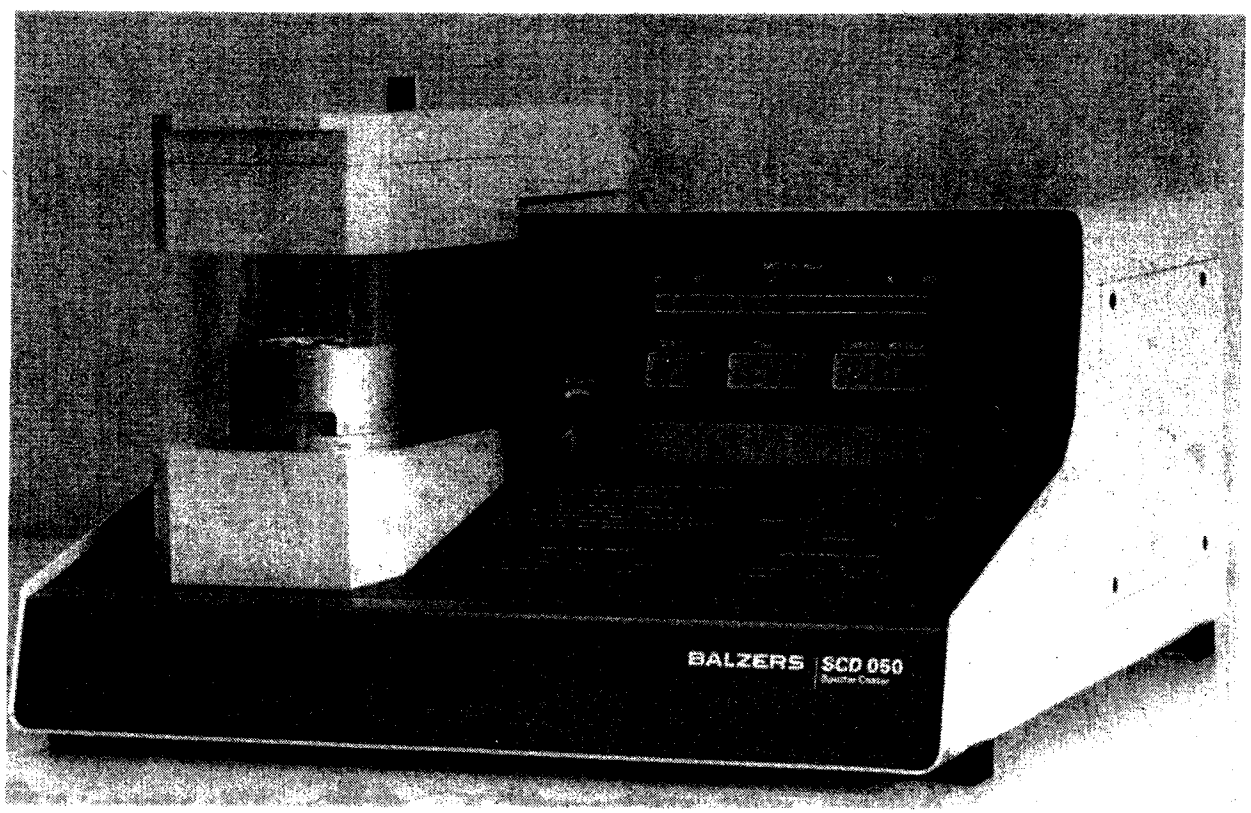
Operating Instructions

Sputter Coater SCD 050



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1. APPLICATION

The surface of specimens to be examinated in the scanning electron microscope must be electrically conductive. This is necessary to prevent image distorting electrical charges from building up on the specimen surface as well as to achieve better secondary electron emission, which is important for the formation of an image.

Specimen surfaces, that are not naturally conductive, must be coated with an appropriate electrically conductive layer. Sputtering for coating with a thin metallic layer, in addition to conventional high-vacuum evaporation, is of particular advantage for coating of highly structured specimen surfaces. The SCD 050 not only sputters metallic layers, it also coats specimens with thin carbon film with a carbon thread evaporation accessory.

The SCD 050, with the appropriate accessories, can be used for the following methods:

- Production of conductive coatings onto scanning electron microscope specimens by sputtering of appropriate metal layers.
- Production of carbon films onto specimens for X-ray microanalysis.
- Depositing metal layers on carbon coated specimen surfaces without interruption of the vacuum (Carbon-metal-carbon coating method according to Prof. R. Blaschke).
- Coating of large surface SEM specimens with the use of a supplemental vacuum chamber with rotary table for quality control of items such as compact discs, wafers, etc. ...
- Cleaning of specimen surfaces by cathodic etching with subsequent coating without interruption of the vacuum.
- Production of shadowing layers onto TEM specimens with W. Colquhoun sputter-shadowing technique.
- Application of carbon reinforcement films on specimen support grids coated with a collodium or formvar film.

2. DESCRIPTION OF FUNCTION

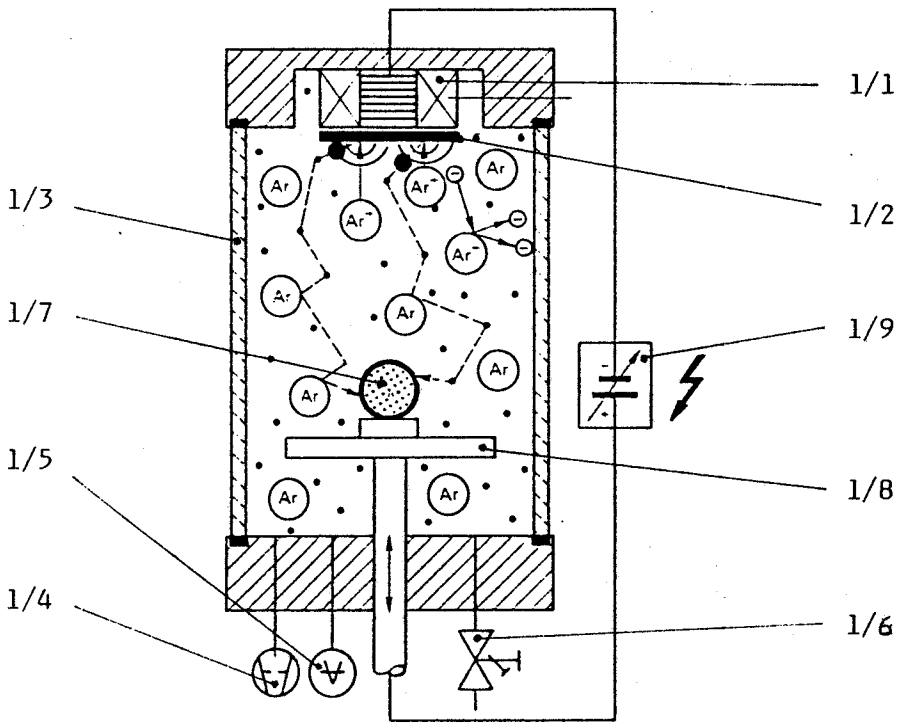


Figure 1 Diagram of sputtering principle

1/1	Permanent magnet
1/2	Sputter target (cathode)
1/3	Vacuum chamber
1/4	Roughing pump
1/5	Vacuum gauge head
1/6	Gas inlet valve (argon)
1/7	Specimen with metal coating
1/8	Specimen table (anode)
1/9	High voltage supply (pole reversible)

Ⓐr	Argon atoms
⊖	Electrons
Ⓐr⁺	Argon ions
●	Metal atoms
•	Residual gas molecules

The Sputter Method

Argon gas is introduced through a gas dosing valve to a specimen chamber, that has been evacuated by a roughing pump. Repeated flushing of the chamber with argon gas makes it easier to remove undesired gases, especially water vapour. This flushing creates an almost pure argon atmosphere in the specimen chamber, where a pressure between 0.05 and 0.1 mbar is established in preparation for the sputter process. High voltage is applied to the target (cathode), which creates a high voltage field between the target and the specimen table (anode). The free electrons in this field are forced into a spiral path by a magnet system, where they collide with the ambient argon atoms. This collision causes an electron to be pulled from the outer shell of the argon atom, whereby the neutral argon atom is charged to a positive argon ion. This is a cumulative process that leads to an ignition of a glow discharge (plasma). The positively charged argon ions are accelerated to the cathode (target), and there release metal atoms from the target as they impact.

The released metal atoms and the many gas molecules in the specimen chamber continue to have repeated collisions. This results in a wide scattering of the metal atoms. A diffuse cloud of metal atoms reach the specimen evenly from all sides and settle there. The specimen surface, even a very fissured one, now becomes coated with a homogeneous, thin metal layer with sufficient electrical conductivity for SEM examination.

The large surface diffusion of gold and silver atoms leads to "island formations". These two metals do not create the desired conductivity until the layer has a thickness of approximately 10 nm. Platinum produces layers with the finest grain.

The grain structure of the sputter layer is dependent on the target material, working distance, gas pressure and sputtering current, as well as processing time.

In practice the desired sputter parameter are primarily dependent on the temperature capacity of the specimen. Temperature sensitive specimens, such as biological objects or foamed material, are sputter-coated at greater working distance and at lower sputter current, taking into account that this requires an extended processing time. Modern scanning electron microscopes have extremely high resolutions that require very finely grained layers to fully exploit their technical possibilities. These fine-grained layers are achieved by proper selection of sputter parameter or by first applying a thin layer of carbon (see carbon-metal-carbon accessory).

A reversal of the current polarity allows high voltage to feed the specimen table instead of the target. This causes material to be sputtered off the specimen, providing a cleaning or "etching" of the surface. A shield protects the target from contamination during this process. The specimen, after a reversal of the current polarity and removal of the shield, can now be sputter-coated without an interruption of the vacuum.

3. DESCRIPTION OF THE UNIT

3.1. Scope of delivery

The SCD 050 is equipped as follows:

- Housing with control, display and process selection panel;

  Specimen chamber base with built-in, height adjustable object table;

  Hinged sputter head with planar magnetron magnet system, target holder and pivoting shield;

  HT 010 high voltage supply for the sputter and etching device;

  Gas inlet system with manually controlled gas dosing valve, electromagnetically controlled cut-off valve and a push-button activated rinsing gas valve;

  Electromagnetically controlled venting valve, coupled with the main switch;

  Vacuum measuring device with TPR 010 fine vacuum gauge head, PP 010 fore-vacuum measuring module and analog/digital LED vacuum display;

  Safety devices for personal protection and interference suppressor of the unit.

- Pyrex glass specimen chamber, 108 mm inner diameter, 106 mm height.

- Set of accessories with

  Miniature fuses

  Main plug (Order No: B 4704 161 HA)

  Target mounting tool (Order No: BU 015 615-T)

  DN 25 KF-28 elbow for vacuum hose connection

  Sleeve for connection of elbow (Order No: BP 217 407-X)

  Hose clamps for vacuum connector hose

  Assorted small parts.

- Tool set with

  Hex socket head wrench 1/16" (Order No: N 5701 144)

  Hex socket head wrench 2 mm (Order No: N 5701 005 BC)

  Hex socket head wrench 2.5 mm (Order No: N 5701 006 BC)

  Hex socket head wrench 5 mm (Order No: N 5701 011 BC)

3.2. Front view of the unit

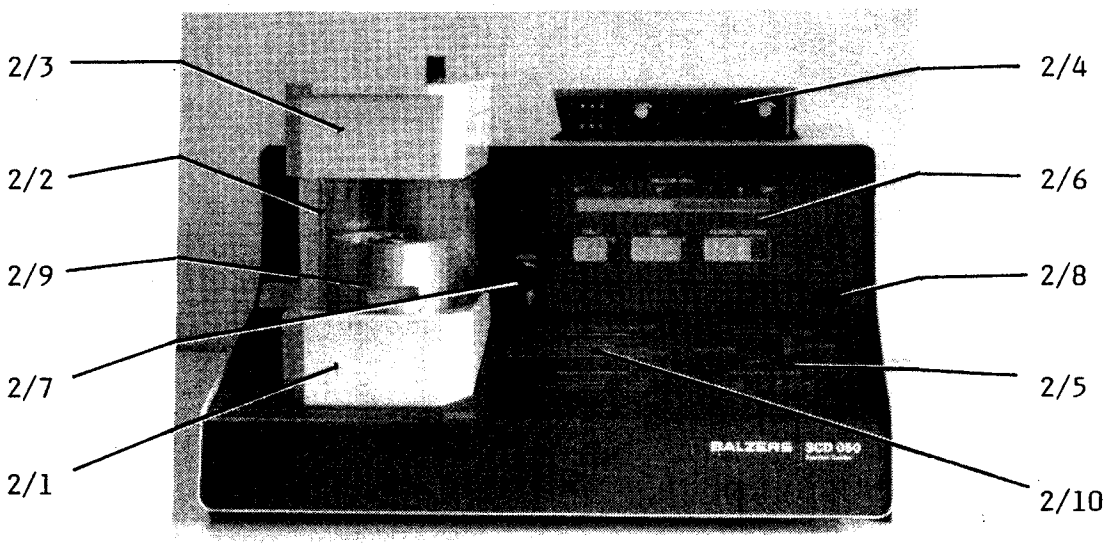


Figure 2 Front view of unit with hinged process selection panel

2/1	Specimen chamber base
2/2	Pyrex glass cylinder
2/3	Sputter head
2/4	Process selection panel
2/5	Control panel
2/6	Display panel
2/7	Manual gas dosing valve ARGON
2/8	Mains switch
2/9	Safety separating switch
2/10	Operating check list

3.3 Specimen chamber

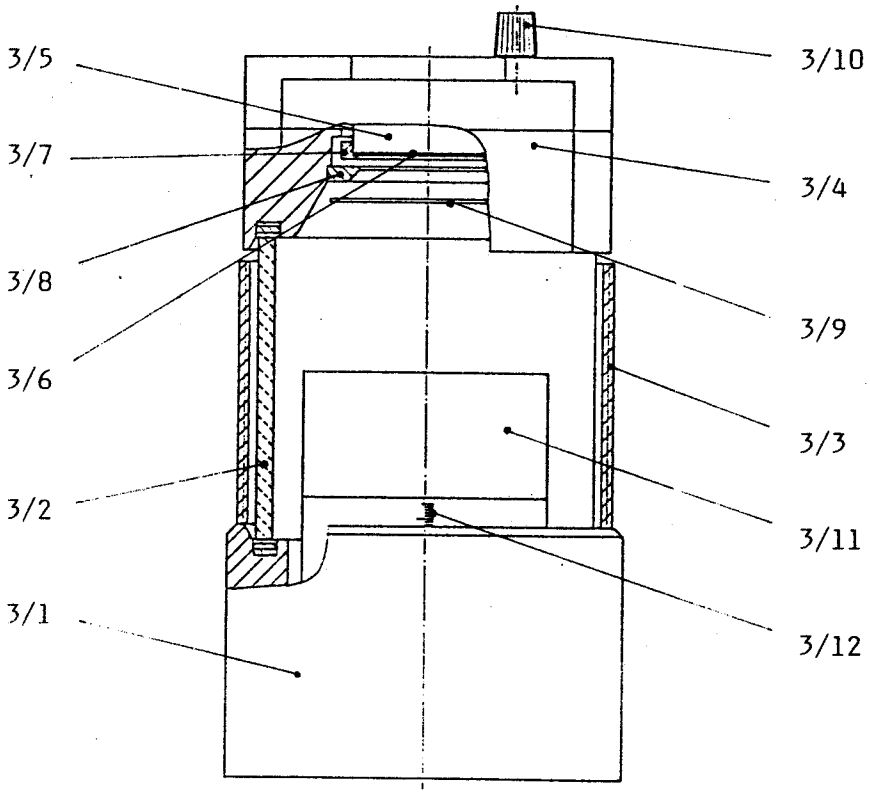


Figure 3 Specimen chamber

3/1	Specimen chamber base
3/2	Pyrex glass cylinder
3/3	Protection shield
3/4	Sputter head
3/5	Magnet system
3/6	Sputter target
3/7	Target supporting ring
3/8	Anode ring
3/9	Pivoting shield
3/10	Control knob for pivoting shield
3/11	Object table
3/12	Working distance scale

3.4. Back view of the unit

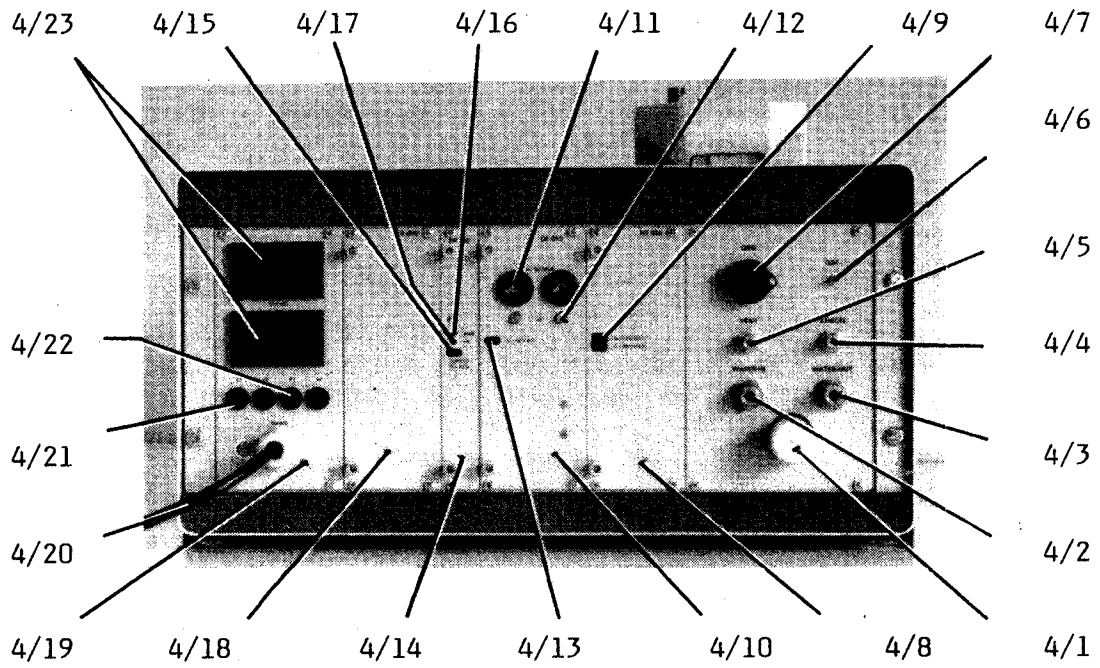


Figure 4 View of back panel

4/1	Vacuum connection
4/2	Cooling water connection WATER IN
4/3	Cooling water connection WATER OUT
4/4	Operating gas connection ARGON
4/5	Vent connection VENT
4/6	QSK 301 quartz head connection
4/7	QSG 301 reverting signal connection
4/8	HT 010 high voltage supply module
4/9	Recorder connection for current and voltage 0-6 V and 0-10 V DC
4/10	CE 010 high current module for carbon evaporation (accessory)
4/11	Connection sockets for high current cable
4/12	Connection for high current cable ground
4/13	Recorder connection for evaporator current 0-10 V DC
4/14	PP 010 vacuum measuring module
4/15	Recorder connection for vacuum display 0-10 V DC
4/16	Trimming potentiometer for atmospheric equalization ATM
4/17	Trimming potentiometer for high vacuum HV
4/18	Mains supply module
4/19	Mains supply lead-in
4/20	Mains connection cable (115 V, 220 V, 240 V)
4/21	F 1, F 2, fuses for drive 1 AT (220-240 V), 2 AT (115 V)
4/22	F 3, F 4, fuses for supply 2.5 AT (220-240 V), 5 AT (115 V)
4/23	Mains connection SOCKET for external devices (115 V, 220 V, 240 V)

3.5. Electrical supply

The electrical supply for the SCD 050 sputter coater consists of the following components:

- Mains lead-in with permanently installed connector cable, reversible supply transformer for 115 V, 220 V and 240 V mains voltage, contactor and two outlets for external devices, as well as fuse holders for electrical drive and supply.

- Mains supply module with necessary output voltages of 5 V, 15 V, 20 V and 24 V for electrical control of the components of the unit.

- HT 010 module for the high voltage, short-circuit-proof, rated for a maximum current of 150 mA (no-load voltage approximately 1000 V DC) with output of 0-6 V DC (0-150 mA) and 0-10 V DC (0-1000 V DC) for recorder connection.

- PP 010 fore-vacuum measuring module with recorder output 0-10 V DC, maximum load capacity 1 mA.

HV	0,00	0.02 V DC
1×10^{-3} mbar	0.10	0.05 V DC
1×10^{-2} mbar	1.10	0.01 V DC
1×10^{-1} mbar	3,43	0.01 V DC
1 mbar	5.57	0.01 V DC
10 mbar	7.73	0.01 V DC
100 mbar	9.66	0.01 V DC
1 bar	10.00	0.02 V DC

3.6. Electrical control

The electrical control of the SCD 050 sputter coater consists of the following components:

- Process selection panel with switch elements for process selection and process time, film thickness control, current or process voltage selection and display, as well as for control of drive unit.

- Display panel with display of vacuum, object table temperature and process time, as well as current and voltage display.

- Control panel with touch-pads for ON and OFF control of high voltage and the rinsing valve for sputter and etching processes, as well as for control of carbon evaporation device (accessory).

3.7. Electrical safety devices

The electrical safety devices are designed to meet the requirements of the German Employer's Liability Insurance Association, whereby the following specifications have been considered: general specifications VDE 0411, part 1, VDE 0113, part 1, section 5.1, 1, 1 b for safety, and VDE 0871, limit class B for interference suppression.

The safety system consists of the following:

- Vacuum switch for interruption of the high voltage supply with vented specimen chamber.
- Mechanical, forcibly actuated separation switch on sputter head carrying arm for interruption of the high voltage supply during opening of the specimen chamber.
- Safety separation plug on specimen chamber protection shield for interruption of the high voltage supply if specimen chamber is removed.

All exposed parts of the unit have an earthed-neutral system.

The water conducting plastic hoses are covered by a grounded metal fabric for protection.

Interference protection of the unit is provided by a line filter.

4. TECHNICAL DATA

Dimensions

Unit	see scale drawing
Vacuum chamber	
Inside diameter	108 mm
Heights	106 mm
Specimen table, diameter	82 mm
Foil target	
Diameter	54 mm
Foil thickness	0.2 mm
Working distance	
minimum	30 mm
maximum	82 mm

Weight

without vacuum pump DUO 004 B	36 kg
with vacuum pump DUO 004 B	56 kg

Connection data

Electrical connection

Voltage (L + N + PE)	220/240/115 V
Frequency	50/60 Hz
Power consumption without DUO 004 B	510 VA
Power consumption with DUO 004 B	800 VA
Main fuse at 220-240 V	1 A (slow)
Main fuse at 115 V	2 A (slow)

Process gas

Hose nipple connection	Ø 6 mm (G 1/8")
Connection pressure	1-2 bar
Gas consumption	approx. 0.3 mbar l/sec

Venting gas

Hose nipple connection	Ø 6 mm (G 1/8")
Connection pressure	1-2 bar

Cooling water

Hose nipple connection	Ø 8 mm (G 1/4")
Connection pressure	1-4 bar
Recommended temperature	10-15° C
Rate of flow	approx. 0.5 l/min

Vacuum connection

Hose clamp	Ø 26 mm

Operational data

Sputter current	max. 150 mA
No-load voltage	approx. 1000 V DC
Sputter output	max. 100 W

Sputter rate for gold at a

Working distance of 50 mm in argon atmospere	33 nm/min at 60 mA

Process time, adjustable	0 to 999 seconds

Pumping time

to 5 x 10^{-2} mbar with a two-stage rotary vane pump with 4 m /h capacity and a vacuum connector hose of 1.5 m length	approx. 2 min

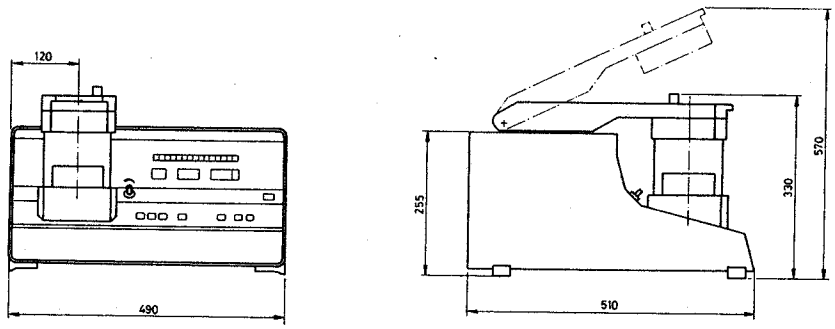


Figure 5 Scale drawing of SCD 050 sputter coater

5. INSTALLATION

Notice:

- Check for damage upon receipt of the unit, and make report to carrier if necessary.
- Compare shipping papers and order, notify company in case of missing pieces.
- Save packing. Always return unit in the original packing for service or inspection if possible.

5.1. Setting up

The SCD 050 sputter coater can be placed on any laboratory table without special fasteners. Connections for the vacuum pump, operating gas (argon), and possibly for venting gas, as well as a power supply, are required.

5.2. Connection of vacuum pump

It is recommended that the vacuum pump be a two-stage rotary vane pump with a capacity of 4 m^3/h. The vacuum pump should be placed on the floor to prevent vibration to the sputter coater. The vacuum connector hose should be short to avoid extended pumping time. The vacuum line (Ø 26 mm) is connected on the back side of the unit at Position 4/1.

The exhaust gas line of the vacuum pump is to be conducted either into an appropriate exhaust conduit or outdoors. If this is not possible, an oil mist filter must be installed to the exhaust gas outlet of the vacuum pump (refer to Section 10).

One of the electrical sockets intended for external devices (Position 4/13) on the back side of the unit is used for the electrical connection. (Protective ground at center connector pin).

5.3. Connection of cooling water

The cooling water connection for the specimen table and target holder is connected to the back side of the unit by attaching the flexible line to the hose nozzle (Ø 8 mm). The required SERTO screw fittings are part of the accessories (Position 3/1). They are connected to the G 1/4" threaded pipe WATER IN (Position 4/2) for the water inlet and WATER OUT (Position 4/3) for the water drainage.

5.4. Connection of operating gas

The gas feeding line is connected with the Ø 6 mm accessory hose clamp to the ARGON screw fitting (Position 4/4) on the back side of the unit. A pressure hose for the connection to the gas bottle is to be provided. Argon with a purity of at least 99.5 % is generally used as gas. The gas pressure tank should be obtained from local sources. A pressure reduction valve with manometer, that is adjustable from 1 to 1.5 bar, is needed for the connection of the gas pressure tank to the sputter coater.

Attention: The gas pressure tank must be guarded against tipping to prevent accidents.

5.5. Power connection

A permanently attached cable (2 m) on the back side of the unit (Position 4/20) is provided for the current connection. This cable must be outfitted with a mains plug (L + N + PE) to meet local standards. Following is the identification of the wire colors:

Phase (L) brown or black, zero conductor (N) blue, and ground (PE) green/yellow.

6. START UP

6.1. Mounting the sputter target

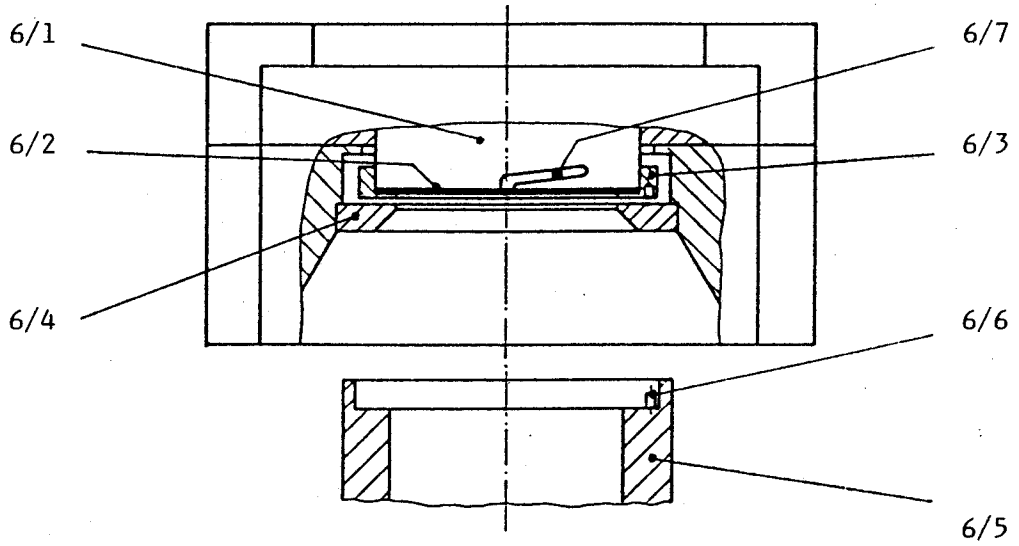


Figure 6 Sputter head with target positioning tool

6/1	Magnet head
6/2	Sputter foil target
6/3	Target supporting ring
6/4	Anode ring
6/5	Target positioning tool
6/6	Carrier pins
6/7	Sealing pins

- Tilt swivel arm with sputter head upward.
- Pull anode ring Position 6/4 (with quick acting ball closure) down.
- Remove target supporting ring Position 6/3 of magnet head Position 6/1. Snap both carrier pins Position 6/6 of the target positioning tool into the two bore holes of the target holder ring, and turn positioning tool counter clockwise.
- Place foil target Position 6/2 on target supporting ring.
- Place supporting ring with target on the magnet head. Slide both sealing pins Position 6/7 of the target supporting ring in the slots of the magnet head, and turn positioning tool clockwise until it stops (approx. 25°).
- Return anode ring to the original position.

6.2. Adjusting the working distance

- Remove protection shield Position 3/3 and Pyrex cylinder Position 3/2.

- Raise or lower specimen table Position 3/11 to the desired working heights. The height is indicated on the scale Position 3/12 on the specimen table cover. The upper rim of the specimen chamber base is the reference point.

6.3. Mounting the specimens

- Fix SEM specimens with silver conducting paint, other suitable adhesive or a bonding agent onto the specimen stubs.

- Place specimen stubs on bore hole of the specimen table. SEM tweezers (Order No: B 8010 030 11) are recommended for moving specimen stubs (see accessories) .

- Larger specimens are placed directly on the specimen table without special carriers. Very light specimens should be secured against "blow off" from the gas stream during venting of the specimen chamber.

6.4. Closing of vacuum chamber

- Place glass cylinder on seal of specimen chamber base. Seal and sealing surface must be clean !

- Attach protection shield. The pin of the safety disconnector plug must be latched in the slot of the disconnector socket Position 2/9.

- Check sealing surface of the glass cylinder and seal of the sputter head for cleanliness. Close specimen chamber for evacuation by lowering the swivel arm. Push swivel arm down until the unit is turned on and the vacuum pump is running.

- The contact of the safety disconnector switch on the sputter head-swivel arm (built into unit) is closed by lowering the swivel arm.

7. OPERATION OF THE UNIT

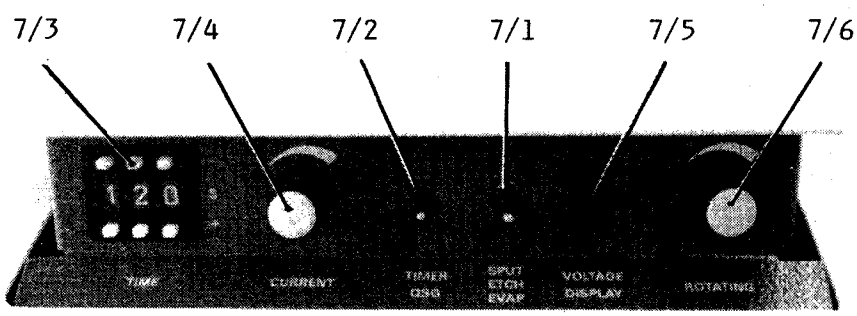


Figure 7 Process selection panel

7/1	Process selection switch
7/2	Selection switch for film thickness control
7/3	Processing time - key pad
7/4	Potentiometer for preselecting process current
7/5	Push button for voltage indicator
7/6	Potentiometer for rotary drive (accessory)

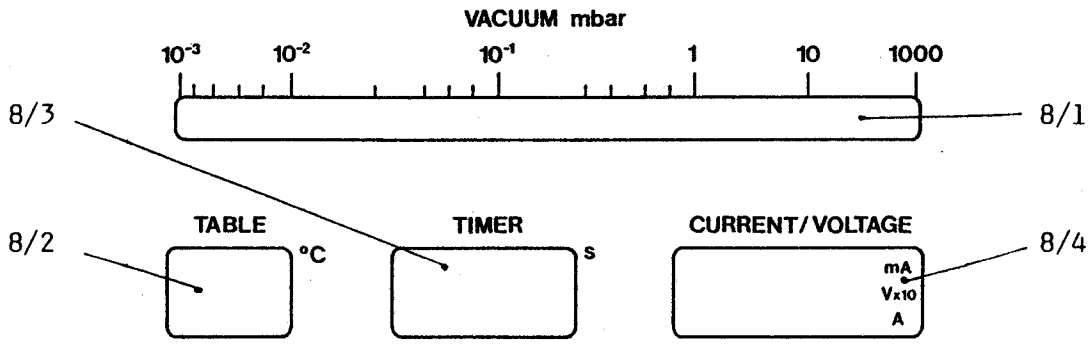


Figure 8 Display panel

8/1	LED display of vacuum
8/2	Temperature display for specimen table
8/3	Process time display
8/4	Current and voltage display

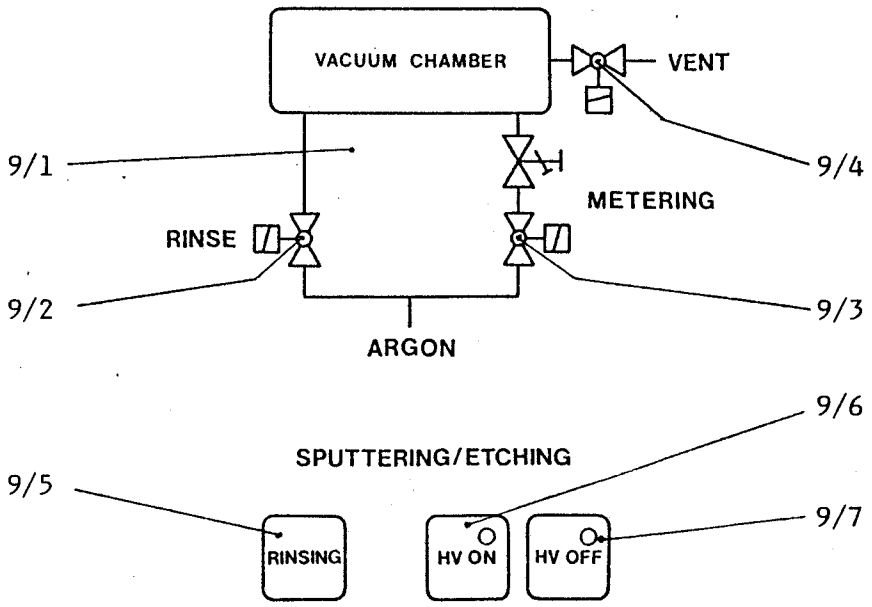


Figure 9 Control panel

9/1	Mimic diagram of valve layout
9/2	LED for rinsing valve RINSE
9/3	LED for cut-off valve METERING
9/4	LED for venting valve VENT
9/5	Touch-pad for rinsing valve RINSING
9/6	High voltage switch HV ON
9/7	High voltage switch HV OFF

7.1. Evacuation of vacuum chamber

Turn on main switch Position 2/8 of the unit:

- Venting valve closes, LED VENT Position 9/4 of the mimic diagram Position 9/1 lights green.
- Vacuum pump starts.
- LED display for vacuum Position 8/1 lights up; red indicates from 1000 mbar to 1.5×10^{-1} mbar, green from 1.5×10^{-1} mbar to 1×10^{-3} mbar (operating range).
- Specimen table temperature displayed in °C Position 8/2.
- Current display (CURRENT/VOLTAGE) Position 8/4 indicates in 00 mA or 0.0 A (depending on position of process selection switch Position 7/1); LED on touch-pad HV OFF Position 9/7 lights red.
- Vacuum switch releases high voltage when pressure reaches approx. 100 mbar.

The specimen chamber should be evacuated to a pressure of at least 5×10^{-2} mbar prior to sputtering or etching. The pressure should be improved prior to a carbon evaporation process.

7.2. Sputtering with sputter time control

- Follow procedure in Section 7.1. for evacuation of specimen chamber.

- Open process selection panel Position 2/4 by pushing on back side of panel top: panel locks in the opened position.

- Preselect sputter process with process selection switch Position 7/1: upper setting SPUT.

- Set switch to preselect sputter time Position 7/2: upper position TIMER.

- Set desired sputter time with touch-pad Position 7/3: time is displayed in seconds from 1 to 999.

- Turn on water cooling for specimen table and sputter target: open water supply valve.

- Open valve on gas pressure tank (see Section 5.3.).

- Close shutter for sputter target by turning knob Position 3/10 to position CLOSED.

- Rinse specimen chamber with argon gas by pressing on RINSING pad Position 9/5. LED for rinsing valve Position 9/2 lights green, as long as pad is held in, and valve is open. Repeat rinsing process several times.

- Turn on high voltage as soon as rinsing process is completed and vacuum drops below 1×10^{-1} mbar. (Important: there must be sufficient argon atoms to ignite the plasma !):

  Press HV ON pad Position 9/6, green LED lights up; cut-off valve METERING Position 6/3 opens, LED Position 9/3 lights green.

- Adjust working pressure with ARGON gas dosing valve Position 2/7 to approx. 5×10^{-2} mbar: valve opens counter-clockwise. Setting is stored for subsequent sputter processes.

- Set desired sputter current with CURRENT potentiometer Position 7/4: CURRENT/VOLTAGE display is in mA (Position 8/4). Setting is stored for future sputter processes.

- Readjust set working pressure with ARGON gas dosing valve if necessary.

- Voltage can be checked by pressing VOLTAGE DISPLAY pad Position 7/5: CURRENT/VOLTAGE display (Position 8/4) shows V x 10 values.

- Open shutter for sputter target by turning knob Position 3/10 to the OPEN position. Preselected sputter time starts to run down; expired time is displayed on TIMER display Position 8/3.

- Sputter process automatically stops when the preselected sputter time has expired:

  LED of HV ON pad goes out;

  LED on HV OFF pad lights red;

  Cut-off valve METERING closes, LED goes out;

  CURRENT/VOLTAGE display indicates zero;

  Expired time on TIMER continues to be displayed.

- The sputter process can be interrupted at any time by pushing HV OFF pad. The sputter process can be resumed to complete the preset sputter time by pushing the HV ON pad.

- Turn off main switch Position 2/8 of sputter coater:
  Vacuum pump stops;
  VENT valve opens, LED goes out;
  TIMER indicator goes to zero;
  All displays on the panel go out.

- Turn off water cooling to prevent condensation on the specimen table and sputter target when the unit is not in use.

- Close valves on gas pressure tank and on venting gas tank, if applicable.

The sputter process can be renewed after the sputter coater was turned off or if preselected sputter time has expired by extending time with touch-pad Position 7/3.

Important: The values listed in the following sputter time diagrams are significantly dependent on working pressure, working distance and sputter current and apply only if argon is used as operating gas.

The working distance is the distance between the sputter target and the specimen surface that is to be coated. The distance is shown on the underside of the specimen table Position 3/12 (see Section 6.2.).

The desired film thickness as a function of sputter time can be reproduced by observing the above decribed working conditions.

A film thickness monitor is recommended for exact measurements (see Section 10 accessories).

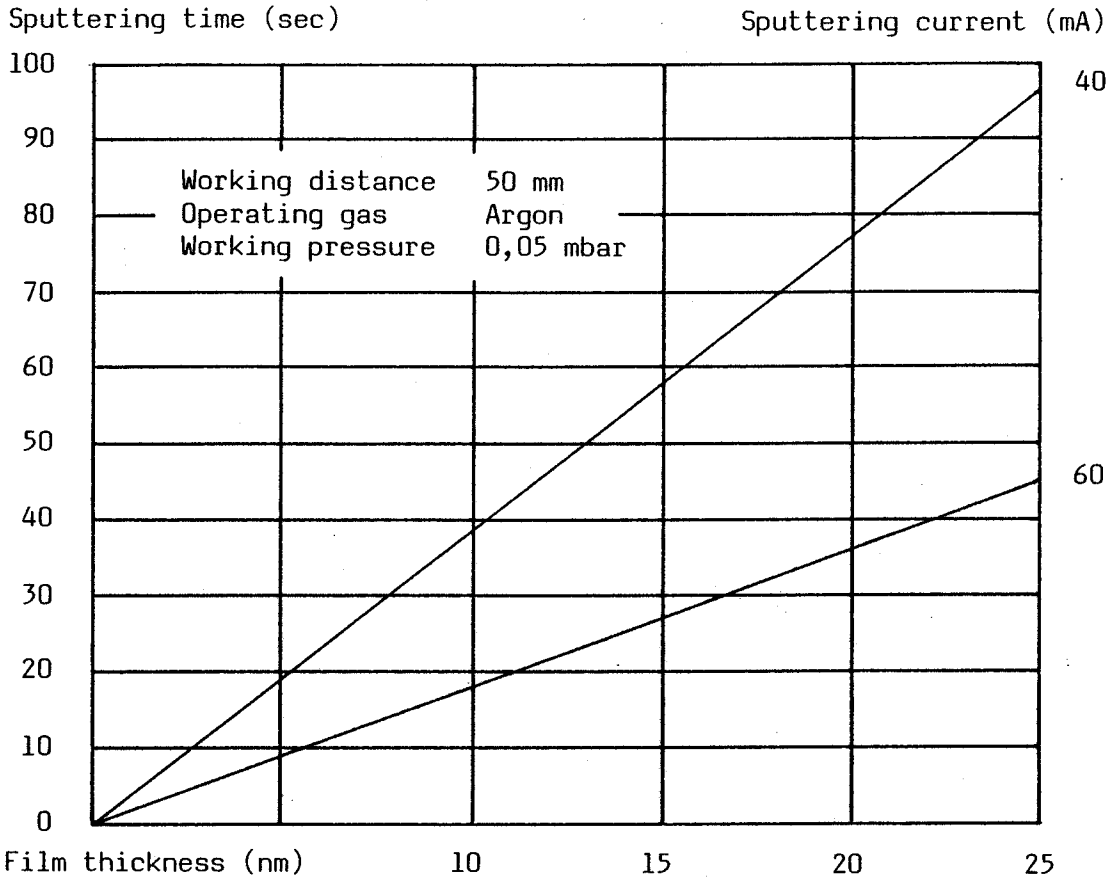


Fig. 10 Sputtering time diagram for gold (19,3 g/cm^3)

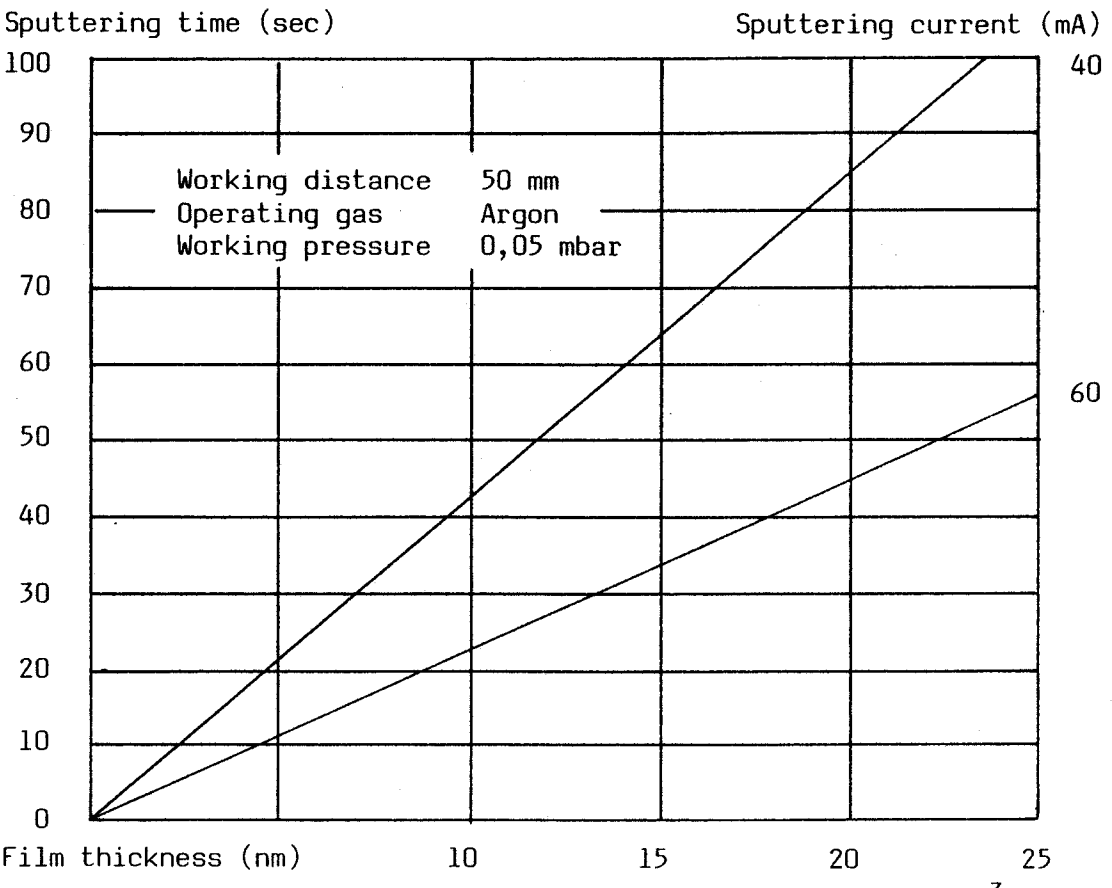


Fig. 11 Sputtering time diagram for gold/palladium (16,7 g/cm^3)

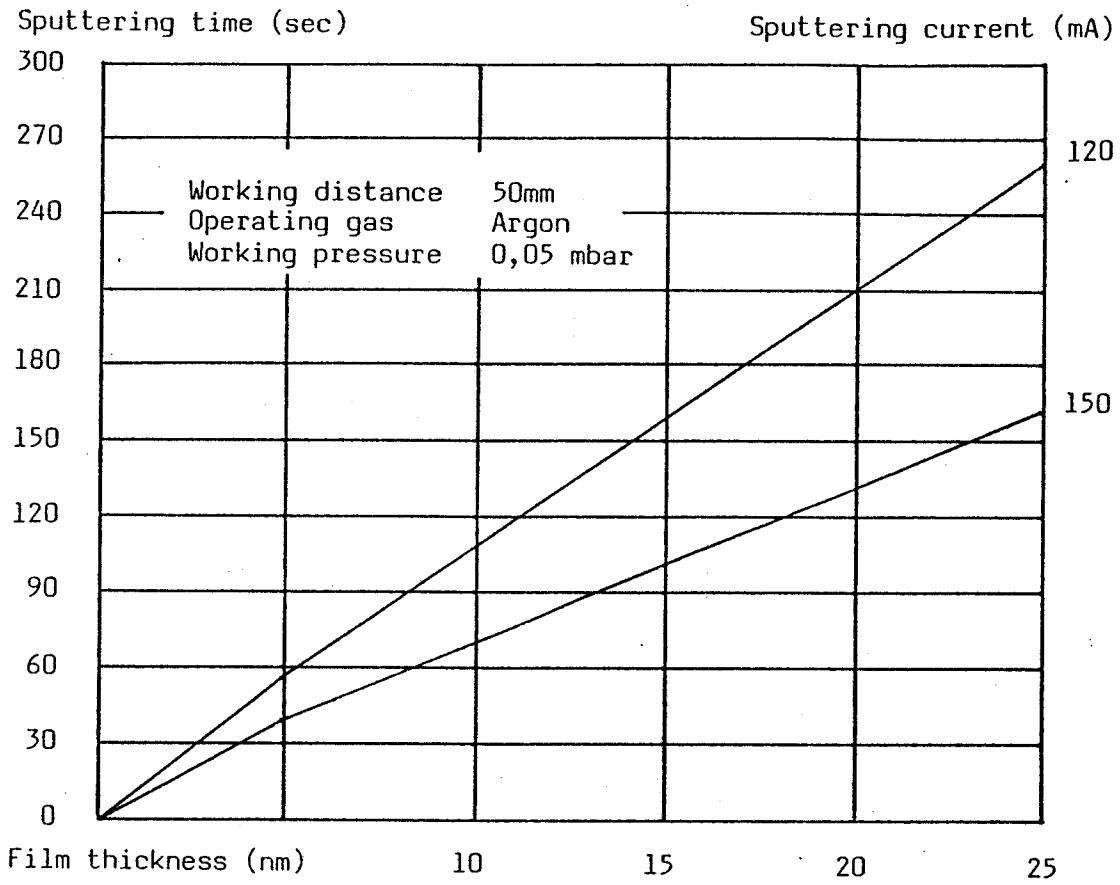


Fig. 12 Sputtering time diagram for chrom (7,2 g/cm^3)

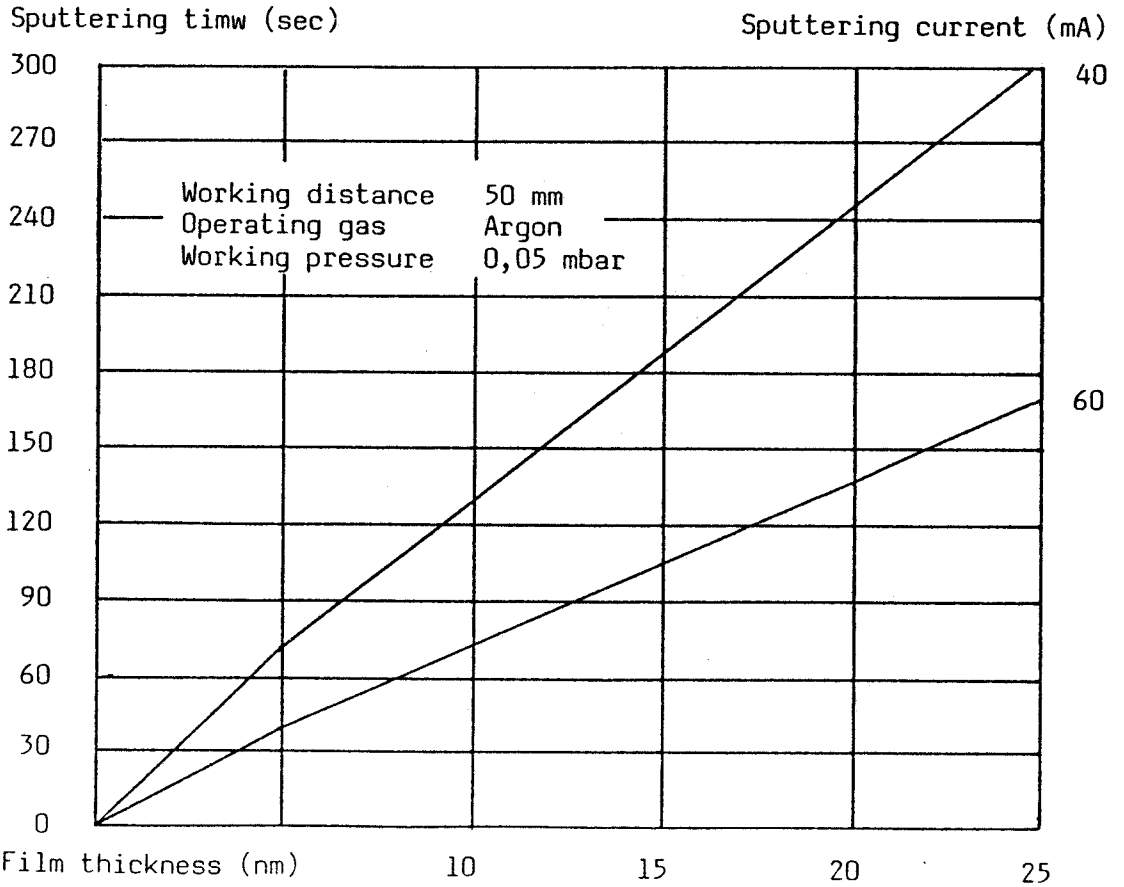


Fig. 13 Sputtering time diagram for copper (8,9 g/ cm^3)

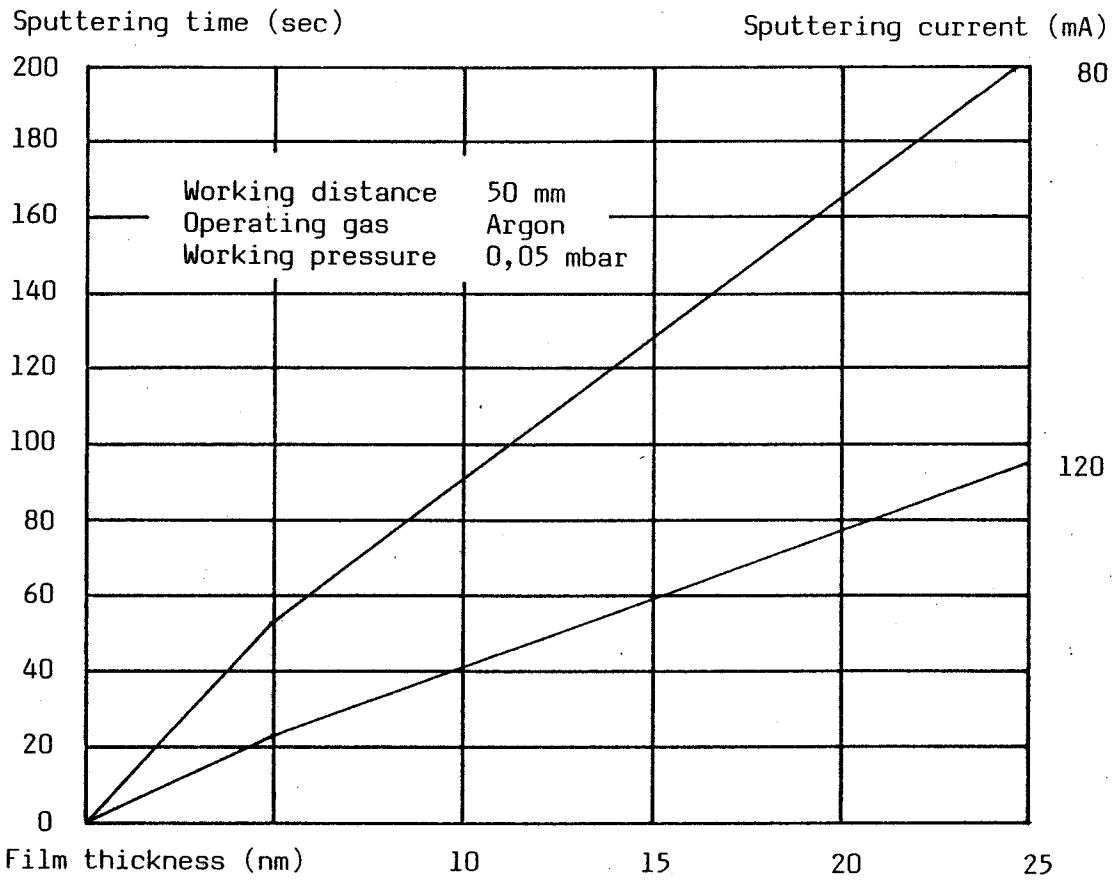


Fig. 14 Sputtering time diagram for nickel (8,9 g/cm^3)

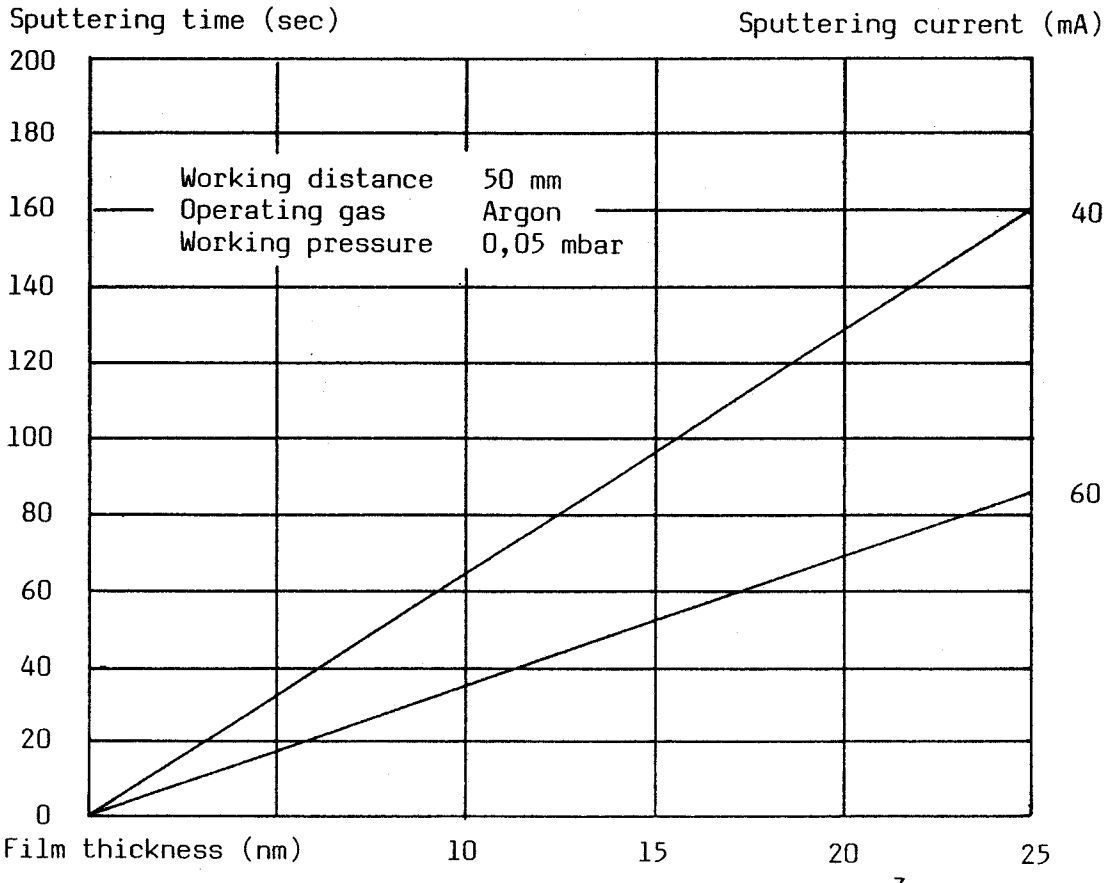


Fig. 15 Sputtering time diagram for platinum (21,5 g/cm^3)

7.3. Sputtering with film thickness control

- Evacuate specimen according to instructions in Section 7.1.

- Open process selection panel by pushing on backside of panel top: panel locks in the opened position.

- Preselect sputter process with process selection switch Position 7/1: upper setting SPUT.

- Preselect film thickness control with commutator switch Position 7/2: lower setting QSG.

- Turn on QSG 301 quartz crystal film thickness monitor (accessory): flip POWER toggle switch into the upper position, LED lights red.

- Enter density of sputter material with DENSITY selection switch, i.e. 19.3 for gold (pay special attention to the decimal point !).

- Select desired range with RANGE selection switch (Example: film thickness of 20 nm "RANGE x 1 red". The red scale applies for this example. The full range of the scale is 30 nm.

- Set shut-off point for the desired film thickness (such as 20 nm) with SET potentiometer by simultaneously pressing the SET button. Use fine screwdriver to adjust setting.

- Adjust loudness level for acoustical frequency control by turning the upper left knob on the QSG 301 clockwise.

- Turn the display of the QSG 301 to zero with the ZERO potentiometer.

- Turn START switch to OPEN. The QSG 301 is now ready for the film thickness control and/or for automatic shut-off of the sputter process after the desired film thickness has been obtained.

- Set TIME entry key to 999 (Position 7/3) if the sputter time for the preset film thickness is to be recorded: sputter time will be indicated on TIMER display after sputter process has been stopped.

- Turn on water cooling for specimen table and sputter target at the line.

- Open check valve of gas pressure tank (see Section 5.3.).

- Close shutter for sputter target: turn knob Position 3/10 to CLOSED.

- Rinse specimen chamber with argon gas: press on RINSING knob (Position 9/5). The RINSE LED Position 9/2 will light green as long as knob is held in, and valve is open. Repeat rinsing process several times.

- Turn on high voltage immediately after completion of rinsing process and vacuum drops below 10 mbar (Important: there must be sufficient argon gas atoms to ignite plasma):

  Press HV ON (Position 9/6) key, LED of pad lights green; cut-off valve METERING opens, green LED Position 9/3 of the valve lights.

Important: The high voltage and thus the sputter current can only be turned on and adjusted when the reversing key for film thickness control Position 7/2 is set to QSG, the QSG 301 film thickness monitor is prepared for the process and the START key of the QSG 301 is in the OPEN position.

- Adjust working pressure with ARGON gas dosing valve (Position 2/7) to approx. $5x10^{-2}$ mbar: valve opens counterclockwise. Setting is stored for subsequent processes.

- Set desired sputter current with CURRENT potentiometer (Position 7/4): CURRENT/VOLTAGE display (Position 8/4) indicates current in mA. Setting is stored for subsequent sputter processes.

- Readjust set working pressure with ARGON gas dosing valve if necessary.

- Applied voltage can be checked by pressing VOLTAGE DISPLAY button (Position 7/5): CURRENT/VOLTAGE display (Position 8/4) indicates value in V x 10.

- Open shutter for sputter target: turn knob Position 3/10 to OPEN position. Coating process starts. Increasing film thickness can be monitored in nm on the QSG 301.
  Decreasing process time is indicated on TIMER display providing the TIME key pad was set to 999 prior to the start of the sputter process.

- The sputter process automatically stops when the preset film thickness has been achieved:
  LED of HV ON pad goes out;
  LED of HV OFF pad lights red;
  METERING cut-off valve closes, LED goes out;
  CURRENT/VOLTAGE display indicates zero;
  TIMER display continues to show expired sputter time.

- The sputter process can be interrupted at any time by pressing the HV OFF pad. Pressing the HV ON pad restarts the process until the preset film thickness has been achieved.

- Turn off mains switch Position 8/2:
  Vacuum pump stops;
  VENT valve opens, LED goes out;
  All panel displays go out;
  QSG 301 thickness monitor turns off.

- Turn off water cooling to prevent condensation on the specimen table and sputter target when the unit is not in use.

- Close valve of gas pressure tank and of venting gas tank, if applicable.

7.4. Sputtering with presputtering

Target material that is not a precious metal must be "pre-sputterd" while the shutter is closed before the specimen is coated. This process is to remove tenacious oxidation, and to prepare the target for the desired sputter process. The required pre-sputter time for metals such as chrome, copper or nickel generally takes several minutes, depending on the condition of the target. The sputter current is set at approx. 100 mA for the pre-sputter process. After pre-sputtering, the specimen can be coated with the "cleaned" target following the procedure described in Section 7.2. and 7.3.

7.5. Cathodic etching

- Evacuate specimen chamber according to Section 7.1.
- Open process selection panel by pushing on backside of panel top: panel locks in the opened position.
- Preselect etching process with process selection switch Position 7/2: center position ETCH:
- Set desired etching time with key pad Position 7/3: time is indicated from 1 to 999 seconds.
- Turn on water cooling for specimen table and target holder: Open valve at the line.
- Open check valve of gas pressure tank (see Section 5.3.).
- Slightly open shutter of sputter target: turn knob Position 3/10 from the CLOSED position to the OPEN position by 10°.
- Turn potentiometer for preselection of process current Position 7/4 to zero: turn knob counterclockwise until it locks.
- Turn on high voltage: press HV ON pad (Position 9/6); LED of pad lights green; cut-off valve METERING opens; green LED Position 9/3 lights.
- Adjust working pressure with ARGON gas dosing valve (Position 2/7) to approx. 8×10^{-2} mbar: valve opens counterclockwise.
- Adjust etching current with potentiometer Position 7/4 to desired value: CURRENT/VOLTAGE display (Position 8/4) indicates in mA.
- Readjust set working pressure with gas dosing valve if necessary.

- The applied voltage can be checked by pressing VOLTAGE DISPLAY pad (Position 7/5): CURRENT/VOLTAGE display (Position 8/4) indicates value V x 10.

- Close shutter: turn knob back to CLOSED position. Preset etching time starts to run down, the expired time is displayed on the TIMER display (Position 8/3).

- The etching process stops upon expiration of the preset etching time:

  LED of HV ON pad goes out;
  LED of HV OFF pad lights red;
  METERING cut-off valve closes, LED goes out;
  CURRENT/VOLTAGE indicates zero;
  TIMER display continues to indicate expired etching time.

- The etching process can be interrupted at any time by pressing the HV OFF pad. Restarting the etching process may blow the fuse. It is therefore suggested, that the potentiometer for process current preselection (Position 7/4) be turned back to zero, and the etching current be reset.

- The sputter coater, upon completion of the etching process, is ready to be programmed for sputtering according to Section 7.2. and 7.3, and the etched specimen can be coated with a metal layer without interruption of the vacuum.

- Turn off mains switch Position 2/8:

  Vacuum pump stops;
  VENT valve opens, LED goes out;
  TIMER indicator shows zero;
  All panel displays go out.

- Turn off water cooling to prevent condensation on the specimen table and sputter target when the unit is not in use.

- Close valve of gas pressure tank and of venting gas tank, if applicable.

7.6. Carbon-Thread Evaporation

The evaporation of carbon thread to produce conductive carbon layers to SEM specimens for X-ray microanalysis requires a CEA 050 carbon thread evaporator accessory BU 007 179-T (see Section 10, accessories).

Following is a description of the preparation of the SCD 050 for operation with the CEA 050 accessory:

- Remove corresponding blind plate and insert high current supply CE 010 into the housing of the SCD 050 from the back (see Figure 4, Position 4/10), unless this connection has not already been made: the plug contact provides automatic connection to the sputter coater drive.

- Turn carrier arm for the sputter head Position 2/3 up.

- Bring specimen table Position 3/11 into the upper position and place extension table (BU 015 883-T) on the specimen table to reduce the working distance.

- Put glass chamber (170 mm heights) of the carbon thread evaporation accessory onto specimen chamber base Position 2/1 after cleaning of seal and sealing surface.

- Fit carbon thread in evaporator flange (see Figure 16). Push spring clamp up from the back, place carbon thread under the clamp disc and release spring clamp. The contact surfaces for the carbon thread must be free of residue from any preceding evaporation process.

Single carbon thread Double carbon thread

Figure 16 Carbon Thread Modifications

- Place prepared evaporator flange on glass cylinder after cleaning of seal and sealing surface.

- Plug high current cable into AC OUTPUT of the CE 010 high current supply (Position 4/11) and connect shield to grounding screw Position 4/12 (yellow-green cable).

- Connect evaporator flange to high current supply via the two high current cables.

- Open process selection panel Position 2/4 by pushing on the backside of the panel top: panel locks in the opened position.

- Preselect evaporation process with process selection switch Position 7/1: lower setting for EVAP.

The sputter coater is now ready for a carbon thread evaporation process:

- Evacuate specimen chamber according to Section 7.1.

- CURRENT/VOLTAGE display Position 8/4 indicates 0.0 A when the switch is set to EVAP.

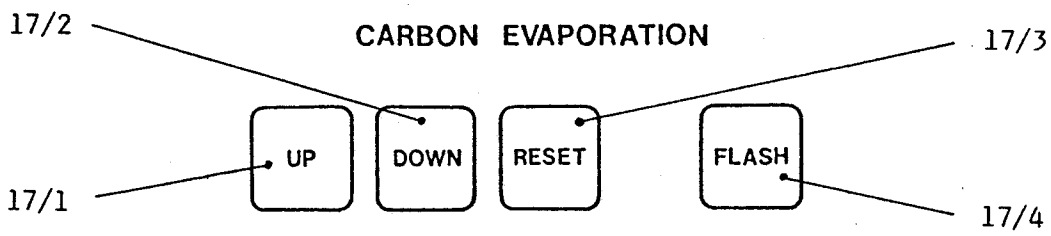


Figure 17 Control Keys for Carbon Evaporation

17/1	UP control for current adjustment
17/2	DOWN control for current adjustment
17/3	RESET control to turn current off
17/4	FLASH control for full evaporation delivery

- Degasing of the carbon thread:
  Adjust current up by pulsing the UP control Position 17/1 to approx. 1.5 A for single thread carbon, and to approx. 2.5 A for double carbon thread.

  Reduce current by pulsing DOWN control Position 17/2, if necessary.

  Pressure increases during degasing and drops to original value after carbon thread is degased.

- Press RESET Position 17/3 to terminate degasing process.

- Start evaporation of the carbon thread by pressing FLASH control Position 17/4. The evaporation process is completed when the carbon thread is "flash" evaporated. This process generally takes 1 to 2 seconds for single carbon thread and approx. 3 seconds for double carbon thread.

- Turn off mains switch Position 2/8:

  Vacuum pump stops;
  VENT valve opens, LED goes out;
  All panel displays go out;

8. MAINTENANCE

The electrical safety features of the sputter coater (see Section 3.7.) must periodically be checked for proper function. Any defective component must be repaired immediately by a qualified technician. The high voltage must remain de-energized when:

- the specimen chamber is being vented (vacuum gauge)
- the sputter head swivel arm is raised (sputter head separation switch)
- the specimen protection shield is not properly installed (safety separation plug).

Possible contamination of the fine vacuum gauge after extended use will show incorrect vacuum. The accuracy of the vacuum gauge should from time to time be checked through the recorder connection of the PP 010 vacuum measuring module (Position 4/15). See Section 3.5. for vacuum values.

The specimen chamber with glass tube, specimen table and sputter head, as well as specimen chamber seal must be kept clean at all times. Scotch-Brite cloth (order No: BU 017 029-T) and/or "Wenol plus K" (order No: B 8010 170 15) is recommended for cleaning of metal parts. Glass parts should be cleaned with an appropriate substrate cleaner (order No: BD 481 900-T and BD 481 901-T), silicon seals should be cleaned with alcohol.

The vacuum pump is subject to maintenance procedures as described in the accompanying operating instructions (DUO 004 B is described in PK 800 086 BN). The same applies to the fine vacuum gauge (operating instructions No: A 51-9853 e).

9. TROUBLESHOOTING

The vacuum pump does not start and the display panel does not light after the mains switch Position 2/8 has been turned on:

- Cable is not properly connected or fuses F 1 and/or F 2 (Position 4/21) are defective. Fuse ratings 1 AT for 220-240 V, 2 AT for 115 V:

  Check connections to unit and fuses, replace if necessary.

Vacuum pump does not start after unit has been turned on.

- Pump connector cable is not hooked up to one of the plugs Position 4/23, or fuses F 1 and/or F 2 (Position 4/21) are defective. Fuse ratings 1 AT for 220-240 V, 2 AT for 115 V:

  Check connection of pump and check fuses, replace if necessary.

Three light bars on the right side of the vacuum indicator light after the unit has been turned on.

- The fine vacuum gauge is not connected or defective:

Check connection of gauge or replace TPR 010 vacuum gauge if necessary.

Sputter process does not start following proper preparation. There is no current or voltage reading.

- Fuses F 3 and/or F 4 (Position 4/22) are defective. Fuse ratings 2.5 AT for 220-240 V, 5 AT for 115 V:

Check fuses and replace if necessary.

- Failure to follow operating instructions caused overheating of the power transformer, which triggered the thermocoupler of the transformer:

The sputter process can be restarted after a waiting period of about 30 minutes.

Sputter- or etching process cannot be started.

- Timer was not set or reset:

See Section 7.2. or 7.5. of the operating instructions.

- Film thickness monitor QSG 301 was not properly prepared for the sputter process:

See Section 7.3. of the operating instructions.

Sputter current reading (Position 8/4) shows increasing values when current is being adjusted up with CURRENT potentiometer (Position 7/4), but charge in specimen chamber does not ignite.

- Short circuit at the sputter source caused by the target supporting ring dropping onto the anode ring:

Properly place target supporting ring and fix as described in Section 6.1.

- Short circuit on high voltage line:

Consult specialist technician for repair or contact BALZERS Service.

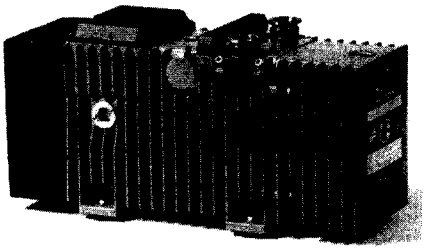
Sputter current reading (Position 8/4) does not increase during adjustment with CURRENT potentiometer (Position 7/4), charge in specimen chamber does not ignite.

- Pressure in specimen chamber is too high or too low:

Adjust working pressure as described in Section 7.2. and 7.3.

10. ACCESSORIES / AUXILIARY DEVICES

DUO 004 B two-stage rotary vane pump



Recommended for sputtering.

Order No: BU 007 150-T for 220 V/50 Hz
Order No: BU 007 151-T for 220 V/60 Hz
Order No: BU 007 155-T for 240 V/50 Hz

DUO 008 B two-stage rotary vane pump

Recommended for sputtering with wafer chamber or carbon thread evaporation.

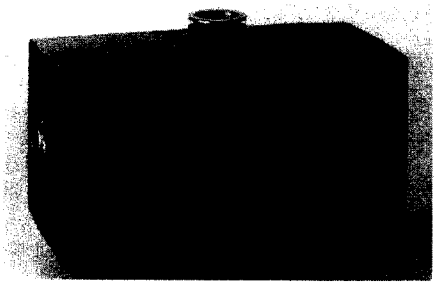
Order No: BU 007 188-T for 220 V/50 Hz
Order No: BU 007 189-T for 220 V/60 Hz
Order No: BU 007 190-T for 240 V/50 Hz

DUO 016 B two-stage rotary vane pump

Recommended for application with longer vacuum hoses.

Order No: BU 007 146-T for 220 V/50 Hz
Order No: BU 007 147-T for 220 V/60 Hz
Order No: BU 007 148-T for 240 V/50 Hz

ONF 025 oil mist filter



Recommended for connection to the exhaust port of the vacuum roughing pump.

Order No: BU 007 153-T

Vacuum hoses

For connection of sputter coater to vacuum roughing pump. One end is fitted with a DN 25 KF-28 flange.

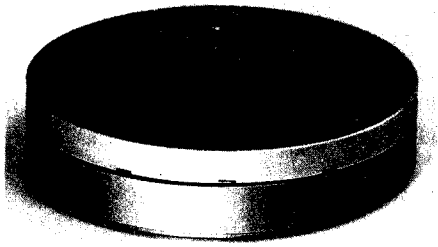
Order No: BU 007 152-T

Quick-change foil targets

Diameter 54 mm, 0.2 mm thickness

Order No: B 8010 072 21 for gold
Order No: B 8010 072 29 for Au/Pd
Order No: B 8010 072 28 for platinum
Order No: B 8010 072 26 for silver
Order No: BU 007 223-T for chrome
Order No: BU 007 224 for copper
Order No: BU 007 222 for nickel

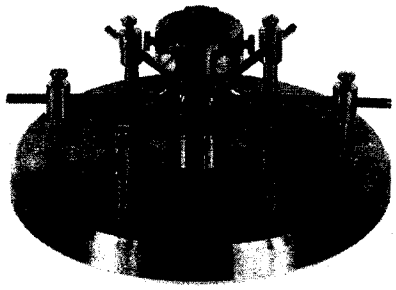
Sputter-shadowing device



This device allows up to twelve TEM specimens to be shadowed with gold or gold/palladium by sputtering (W. Colquhoun technique).

Order No: BU 007 163-T

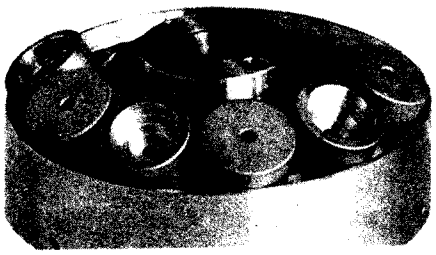
Sputter-shadowing device



This device allows rotational shadowing of up to 6 TEM specimens with gold or gold/palladium by sputtering (W. Colquhoun technique).

Order No: BU 007 164-T

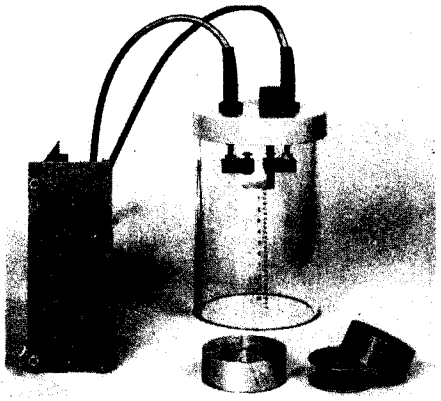
Planetary drive stage



For coating extremely fissured specimen surfaces. With 10 aluminium holders 20 mm diam. for various SEM specimen mounts.

Order No: BU 007 288-T

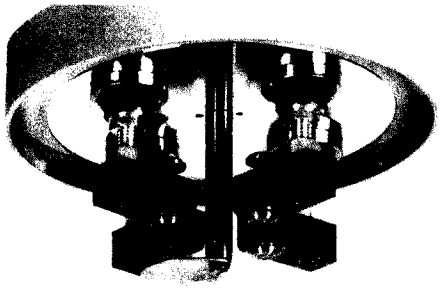
CEA 050 Carbon thread evaporation accessory



For the production of conductive carbon coatings for SEM specimens intended for X-ray microanalysis. The unit consists of: CE 010 high current supply module, single carbon thread evaporator flange, glass vacuum chamber, high current cable, extension table and a spool of carbon thread.

Order No: BU 007 179-T

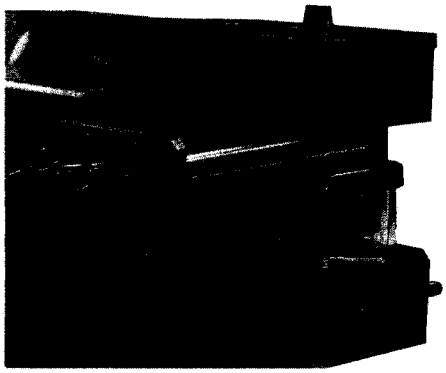
Multiple carbon thread evaporator flange



This unit has four high current feedthroughs for multiple evaporations for the production of thicker carbon coatings without interruption of the vacuum. The unit is used in place of the single carbon evaporation flange of the CEA 050 carbon thread evaporation accessory.

Order No: BU 007 653-T

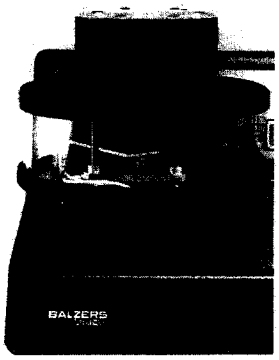
CGC 010 Carbon-metal-carbon coating accessory



This unit is suitable for the production of carbon-metal-carbon sandwich layers onto SEM specimens without interruption of the vacuum (Professor R. Blaschke method). The unit consists of: CE 010 high current module, double carbon thread evaporator accessory, glass vacuum chamber, holder device, high current cable and a spool of carbon thread.

Order No: BU 007 195-T

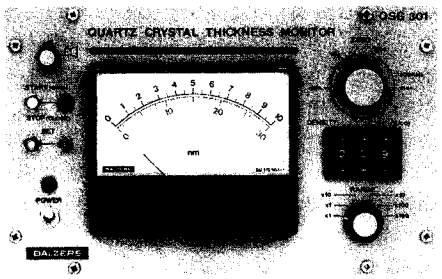
DN 205 Special vacuum chamber

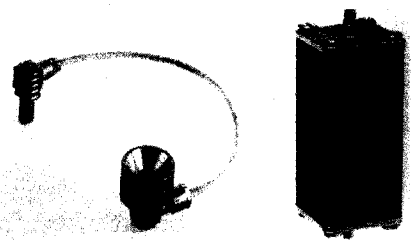


This unit has a built-in, hight adjustable rotary table for coating larger specimens, such as wafers (maximum size 6" round or 5" square), or compact discs for electron microscope examination.

Order No: BU 007 197-T

QSG 301 Quartz crystal film thickness monitor

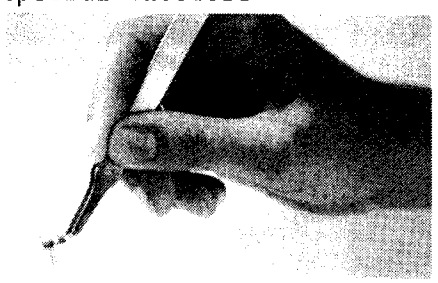




The device allows precise measurements of the thickness of sputtered and evaporated films. The device consists of: QSG 301 film thickness monitor, QSK 301 quartz crystal head, crystal holder, oscillator, set of cables as well as a set of 10 quartz crystals.

Order No: BU 007 298-T

Special tweezers



These tweezers are designed for safe handling of SEM specimen stubs for Cambridge, Etec, Philips and Zeiss microscopes.

Order No: B 8010 030 11

Specimen preparation stage

This specimen stage holds conventional specimen mounts for mounting of specimens.

Order No: BU 014 016-T

Contact and adhesive material:

Silver conducting paint

For the production of conductive coatings and for securing of specimens onto SEM specimen mounts.

Available in 15 ml bottles — Order No: B 8010 140 20

Nickel conducting paint

For the production of conductive coatings and for securing of specimens onto SEM specimen mounts.

Available in 60 ml bottles — Order No: B 8010 140 21

Solvent

For removal of silver and nickel paint residues from SEM specimen mounts. This material interferes with conductivity and should not be used as thinner.

Available in 30 ml bottles — Order No: B 8010 140 98

Hydro-Collag

Conductive carbon glue for securing of specimens onto SEM specimen mounts.

Available in 50 ml bottles — Order No: BU 014 095

Leit-C (after Göcke)

This material has good adhesive properties and good electrical conductivity. Non-conductive layers do not require the use of jumpers after coating with carbon or metal.

Shipped in 30 g packets — Order No: B 8010 140 75

Leit-C-thinner

One packet of thinner is used for every three packets of Göcke Leit-C.

Shipped in 30 ml packets — Order No: B 8010 140 76

Leit-C-Plast

Adhesive for the preparation of larger SEM specimens. The material has high electrical conductivity and good adhesive properties, it is vacuum-proof and causes minimal contamination and shows no ED X-ray lines.

Available in 15 g packets — Order No: B 8010 140 77

Tempfix

A highly vacuum-proof, solvent-free resin. This material is suitable as adhesive for powdered SEM specimens and small specimen particles on SEM specimen mounts.

The Tempfix set contains resin, four aluminium platelets and one specimen mount. Enough for about 50 preparations.

Order No: B 8010 140 78

Aluminium adhesive tape

Thin adhesive tape with conductive adhesive, suitable as SEM specimen base coating. The tape creates a smooth, conductive specimen base.

Width 6.4 mm, length approx. 55 m Order No: B 8010 140 24

Copper adhesive tape

Thin copper tape with conductive adhesive, suitable as SEM specimen base coating. The tape creates a smooth, conductive specimen base.

Width 6.4 mm, length approx. 16 m Order No: B 8010 140 25

3 M double-sided adhesive tape

For securing of specimens onto SEM specimen mounts. Tape has protective backing.

Width 12.7 mm, length approx. 33 m Order No: B 8010 140 23

3 M transfer tape

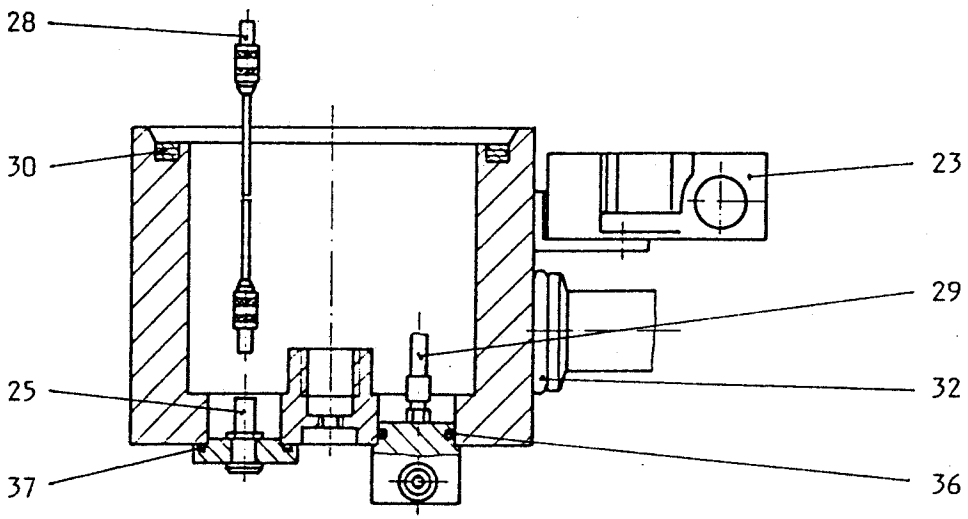
Very thin transparent, double-sided adhesive tape with protective paper backing for securing fine grained specimens, thin layers etc. onto SEM specimen mounts.

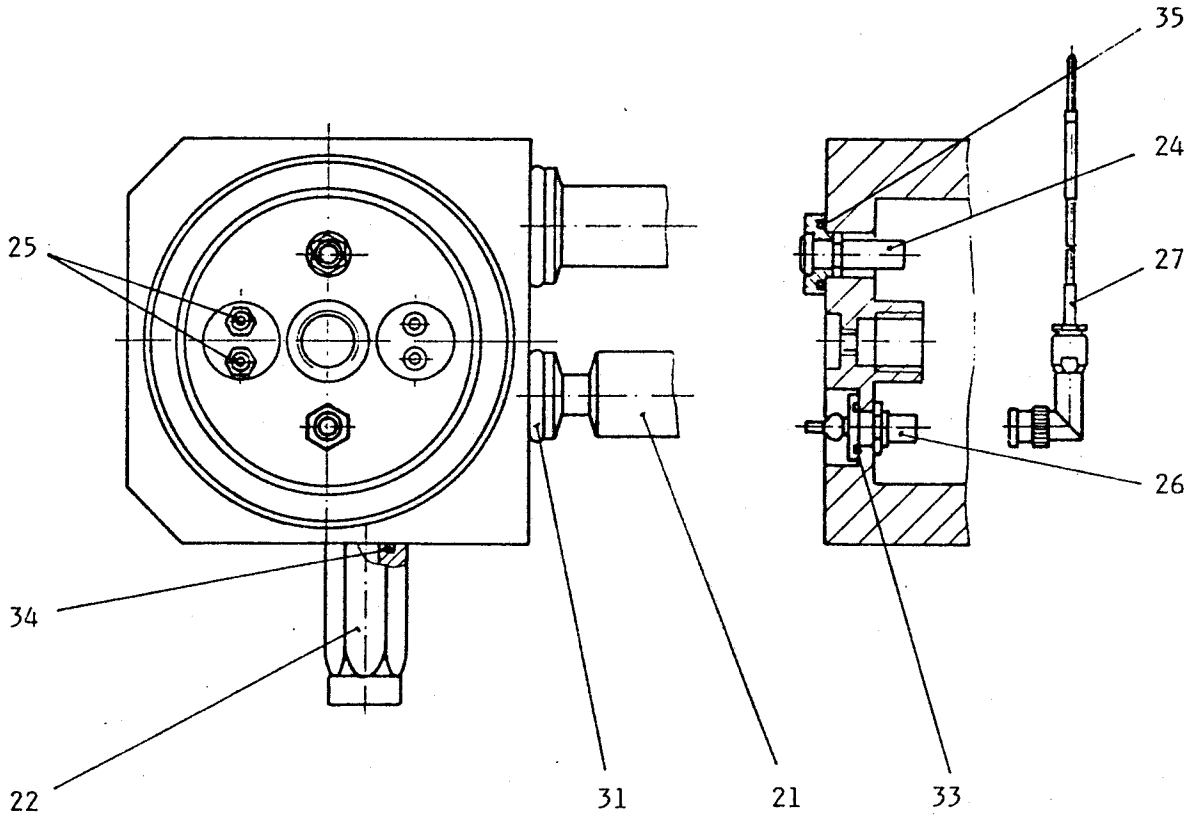
Width 12.7 mm, length approx. 55 m Order No: B 8010 140 26

	Description Teil	Item Pos.	Order No. Bestell-Nr.	S	Reference Bemerkungen
1	Vacuum chamber base, complete	1			BU 800 191 E/2
1	Object table, complete	2			BU 800 191 E/4
1	Sputter head arm, complete	3			BU 800 191 E/5
1	Electrical part	4			BU 800 191 E/6
1	Glass chamber	5	B 8010 075 17		
1	Protection shield	6	BU 015 875-X		
1	Magnet valve "VENT"	7	B 8010 144 08		
1	Magnet valve "RINSE"	8	B 8010 084 74		
1	Magnet valve "ARGON"	9	B 8010 084 74		
1	Needle valve	10	B 8010 074 83		
1	Hose, complete, 0.83 m length	11	BU 015 885-T		
1	Hose Ø 3/5, 1 m long	12	B 8010 075 77		
1	Aperture 150 µm	13	BU 015 541		
2	Seal rings AL	14	B 8010 084 72		
8	Seal rings AL	15	B 8010 086 89		
2	Seals CU	16	B 4119 517-K		
1	Rocker switch	17	B 8010 206 44		

	Description Teil	Item Pos.	Order No. Bestell-Nr.	S	Reference Bemerkungen
1	TPR 010 fine vacuum gauge	21	BG G02 250		
1	Vacuum switch	22	BU 020 717-R		
1	Safety switch	23	B 8010 056 38		
1	G box 2 P	24	B 8010 055 46		
2	D box	25	B 8010 079 78		
1	Frame socket	26	B 4728 122 BB		
1	Cable, 0,35 m length	27	BU 005 124-T		
2	Cable, 0,24 m length	28	BU 005 122-T		
2	Hose, Ø 3/5, 0,22 m length	29	B 8010 075 77		
1	Silicon seal	30	BU 007 471		
1	Seal DN 10 ISO-KF	31	BP 213 326-T		
1	Seal DN 25 ISO-KF	32	BP 213 328-T		
1	O-Ring Ø 12,42 x 1,78	33	B 4070 201 PV		
1	O-Ring Ø 14 x 1,78	34	B 4070 234 PV		
1	O-Ring Ø 17,17 x 1,78	35	B 4070 291 PV		
1	O-Ring Ø 23,52 x 1,78	36	B 4070 399 PV		
1	O-Ring Ø 26,7 x 1,78	37	B 4070 449 PV		

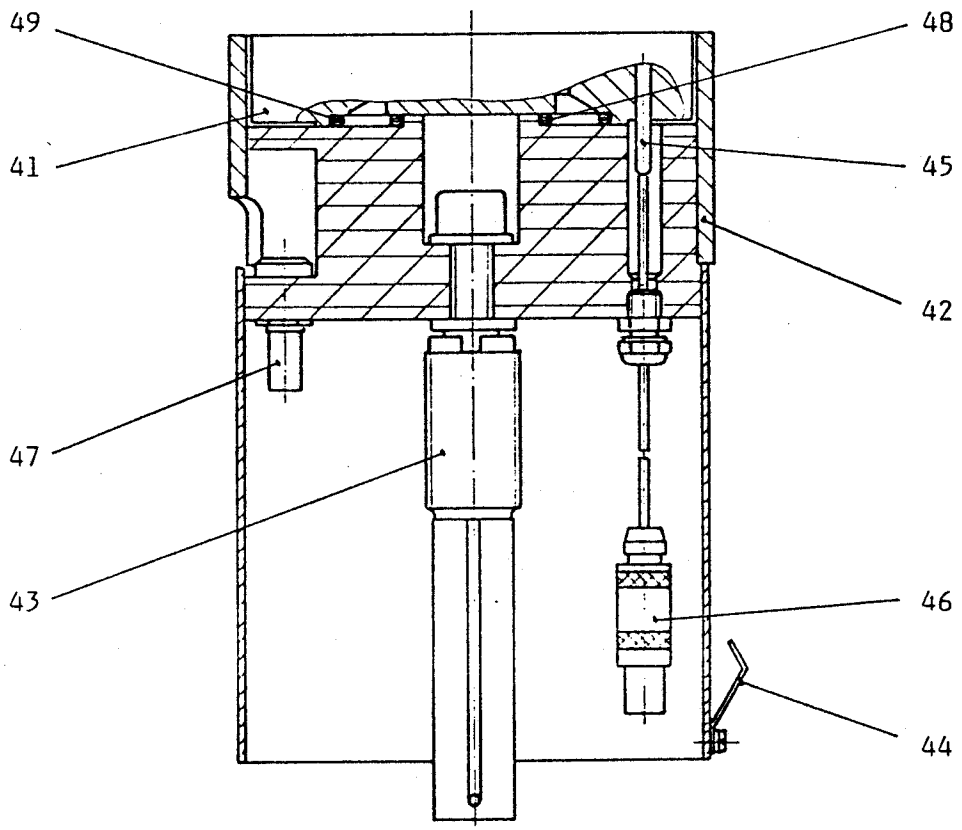
Spare Parts for/Ersatzteile zu		BALZERS
Specimen Chamber Base	BU 015 803-T	BU 800 191 E/2





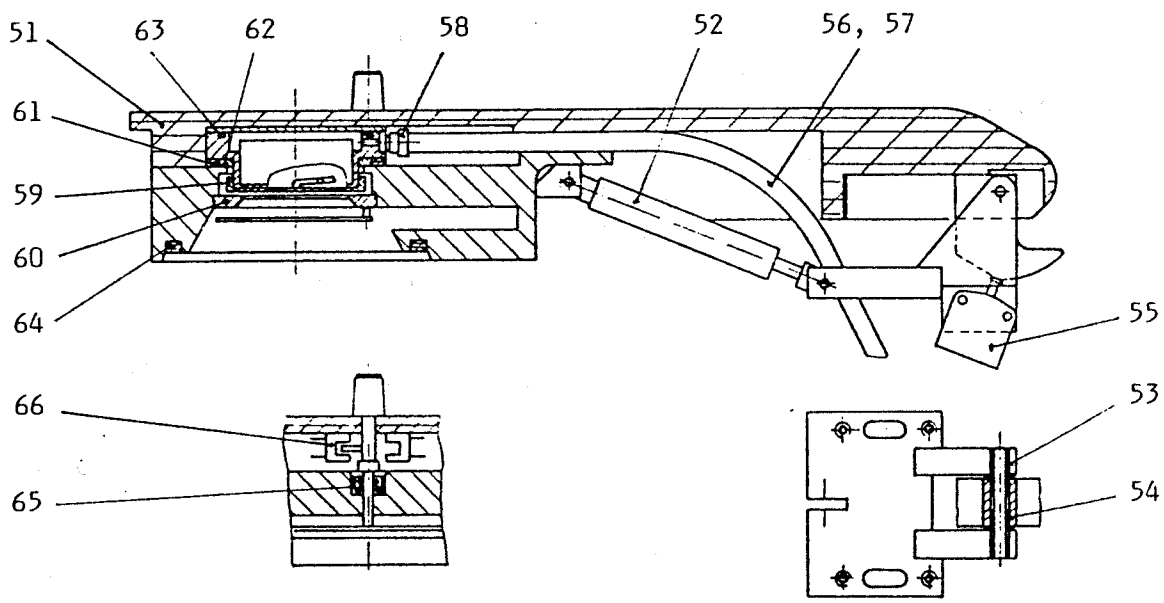
Spare Parts for/Ersatzteile zu		BALZERS
Specimen Chamber Base	BU 015 803-T	BU 800 191 E/3

	Description Teil	Item Pos.	Order No. Bestell-Nr.	S	Reference Bemerkungen
1	Supporting plate	41	BU 015 609		
1	Tube	42	BU 015 608		
1	Socket M 18 x 1	43	B 8010 054 17		
2	Contact spring	44	BU 015 827		
1	Temperature sensor	45	B 8010 055 45		
1	K-plug 2 P	46	B 4722 015 LA		
2	G-box	47	B 8010 079 78		
1	O-ring Ø 25,07 x 2,62	48	B 4070 437 PV		
1	O-ring Ø 47,29 x 2,62	49	B 4070 742 PV		



Spare Parts for / Ersatzteile zu		BALZERS
Object Table, complete	BU 015 802-T	BU 800 191 E/4

	Description Teil	Item Pos.	Order No. Bestell-Nr.	S	Reference Bemerkungen
1	Hinged arm	51	BU 015 587		
1	Damper LIFT-O-MAT	52	B 8010 145 30		
2	Bushing Ø 6/8 x 8	53	B 8010 084 90		
2	Bushing Ø 6/8 x 10	54	B 4063 113		
2	Touch pad	55	B 8010 079 33		
1	Hose, complete, 0,78 m length	56	BU 015 886-T		
1	Hose, complete, 0,54 m length	57	BU 015 887-T		
2	Hose clamp 7-9	58	B 4163 244 Z		
1	Target supporting ring	59	BU 015 807-T		
1	Anode ring	60	BU 007 977-U		
1	Ring	61	BU 015 613		
1	O-ring Ø 66,04 x 5,34	62	B 4070 963 PP		
1	O-ring Ø 63,17 x 2,62	63	B 4070 923 PV		
1	Silicon seal	64	BU 007 471		
1	Rotary shaft seal	65	N 4083 011 PD		
2	Optocoupler	66	B 5060 075 EQ		



Spare Parts for/Ersatzteile zu		BALZERS
Sputter Head Arm	BU 015 804-T	BU 800 191 E/5

	Description Teil	Item Pos.	Order No. Bestell-Nr.	S	Reference Bemerkungen
1	VS 010 supply module	71	BU 005 095-T		
1	PP 010 vacuum gauge module	72	BU 005 096-T		
1	HT 010 high current supply module	73	BU 005 101-T		
1	Operating PC board	74	BU 005 102-T		
1	Relais PC board	75	BU 005 103-T		
1	Display PC board	76	BU 005 104-T		
1	Connection PC board	77	BU 005 106-T		
1	Ring core transformer	78	BU 005 118-T		
1	Transformer 150 VA, EI 96 B/45.7	79	B 8010 055 49		
2	Voltage selector	80	B 8010 055 48		
1	Filter 4 A/250 V	81	B 8010 054 62		
1	Contactor 24 V, 50/60 Hz	82	B 4771 156 NB		
2	Flush fitting socket 2 P + E	83	B 8010 148 53		
4	Fuse holder 5 x 20	84	B 4661 214 81		
5	Multi switch	85	B 8010 056 08		
1	Rocker switch 1-1/2 U	86	B 4752 212 SA		
1	Rocker switch 1-1-1/2 U	87	B 8010 054 84		
1	Push button 1-M/1 U	88	B 4751 761 AK		
1	Potentiometer	89	BG 290 519-R		
1	Wire-potentiometer	90	BU 005 534		
1	Mains cable 2 P + E, 2 m	91	BU 005 493-T		
1	Flat strip cable 26 POL.	92	BU 005 113-T		Pos. 75 / Pos. 76
1	Flat strip cable 20 POL.	93	BU 005 114-T		Pos. 76 / Pos. 77
1	Flat strip cable 16 POL.	94	BU 005 115-T		Pos. 76 / Pos. 77
1	Flat strip cable 26 POL.	95	BU 005 123-T		Selection panel / Pos. 76
2	Microfuse F 1, F 2, 1 AT	96	B 4666 436		for 220-240 V
2	Microfuse F 1, F 2, 2 AT	97	B 4666 442		for 115 V
2	Microfuse F 3, F 4, ~~2.5 AT~~ 1,6 AT	98	B 4666 ~~444~~ 446		for 220-240 V
2	Microfuse F 3, F 4, ~~5 AT~~ 3,15 AT	99	B 4666 ~~450~~ 446		for 115 V

Spare Parts for/ Ersatzteile zu	BALZERS
Electrical Part	BU 800 191 E/6

BAL-TEC

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