filament and cause short-cuts between the tip (at HV potential) and the filament (at ground potential). Although the power supply is protected against HV short cut damage this condition must be avoided.

Use shorter tips or re-adjust the mechanical end stop to prevent shorting. The mechanical end stop is adjusted correctly when the end of the tip holder tube is in line with the end of the Wehnelt cylinder with the tip not touching the filament.

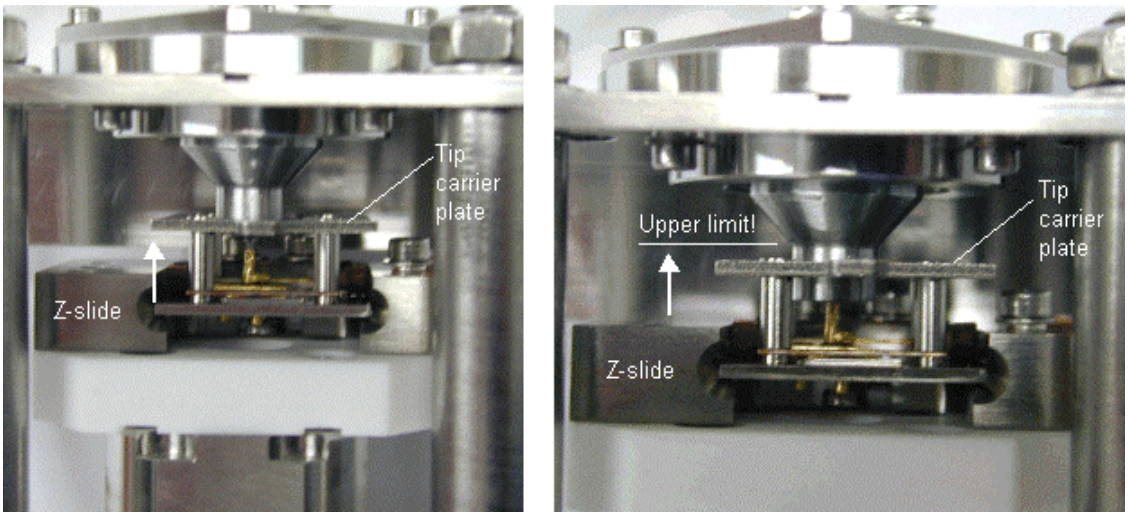

Figure 6. Moving up the tip assembly.

- A reasonable heating power is reached between about 1.5 W up to 2.0 W corresponding to emission currents between 1.5 mA and 2.0 mA at 1.0 kV tip voltage.
- Once the desired emission current has been reached leave the tip assembly in its position for a couple of seconds.
- Finally, retract it quickly or simply decrease the high voltage.

This complete procedure should be carried out as quickly as possible in order to avoid heating peripheral parts of the tip carrier assembly.

- After tip preparation turn the high voltage to 0 V and slowly decrease the filament current to 0 A. Switch the power supply off.
- Fully retract the Z-drive to its lower mechanical end stop.
- Remove the tip carrier plate with the wobblestick.

5. Power Supply

Figure 7. Power supply front panel.

Front panel left hand side:

- Low voltage high current power supply
- Current adjustable with 10-turn potentiometer
- Display shows filament current

Front panel right hand side:

- High voltage low current emission supply
- Voltage adjustable with 10-turm potentiometer
- Display switchable between high voltage and emission current

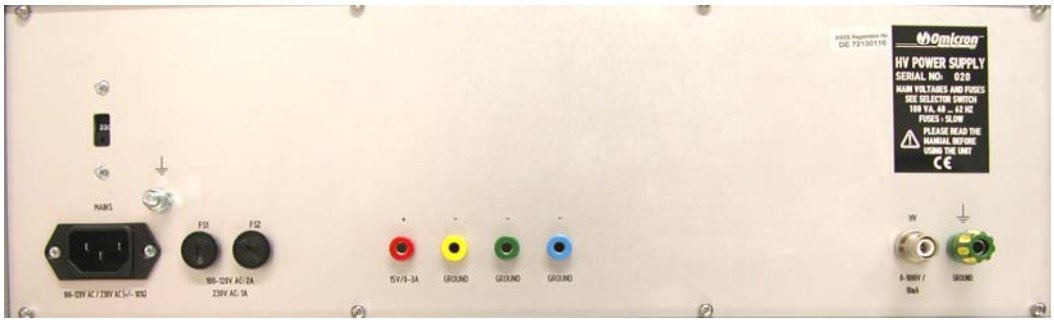

Figure 8. Power supply back panel.

Back panel:

- Mains power connection (110/115 V and 230 V input selectable)
- Filament supply output via banana plugs (15 V, 0 to 3 A)
- High voltage output via SHV connector (1000 V, 10 mA)

6. Appendix

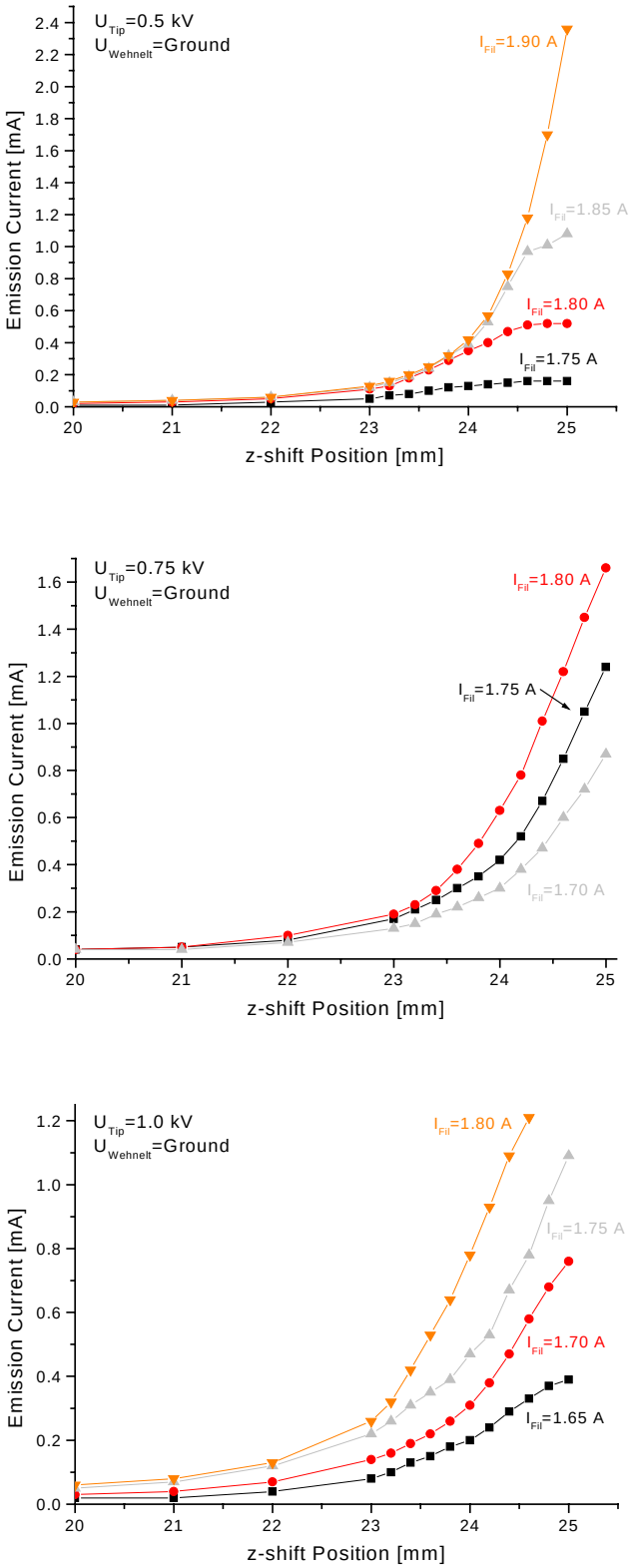

Figure 9. Emission current vs. tip position for different tip voltages (U_{TIP}) and filament currents (I_{FIL}). Use the graphics above as a guide.

Hints and Tips

- Due to different tip lengths, tip shapes and oxide thickness the values given in figure 9 on page 14 will vary for different tips.
- The emission current also varies for a prepared or unprepared tip as shown in figure 10 below.
- A heating power of 3 W or more will cause melting of the tip.

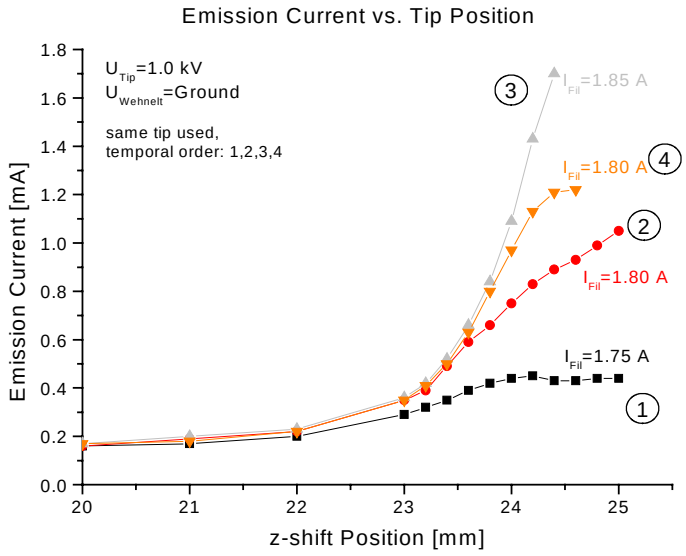

Figure 10. Emission current for the same tip before and after preparation (stages 1-4 in chronological order).

Connector Pinout

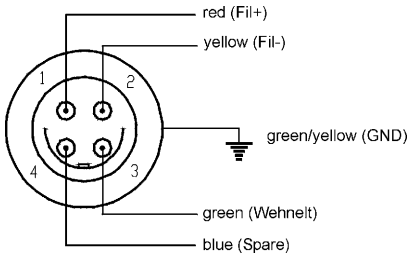

Figure 11. 4-way Fisher connector pinout.

Service at Omicron

Should your equipment **require service**

- Please **contact Omicron** headquarters or your local Omicron representative to discuss the problem. An up-to-date address list is available on our website under

  http://www.omicron.de/contact/representatives.html

  or via e-mail reply service under

  contact.info@omicron.de.

- Make sure all necessary information is supplied. Always **note the serial number(s)** of your instrument and related equipment (e.g. head, electronics, preamp...) 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 in a polythene bag.
- **Reuse the original packaging and transport locks.**
- Take out a **transport insurance policy.**

For ALL vacuum equipment:

- Include a filled-in and signed copy of the "Declaration of Decontamination" form which can be found at the back of the equipment manual.

No repair of vacuum equipment without a legally binding signed decontamination declaration !

- Wear suitable cotton or polythene gloves when handling the equipment.
- **Re-insert all transport locks (**if applicable**).**
- Cover the instrument with aluminium foil and/or place it in a polythene bag. Make sure no dust or packaging materials can contaminate the instrument
- Make sure the **plastic transport cylinder (**if applicable**) is clean**.
- Fix the instrument to its plastic cylinder (if applicable).

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 dangerous 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.
- "***Dangerous substances***" are defined in European Community Countries as materials and preparations according to Article 2 of the Dangerous Preparations Directive **1999/45/EC**.

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 (α,β,γ, neutrons, ...)? Yes ☐ No ☐

For all dangerous 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 dangerous 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 dangerous 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:**