OPERATING INSTRUCTIONS

Zepto special
Serial number

Zepto
Serial number

Atto
Serial number 114292

Please read this manual carefully before installing the machine.
Summary of Delivered Components

Customer:________________________________________

Date of delivery:________________________________________

Please note that only the marked chapter have to be read to operate your machine!

1. Cabinet
   - Zepto special
   - Zepto
   - Atto

2. Gas supply
   □ obligatory

3. Connections
   □ obligatory

4. Control
   □ obligatory

5. Generator
   □ 40 kHz
   □ 13,56 MHz

6. Pump
   □ No Name vacuum pump
   □ Pfeiffer vacuum pump

7. Options
   □ Carrier aluminium
   □ Carrier borosilicate glass
   □ Timer analog
   □ Pirani sensor
   □ Spare parts
   □ Pressure regulator
   □ Process gas bottle
   □ Gas bottle retainer
   □ Faraday box
   □ Monomere bottle
   □ Test ink set
   □ slowly venting
   □ slowly pumping down
   □ Quartz glass chamber
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1. Delivered components and description ..................................................
2. Connecting of the machine .................................................................
3. Safety warnings ..............................................................................
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6. EC declaration of conformity ............................................................
7. Warranty ..........................................................................................
8. Information according plasma processes ............................................
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1.1 Delivered Components and Description

1.1 Cabinet

1.1.1 CABINET TYPO ZEPTO SPECIAL
- Dimensions:
  - Width: approx. 269 mm
  - Depth: approx. 324 mm
  - Height: approx. 176 mm (463 mm incl. plug)

1.1.2 VACUUM CHAMBER TYPE ZEPTO SPECIAL
- Material: Borosilicate glass
- Dimensions:
  - Ø: approx. 105 mm
  - Length: approx. 200 mm
  - Volume: approx. 1.7 Litre

1.1.3 CABINET TYPE ZEPTO
- Dimensions:
  - Width: approx. 425 mm
  - Depth: approx. 450 mm (477 mm incl. plug)
  - Height: approx. 185 mm

1.1.4 VACUUM CHAMBER TYPE ZEPTO
- Material: Borosilicate glass
- Dimensions:
  - Ø: approx. 105 mm
  - Length: approx. 300 mm
  - Volume: approx. 2.6 Litre

1.1.5 CABINET TYPE ATTO
- Dimensions:
  - Width: approx. 425 mm
  - Depth: approx. 450 mm (477 mm incl. plug)
  - Height: approx. 275 mm

1.1.6 VACUUM CHAMBER TYPE ATTO
- Material: Borosilicate glass
- Dimensions:
  - Ø: approx. 211 mm
  - Length: approx. 300 mm
  - Volume: approx. 10.5 Litre
1.2 GAS SUPPLY

1.2 GAS SUPPLY ZEPTO SPECIAL
Gas channels with 1 needle valve:
Gas flow: Gas 1 ZEPTO SPECIAL: 100 sccm

1.3 GAS SUPPLY ZEPTO AND ATTO
- 2 Gas channels each with 1 needle valve:
  - Gas flow:
    - Gas 1 ZEPTO: 100 sccm
    - Gas 2 ZEPTO: 100 sccm
    - Gas 1 ATTO: 100 sccm
    - Gas 2 ATTO: 100 sccm

The handling of the needle valve is very easy. To control the gas flow and therefore the process pressure, the valve will be opened or closed. The direction (to open and close the valve) is easily to see.

Please note following things:
- The not used valve needs to be closed with a blind flange, otherwise gas will still be fed into the chamber.
- The gas flow ball, in the glass gauge tube of the valve, sometimes gets caught at the upper end of the scale. That happens when the valve has been opened too much. To release the ball in the flow indicator, tap lightly on the glass surrounding the gauge tube.
- Liquids may damage the needle valve. (Agglutinating of the valve)
- Some aggressive solutions and gases (like HNO3, HCl, NH₄) may destroy the sealing of the needle valve.
- The machine is not qualified for usage of aggressive gases and chemicals!
1.3 Connections

1.3.1 CONNECTIONS FOR CABINET TYPE ZEPTO SPECIAL
- Gas: Schott quick connector 4/6 mm
- Voltage / Power: 230 V / 6.3 A
- Exhaust air: plastic tube, inner diameter approx. 10 mm

1.3.2 CONNECTIONS FOR CABINET TYPE ZEPTO
- Gas: Schott quick connector 4/6 mm
- Voltage / Power: 230 V / 6.3 A
- Exhaust air: plastic tube, inner diameter approx. 10 mm
1.3 Connections

1.3.3 CONNECTIONS FOR CABINET TYPE ATTO

- Gas: Schott quick connector 4/6 mm
- Voltage / Power: 230 V / 6.3 A
- Exhaust air: plastic tube, inner diameter approx. 10 mm
1.4 Control

At all machines, without reference to the type of control, there are 5 process steps:

1. Pumping down:  Recipient is evacuating to lower pumping down pressure
2. Gas stabilization time:  Gas is feeding in and pressure stabilize automatic
3. Process time:  HF-Generator is turned on
4. Flushing time:  Pump is running while purge gas (f.e. Air) rushes into the chamber. The chamber is flushed from eventually harmful process gases.
5. Venting time:  Chamber is filling with Air. The pump has to be off.

For more information see chapter 10 'Information According Plasma Processes' and the brochure 'Plasma Technology'
1.4 Control

1.7.1 CONTROL TYPE: SEMI-AUTOMATIC

- The control of the process requires some manual intervention
- Pump, gas flow, plasma process and venting have to be started manually
- Selectable parameters: process time, power, kind of gas, gas flow

The single process steps are selected manual by user:

1. turn on pump
2. turn on process gas (open needle valve)
3. set time
4. set power
5. start generator
6. vent

ZEPTO SPECIAL
1.4 Control

ZEPTO

- Power regulation
- HF-generator
- Main power switch
- Pressure display
- Timer
- Venting
- Needle valves
- Pump

ATTO

- Power regulation
- HF-generator
- Pressure display
- Main power switch
- Timer
- Pump
- Power switch
- HF-generator
- Venting
- Needle valves
1.4 Control

Timer settings – Zepto and Atto

On the timer board (see photo) are three jumper positions selectable:

- Final value 10000 seconds
- Final value 1000 seconds* (*State of Delivery)
- Final value 100 seconds

Accordingly of this preselected range is a variation by means of the front-sided mounted potentiometer possibly. Nevertheless, the set value must be checked because the scale of the potentiometer will not correlate with the time target.

Choose the time range accordingly the process:

<table>
<thead>
<tr>
<th>Example:</th>
<th>Process duration: 5 minutes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre chosen time range: 1000 seconds</td>
</tr>
</tbody>
</table>

At the potentiometer on the front of the machine the time can be varied between 1 second and 16.67 minutes via the scale division parts 0 – 100.

Set value potentiometer: 30

For more information see chapter 9 ‘Information According Plasma Processes’ and the brochure ‘Plasma Technology’.

- Connect 230 V (16 A)
- Turn on main power switch
- Turn off venting valve
- Load machine
- Take the door and push it against the chamber opening (while pump is on)

This type of control is very comfortable to handle by operating with just one switch. The single process steps are shown via analog measurement instruments.
Timer setting – Zepto Special

The timer can be adjusted with a screwdriver at the bottom of the plant.

The direction of adjustment is indicated.
# 1.5 Generator

<table>
<thead>
<tr>
<th>SELECTION OF GENERATORS</th>
<th>1.5.1 TYPE A</th>
<th>1.5.1 TYPE A</th>
<th>1.5.2 TYPE B</th>
<th>1.5.3 TYPE C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency</td>
<td>80 kHz</td>
<td>40 kHz</td>
<td>40 kHz</td>
<td>13.56 MHz</td>
</tr>
<tr>
<td>Power</td>
<td>0 - 30 W</td>
<td>0 - 100 W</td>
<td>0 - 200 W</td>
<td>0 - 50 W</td>
</tr>
<tr>
<td>Available for machine type</td>
<td>only Zepto special</td>
<td>only Zepto</td>
<td>only Atto</td>
<td>Zepto + Atto</td>
</tr>
<tr>
<td>Puls function</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Impedanz matching</td>
<td>-</td>
<td>automatic</td>
<td>automatic</td>
<td>fixed</td>
</tr>
<tr>
<td>Display of forward power</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Display of reflected power</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Quartz stabilized frequency (+/- 0.05 %)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>✓</td>
</tr>
<tr>
<td>PC Interface</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Main areas of application</td>
<td>activation, cleaning, etching, semi conductor (back-end) Plasma-polymerisation</td>
<td>activation, cleaning, etching, semi conductor (back-end) Plasma-polymerisation</td>
<td>activation, cleaning, etching, semi conductor (back-end) Plasma-polymerisation</td>
<td>activation, cleaning, etching, semi conductor (back-end) Plasma-polymerisation</td>
</tr>
</tbody>
</table>
Vacuum pumps are necessary to produce a vacuum in the plasma machine's recipient.

<table>
<thead>
<tr>
<th>SELECTION OF VACUUM PUMPS</th>
<th>1.6.1 TYPE A</th>
<th>1.6.2 TYPE B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description</td>
<td>DUO 1,3</td>
<td>DUO 3</td>
</tr>
<tr>
<td>Description</td>
<td>rotary slide pump</td>
<td>rotary slide pump</td>
</tr>
<tr>
<td>Exhaust filter</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Manufacturer</td>
<td>Pfeiffer</td>
<td>Pfeiffer</td>
</tr>
<tr>
<td>Suction power (m³/hour)</td>
<td>1.3 m³ / h</td>
<td>3.0 m³ / h</td>
</tr>
<tr>
<td>Oil type</td>
<td>mineral oil</td>
<td>mineral oil</td>
</tr>
<tr>
<td>Can work with oxygen, argon and all other usual process gases</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>

* The working life of the pump is limited at using of CF₄ / O₂ or SF₆.

By the factory made installation (by Diener electronic) of a purge gas valve, a safe working method is guaranteed. The rotary slide pump compress the gas, therefore a oil mist can arise and in worst case it may happen, that a explosive mixture of oil mist and oxygen gas arises. To avoid this risk the purge gas valve will be installed. The venting prevents the arising of the critical concentration of O₂ (<30%).

For better understanding see figure below.

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Purge gas valve for pump
1.6 Vacuum pump

Figure: Function of pump with purge gas valve:

- Pressure side
- Suction side
- O₂ + N₂
- O₂
- O₂-Amount < 30 %
- Vacuum pump oil

Purge gas valve
N₂ or air
1.6 Vacuum pump

Connect vacuum pump with chamber. Place pump below the machine (on the floor) to avoid that in case of malfunction pump oil flows back to the chamber.

Connect exhaust pipe. Exhausts have to be directed to fresh air or a professional exhaust system.

- Connect pump power supply line at plug 'Pump' at the back of the machine.
- Connect process gases (Pre - pressure at gas bottle approx. 0,5-1,0 bar)
1.6 Vacuum pump

Pump – Connections

Example:

- On-/Off switch
- Exhaust pipe
- Exhaust filter
- Connection vacuum tube
- Power supply pump
- Power supply machine
- Connection power supply pump
1.7 Options

1.7.1 Spare Part Set – Standard
- 1 clamping ring + 1 seal
- 1 glass window
- 1 door seal
- 10 pcs. fuses for plasma machine
- 1 litre mineral oil for vacuum pump

1.7.2 Carrier made of metal
   Material: aluminium
   - Dimensions for Zepto special: 160 mm x 85 mm x 3 mm
   - Dimensions for Zepto: 260 mm x 85 mm x 3 mm
   - Dimensions for Atto: 260 mm x 200 mm x 3 mm

1.7.3 Carrier made of glass
   Material: borosilicate glass
   - Dimensions for Zepto special: 160 mm x 85 mm x 5 mm
   - Dimensions for Zepto: 260 mm x 85 mm x 5 mm
   - Dimensions for Atto: 260 mm x 200 mm x 5 mm
1.7 Options

1.7.4 Timer
- Analog timer without display only Zeplo and Atto

Timer settings:

On the timer board (see photo) are three jumper positions selectable:

| Final value | 10000 seconds |
| Final value | 1000 seconds* |
| Final value | 100 seconds   |

Accordingly of this preselected range is a variation by means of the front-sided mounted potentiometer possibly. Nevertheless, the set value must be checked because the scale of the potentiometer will not correlate with the time target.

* State of delivery
1.7 Options

1.7.5 Monomer Bottle
- Accessory for polymerizations
- To connect liquid monomers with the vacuum chamber
- Connection is only possible with needle valve!

Figure: Connection monomer bottle

1.7.6 Vacuum pump

1.7.6.1 No Name Vacuum Pump
- Suction Power 1.5 m³ / h

1.7.6.2 Pfeiffer Vacuum Pump
- Type: DUO 3.0
- Suction Power: 3.0 m³ / h
- Manufacturer: Pfeiffer

1.7.7 Pressure Regulators
- For connection to the gas bottle - 200 bar
- Available / pressure: 200 bar
- Different gases require different pressure regulators
- Pressure regulators for noble gases, H₂, O₂, N₂, CF₄, CF₃F₈

<table>
<thead>
<tr>
<th>connector no.</th>
<th>permitted gases</th>
<th>thread</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>methane, silane, hydrogen</td>
<td>W 21,80 x 1/14&quot; LH</td>
</tr>
<tr>
<td>3</td>
<td>acetylene</td>
<td>connection for clamp</td>
</tr>
<tr>
<td>5</td>
<td>carbon monoxide</td>
<td>1&quot; LH</td>
</tr>
<tr>
<td>6</td>
<td>ammonia, argon, helium, hexafluoroethane, carbon dioxide, sulfur hexafluoride, tetrafluoromethane</td>
<td>W 21,80 x 1/14&quot;</td>
</tr>
<tr>
<td>8</td>
<td>hydrogen chloride, nitrogen dioxide</td>
<td>1&quot;</td>
</tr>
<tr>
<td>9</td>
<td>oxygen</td>
<td>G 3/4&quot;</td>
</tr>
<tr>
<td>10</td>
<td>nitrogen</td>
<td>W 24,32 x 1/14&quot;</td>
</tr>
</tbody>
</table>
1.7 Options

1.7.8 Process Gas Bottle

- **Oxygen** – gas bottle as process gas
- **Hydrogen** – gas bottle as process gas
- **Argon** – gas bottle as process gas

**Purity of Gases:**

In general gases with technical purity are used. Do you want to treat parts with a very high demand on the surface purity so choose a gas with high purity.

This is relevant special for semiconductor front end processes or analytic applications (SEM, …).

*For more information to the gases see chapter 10 Information According Plasma Processes.*

1.7.9 Gas Bottle Retainer

- To mount on desk, wall or shelf
- Span width 70 mm
- Lashing strap retains bottle without any scope
- Suitable for all bottle sizes

1.7.10 Pressure Gauge

- Pirani Sensor

1. The pirani sensor measures the pressure in the vacuum chamber at a process pressure below 10 mbar.

   The pirani sensor itself is made of a thin metal wire.

   This wire has a resistor of approx. 2.5 Ω at atmospheric pressure.

   The resistor rises with lower pressure, when the wire is heating up by current flow (approx. 0.1 A).
2. Test of Pirani-Sensor – not for Zepto special

To test the sensor, the resistor should be tested with an ohmmeter. Before the testing, the plug for the pirani sensor has to be disconnected.

The resistance has to be between 2.2 and 2.6 Ω.
3. Calibration of Printed Circuit Board (PCB):

3.1. The PCB has to linger with all connections in the machine.
3.2. Ventilate the vacuum chamber.
3.3. Apply voltmeter to M1 and GND.
3.4. Adjust 9.9 V with the potentiometer P3.
3.5. Check the adjusted value: PC-controlled machine: 9.99 mbar
    other machines: 10 mbar
3.6. Now evacuate vacuum chamber.
3.7. The relay will turn on / off the gas supply and the generator.
3.8. Lower switchpoint: The LED shines green at a pressure below 0.4 mbar (adjust with P1).
    In special cases, the pressure can be raised up to max. 1 mbar.
    Normally the machine has to be pumped down to a pressure of approx. 0.3 mbar.
    In special cases (heavy outgasing parts) up to approx. 1 mbar.
3.9. Upper switchpoint: The LED turns off at a pressure over 4.0 mbar (adjust with P2).
    For safety reasons the gas supply has to be closed at a process pressure over 4 mbar, for the same reason the generator turns off.
3.10. The PCB is a window comparator, the machine works with a pressure between 0.4 and 4 mbar.
1.7 Options

1.7.11 Pirani - digital

1. Application Areas

Measuring pressures of vacuum systems

Technical Data:

- Measurable Pressure Range: $10^{-2}$ to 10 mbar
- Absolut tolerance of final scale: < 5%
- Analog outlet: 0 to 10 Volt
- Power supply: 24 +/- 10% V DC
- Power consumption max.: 150mA
- Mass (sensor head): 180g
- Sensor size: D: 60 mm, L: 63 mm
- Flange connection: KF 16
- PCB-dimensions: 100 mm x 76 mm

Switching output for process release (min./max. pressure) loadable up to 24V AC/8A
Threshold values adjustable with internal adjustment regulator possible via software

Interface: RS485 for embedded mode available in process control.

Due to the electro-mechanical design of the sensor head (0.1 mm wire made from a stainless steel alloy) very robust against chemical influence.

Can be supplied with a calibration certificate.
2. Pirani – Inspection and Calibration

Calibration

The Pirani sensor head can only be calibrated at the factory.

There the relevant precise measuring devices are used, which take up the characteristic lines of the sensor and calibrate accordingly.

Checking the Sensor Head

For checking, a reference sensor of the same make is used with the relevant controller board.

Both are operated parallel to the sensor to be measured and can easily be attached to the system.

For this reason there exists a further flange, measuring value inlet and bus connection at the system.

A sub-programme can be called up in the control computer of the system that permits the simple comparison of both measuring values at different pressures.

In case of deviations being too large, the programme reports a fault and the sensor must be exchanged.
3. Characteristic output curve Pirani digital

<table>
<thead>
<tr>
<th>Pressure [mbar]</th>
<th>Initial Voltage [V]</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.01</td>
<td>0.00</td>
</tr>
<tr>
<td>0.10</td>
<td>1.00</td>
</tr>
<tr>
<td>0.20</td>
<td>2.00</td>
</tr>
<tr>
<td>0.25</td>
<td>2.50</td>
</tr>
<tr>
<td>0.45</td>
<td>3.50</td>
</tr>
<tr>
<td>0.65</td>
<td>4.50</td>
</tr>
<tr>
<td>0.85</td>
<td>5.50</td>
</tr>
<tr>
<td>1.00</td>
<td>6.00</td>
</tr>
<tr>
<td>2.00</td>
<td>8.00</td>
</tr>
<tr>
<td>4.00</td>
<td>9.00</td>
</tr>
<tr>
<td>10.00</td>
<td>10.00</td>
</tr>
</tbody>
</table>
1.7 Options

1.7.12 Faraday Box / Cage
- For electric sensitive parts
- The parts will be placed at the inside of the box.
- The Faraday Box can be moved out of the vacuum chamber.

1.7.13 Test Ink Set
- Test inks for an easy analysis of the surface energy.
- Included sizes in ink set: 28, 38, 56, 64, 72 and 105 mN/m
- Other values are available on request.

For more information see brochure 'Plasma Technology'.

1.7.14 Slow ventilation of the vacuum chamber
- The vacuum chamber will be vented slower by installing a filter.
- The gyrate of small parts will be prevented.

1.7.15 Slow pump down of the vacuum chamber
- The chamber will be slowly pumped down by bypass valve.
- The gyrate of small parts will be prevented.

1.7.16 Documentation in national language
- Documentation according to the machine rules 89/392/EWG
- does not apply for german and english language
- this option have to be ordered, otherwise a documentation isn't attached
2. Connecting the machine

1. Place machine on table or on the place you supposed for it.

2. Place pump on the floor.

3. Remove protective caps from pump and machine.

4. Place seals between vacuum tube and junctions (1x machine, 1x vacuum exit of pump), before mounting the clamp to fix the tube with the junctions.

5. Connect exhaust tube with pump. Normally a picture sticks on the pump by the manufacturer, which clearly shows the in- and output of the suction power.

6. Connect power supply of pump with machine. (The connections are obvious marked on the back of the machine.) Turn on main power switch of pump. See pictures below:

7. Connect power supply of machine with mains.

8. Connect gas tube with machine and gas bottle.

order for connection of gas gas connection on machine

9. Adjust max. a pre-pressure of 0,5-1,0 bar at the gas bottle!
10. Find more information to the controls in chapter 1.4 Controls.

**Note:** The following steps have to be processed in correct order, otherwise the chamber may be damaged!

Diener electronic GmbH does not grant warranty for defects caused by wrong usage!

a) Load chamber.

b) Press door against chamber opening.

c) Turn on pump ('Pump' button). Keep door pressed against chamber wall until it will be primed.

d) Adjust time. More information in chapter 1.4 Control.

e) Turn on gas supply by opening the needle valve. (The not used needle valve/gas channel need to be closed with a blind flange during the process.)

f) Adjust desired gas flow or pressure by opening/closing the needle valve.

g) Adjust the desired generator power. The upper row of numbers on the potentiometer shows the tenth, the lower row the unit place. See figures below:

![Power knob images]

- 100% power
- 65% power

h) Start generator (The generator turns off automatic after cycle of time.)

i) Turn off pump, by pushing of 'Pump' button.

j) Vent chamber ("Vent")

k) When chamber is ventilated, the door let's easily open/remove.
3. Safety Guidelines

Voltage
- The altitude of generators idle may has until approx. 2000 V! Handle with care!
- The machine has to be connected with a power supply system, which voltage is conformable with specification on type label.
- Diener electronic GmbH & Co. KG does not grants liability for defects caused by incorrect usage (e.g. short circuit caused by unsuitable power supplies)!

Vacuum
- Caution! Hands off from openings of the vacuum chamber, valves and the connections of the pump during the running process.

Damp Rooms
- The plasma machine is not moisture proof. The machine must not be used in damp rooms.

Short Circuit
- The electrode must not be circuited. Conductive parts must not touch the electrode.

Thermic Endanger
- The electrode may become hot during operation. Take care while loading the machine, to not touch the electrode (to avoid burn).

Process Gas
- Check for leaks in the pipes before any start.
- It is forbidden to produce explosive gas mixtures in the chamber.
- The machine must not be operated with flammable gases.
- Please note the appropriate rules (TRG) of each process gas.
3. Safety Guidelines

Exhausts

- Exhausts have to be piped into fresh air/ outside.
- Outlet of exhaust pipe must not be closed, to not destroy pump.

Aggressive Liquids

- Needle valves may be destroyed by aggressive liquids (formic acid).

<table>
<thead>
<tr>
<th>Design</th>
<th>Unprohibited gases</th>
<th>Formula</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard</td>
<td>argon, helium, hexamethyldisiloxane, carbon monoxide, carbon dioxide, air, oxygen, nitrogen, nitrogen dioxide, nitrogen oxide, hydrogen,</td>
<td>Ar, He, HMDSO, CO, CO₂, O₂, N, NO₂, NO, H₂</td>
</tr>
</tbody>
</table>

Following materials must never be connected with our machines: Bromine, chlorine, iodine, borrichlorine, tetrachloromethane and all other chlorine containing and high corrosive materials.

Diener electronic GmbH & Co. KG will not grant liability for damages on the machine which are caused by using those materials (corrosive gases on standard machines and oil pumps)!

The machine is NOT suitable for aggressive gases and liquids!
3. Safety Guidelines

Power Plug

- Do not pull out power plug on wire.
- In case that the power plug of the plasma system is damaged it has to be replaced, to avoid endanger.
- Before open the cabinet, pull power plug.

Animals

- Animals must not be encased in the plasma system.

Contaminations

- Try to avoid contaminations like dust, dirt, glass- and metal splinters before and during the operation. Those can damage the machine permanent and change the effect of the plasma treatment as well.

Pacemakers

- No persons with pacemakers
In rare cases electromagnetic fields that emanate from these devices can cause temporary interference with the pacemaker. Signs of danger may include: dizziness, palpitations or an irregular pulse. For more information on Electromagnetic Fields see BGV B11 "Electromagnetic Fields" - www.bgn.de/9418
3. Safety Guidelines

Maintenance and Repair

- The maintenance has to be done all 6 months by Diener electronic GmbH + Co. KG.

- Only mineral oil from Diener electronic must be refilled into the pump. We don’t use fluorine containing oil. Therefore the pumps can be used for oxygen processes.

- Do not perform unlicensed changes on the machine.

- Repairs on this machine are only permitted by experts of Diener electronic GmbH + Co. KG. Otherwise the liability expires.

Further Manuals

- Please follow all information in the supplied manuals!
4. Maintenance

4.1 Pump
- Check oil level daily.
- Please follow manual of pump manufacturer.
- For oil change interval see manual. The oil change has to occur every 3 months.

4.2 Cleaning
- For the cleaning of the outside of the plasma system use only a light wet cloth. For the cleaning of the chamber see chapter 1.4 Vacuum Chamber. Never use solvents for the cleaning!
- Stainless steel recipients are easier to clean with chrome polisher. Therefore remove / uninstall electrode previously.

4.3 Seals
- The door seal should be wiped off every day and semi-annual changed.
## 5. Troubleshooting

<table>
<thead>
<tr>
<th>Fault</th>
<th>Possible cause</th>
<th>Remedy</th>
</tr>
</thead>
<tbody>
<tr>
<td>plasma system running, plasma not burning</td>
<td>gas line is not opened</td>
<td>open gas line</td>
</tr>
<tr>
<td></td>
<td>needle valve is closed</td>
<td>open needle valve</td>
</tr>
<tr>
<td></td>
<td>short circuit, caused by conductive parts touching the electrode</td>
<td>place conductive parts in that way, that they don't touch the electrode</td>
</tr>
<tr>
<td>door can not be opened</td>
<td>pump is still running</td>
<td>turn off pump</td>
</tr>
<tr>
<td>protections trips / fuse blows</td>
<td>pump is still cold (room temperature &lt; 20°C)</td>
<td>regard on a room temperature higher than 20°C</td>
</tr>
<tr>
<td>pump not running</td>
<td>power switch on pump is off</td>
<td>turn on power switch</td>
</tr>
<tr>
<td></td>
<td>power plug of pump is off</td>
<td>check power plug and plug in</td>
</tr>
<tr>
<td>plasma turns off</td>
<td>needle valve is closed, no gas flow comes into the recipient, therefore generator is not able to support power</td>
<td>open needle valve and adjust gas flow</td>
</tr>
<tr>
<td>machine doesn't start the generator</td>
<td>needle valve is opened too much</td>
<td>close needle valve and decrease gas flow</td>
</tr>
</tbody>
</table>

Otherwise: Contact our service technicians!
6. EC-Declaration of Conformity

We hereby declare that our plasma systems in the

Production series:

Atto – Serial number: 114292

in the versions that we placed on the market, meet the following fundamental safety
requirements. This declaration loses its validity where a modification is made without our
agreement.

Applicable EU Directives:
- EU Machinery Directive (2006/42/EC)
- EU Low Voltage Directive (2006/95/EC)

Applied, harmonized standards:
- DIN EN ISO 12 100:2010
- DIN EN 62 311:2008-09
- DIN EN 60 204-1:2011-01
- DIN EN 61 000-4-2:2009-12
- DIN EN 61 000-4-4:2012

Applied national standard:
- VDE 0848

Ebhausen, dated 2014-06-24

Diener electronic GmbH + Co. KG
Christof Diener
Managing Director
7. Warranty

The warranty is for 1 year commencing on the date of the invoice.

If you have any problems with your plasma system, we'll be very pleased to help. Please call us on:
Tel: 00 49 74 58 999 31 - 0
From USA: 011 49 74 58 999 31 - 0

During the warranty period:
The faulty plasma system can be sent back to us. You will receive a new or repaired device in return.

After the warranty period runs out:
You can also send the faulty device to the address below for repair. A charge will then be made for the repair.

The warranty is invalidated if the device is misused or handled incorrectly, if excessive force is applied, or in the case of intervention by anyone other than ourselves.

For repair purposes, please pack the plasma system carefully and send it to:

Diener electronic GmbH + Co. KG
Nagolder Str. 61
D-72224 Ebhausen
Germany

Tel.: 00 49 74 58 / 999 31 0
From USA: Tel.: 011 49 74 58 / 999 31 0
Fax: 00 49 74 58 999 31 50
E-mail: info@plasma.de
www.plasma.de
8. Information According Plasma Processes

Directory Plasma Process:

8.1 Parameters .........................................................................................................................
8.2 Materials ..............................................................................................................................
8.3 Spread of plasma ...................................................................................................................
8.4 Pressure of gas bottle ..........................................................................................................  
8.5 Selection of gases ................................................................................................................
  8.5.1 Purity of gases ................................................................................................................
  8.5.2 Selection of pressure regulator .......................................................................................  
8.6 Gas piping ............................................................................................................................
8.7 Gas bottle safety guidelines .................................................................................................
8.8 Gas consumption ................................................................................................................ 
8.9 Gas correction factor (GKF) ............................................................................................... 
8.10 Process parameters in general ...........................................................................................
  8.10.1 Cleaning ........................................................................................................................
    8.10.1.1 Cleaning of metals ....................................................................................................
    8.10.1.2 Cleaning of plastics .................................................................................................
    8.10.1.3 Cleaning of glasses and ceramics .........................................................................
  8.10.2 Activation ......................................................................................................................
    8.10.2.1 Activation of metals ..............................................................................................
    8.10.2.2 Activation of plastics ............................................................................................
    8.10.2.3 Activation of glasses and ceramics ....................................................................
    8.10.2.4 Activation of powders ..........................................................................................
8. Information According Plasma Processes

In the following chapter you will find some information, which shall help you to find the right process parameters.

8.1 Parameters:
These parameters are not exact specifications, which refer to our standard systems. For the parameters it doesn't matter what kind of generator is installed.

8.2 Materials:
Regard the product attributes concerning sensitivity to heat, UV or single process gases, by choosing the process parameters.

8.3 Spread of Plasma:
For an optimal plasma treatment, the plasma has to be spread equable into the chamber (see pictures).

![Air plasma (kHz - generator)](image)
![Oxygen plasma (kHz-generator)](image)

8.4 Pressure of gas bottle:
Please check the pressure of the gas bottle before starting the process (Is there enough gas in the bottle?) and check the adjusted pre-pressure on pressure regulator (pre – pressure not higher than 0.5 -1.0 bar, because MFC may be damaged).

[Diagram of gas regulator with labeled parts: Display pre-pressure, Valve (Connection bottle to chamber), Display (pressure of bottle), Connection for tube, Connection to bottle, Regulation pre - pressure]
8. Information According Plasma Processes

8.5 Selection of gases
To select the right gases for the different plasma processes, look for information in the chapters cleaning, activation, etching and coating according to your application.

8.5.1 Purity of gases:
Most commonly used are gases with technical purity, if you want to treat parts with very high requirements to the surface purity, choose a gas with ultra high purity.

This applies special to semi-conductor-front-end – processes or for analysis applications (SEM,...)

8.5.2 Selection of pressure regulator
There are some standard pressure regulators for oxygen, flammable gases (e.g. hydrogen) and noble gases (e.g. argon), also there exist some special pressure regulators for special gases. To select the right pressure regulator, see table below.

Standard Pressure Regulator:

- O₂ – pressure regulator
- Ar – pressure regulator
- H₂ – pressure regulator

Special Pressure Regulator:

- CO – pressure regulator
- NH₃ – pressure regulator
Find following table as an overview to select the right pressure regulator for your gas bottle. For special gases ask your local gas supplier.

**Gas connections according to DIN 477**

<table>
<thead>
<tr>
<th>Connection-no.</th>
<th>Allowed gases</th>
<th>Threads</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>methane, silane, hydrogen</td>
<td>W 21,80 x 1/14&quot; LH</td>
</tr>
<tr>
<td>3</td>
<td>acetylene</td>
<td>Anschluss für Spannbügel</td>
</tr>
<tr>
<td>5</td>
<td>carbon monoxide</td>
<td>1&quot; LH</td>
</tr>
<tr>
<td>6</td>
<td>ammonia, argon, helium, hexafluoroethane, carbon dioxide, sulfurhexafluoride, tetrafluormethane</td>
<td>W 21,80 x 1/14&quot;</td>
</tr>
<tr>
<td>8</td>
<td>nitrogen dioxide</td>
<td>1&quot;</td>
</tr>
<tr>
<td>9</td>
<td>oxygen</td>
<td>G 3/4&quot;</td>
</tr>
<tr>
<td>10</td>
<td>nitrogen</td>
<td>W 24,32 x 1/14&quot;</td>
</tr>
</tbody>
</table>
8.6 Gas piping

Our machines are equipped with swageoks of the size 6 mm, therefore you need stainless steel tubes with an inner diameter of 4 mm and an outer diameter of 6 mm to observe the regulation TRGS (no. 220) for gas piping.

To open and close the piping you will need an open-end-wrench with a size of 14 mm. For laboratory operation with incombustible and non-toxic gases you can use pressure resistant flexible tubes (PU-hose with Ø outside: 6 mm, Ø inside: 4 mm) instead of stainless steel tubes.

Quite safely gases are: N₂, O₂, noble gases, CF₄.

Etching gases like NF₃ and NH₃ have to be piped with stainless steel.

At use of special gases contact your local gas supplier.


8.7 Gas bottle safety guideline

To ensure a riskless operation with gas bottles note following things:

- Store gas bottles in suitable containers at the outside of the building (if possible).
- In case that it is not possible to store the containers outside (by structural engineering of the building), the gas bottle has to be protected from impacts and falling down. Therefore special equipment is available, like bottle retainers with chains.
- Check fitting for leaks by connecting the fitting with the bottle. At obscurities check the fitting audible (is there a hissing to hear?) and visual (drop some water on fitting and look for bubbles).
- The connection for the tube towards the fitting must never be mounted with tools! This will squeeze the flexible tube too much and may damage it.
- By using PU-tubes as gas piping, you have to operate with the right equipment (bracing sleeve, clamping ring, screw cap). Brass connectors must ever be mixed with stainless steel connectors!

![Image of gas bottle safety components]

- Concerning the safety guidelines for special gases, please contact your local gas supplier or read the particular safety data sheet (chapter 'safety data sheets').
- An amount of 4 % hydrogen in the air is already explosive. To calculate the explosion hazard for your workstation use following formula:

  e.g.:

  Volume of hydrogen bottle: 2 litres
  Pressure of bottle (full): 200 bar

  Dimension of room: 50 m²,
  Height of room: 3 m
  Volume of room: 150 m³

  Gas escapes / leak: 2l (200bar) → 400l (1bar)
  400l → 0.4 m³/150 m³ = 0.0026 % hydrogen in atmosphere of a 50m² big and 3 m high room.
8. Information According Plasma Processes

8.8 Gas consumption

The enclosed table should create an overview on the gas consumption:
The values are in relation to the max. flow per MFC. That means: at a MFC with 50 sccm we
originated from a gas flow of 50 sccm/min. per process.
To calculate your individual gas consumption, you find the formula below the table.

<table>
<thead>
<tr>
<th>Type of machine</th>
<th>size of bottle [litres]</th>
<th>bottle pressure [bar]</th>
<th>size of MFC [sccm]</th>
<th>bottle empty in ... hours</th>
<th>average consumption [sccm]</th>
<th>bottle empty in ... hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Femto</td>
<td>2</td>
<td>200</td>
<td>20</td>
<td>333</td>
<td>10</td>
<td>667</td>
</tr>
<tr>
<td>Pico</td>
<td>2</td>
<td>200</td>
<td>50</td>
<td>133</td>
<td>30</td>
<td>222</td>
</tr>
<tr>
<td>Nano</td>
<td>2</td>
<td>200</td>
<td>100</td>
<td>67</td>
<td>40</td>
<td>187</td>
</tr>
<tr>
<td>Nano</td>
<td>15</td>
<td>200</td>
<td>90</td>
<td>556</td>
<td>20</td>
<td>2,500</td>
</tr>
<tr>
<td>Tetra 100</td>
<td>15</td>
<td>200</td>
<td>100</td>
<td>500</td>
<td>20</td>
<td>1,000</td>
</tr>
<tr>
<td>Tetra 100</td>
<td>15</td>
<td>200</td>
<td>200</td>
<td>250</td>
<td>100</td>
<td>500</td>
</tr>
</tbody>
</table>

The individual gas consumption strongly depends on the suction power of your pump.

Formula:

1. Volume of bottle (litre) x volume (in bar) = volume (litre) at 1 bar

2. \[
\frac{\text{volume at 1 bar \times 1000}}{\text{Gas flow in cm}^3} = t \ [\text{minutes}]
\]

3. \[
\frac{t \ [\text{minutes}]}{60} = t \ [\text{hours}]
\]

Calculation example Femto (first line of table)

1. \[
2 \ l \times 200 \text{ bar} = 400 \ l \ (at \ 1 \text{ bar})
\]

2. \[
\frac{400 \ l \times 1000}{20 \ cm^3} = 20,000 \text{ minutes}
\]

3. \[
\frac{20,000 \text{ Min.}}{60} = 333 \text{ hours}
\]
8. Information According Plasma Processes

8.9 Gas correction factor (GKF)
The gas correction factor (GKF) has to be typed in at computer controlled machines. This setting can be changed in the software ‘PRS’ in the table ‘settings’.

Changing the gas correction factor:

1. First you have to login (password: PRS)

2. Select table ‘settings’.

3. Type in the name of the gas in data item ‘gas correction factor’ (overwrite therefore the data item ‘freil’)

4. Change gas correction factor as shown in table below.

<table>
<thead>
<tr>
<th>Gas</th>
<th>Symbol</th>
<th>GKF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air</td>
<td>---</td>
<td>1.00</td>
</tr>
<tr>
<td>Ammonia</td>
<td>NH₃</td>
<td>0.73</td>
</tr>
<tr>
<td>Argon</td>
<td>Ar</td>
<td>1.39</td>
</tr>
<tr>
<td>Chlorine</td>
<td>Cl₂</td>
<td>0.86</td>
</tr>
<tr>
<td>Carbon dioxide</td>
<td>CO₂</td>
<td>0.70</td>
</tr>
<tr>
<td>Carbon monoxide</td>
<td>CO</td>
<td>1.00</td>
</tr>
<tr>
<td>Ethane</td>
<td>C₂H₆</td>
<td>0.50</td>
</tr>
<tr>
<td>Freon 14</td>
<td>CF₄</td>
<td>0.42</td>
</tr>
<tr>
<td>Freon C318</td>
<td>C₄F₈</td>
<td>0.17</td>
</tr>
<tr>
<td>Helium</td>
<td>He</td>
<td>1.45</td>
</tr>
<tr>
<td>Hydrogen</td>
<td>H₂</td>
<td>0.89</td>
</tr>
<tr>
<td>Nitrogen</td>
<td>N₂</td>
<td>1.00</td>
</tr>
<tr>
<td>Nitrogen dioxide</td>
<td>NO₂</td>
<td>0.74</td>
</tr>
<tr>
<td>Nitrogen monoxide</td>
<td>NO</td>
<td>0.99</td>
</tr>
<tr>
<td>Methane</td>
<td>CH₄</td>
<td>0.72</td>
</tr>
<tr>
<td>Oxygen</td>
<td>O₂</td>
<td>1.00</td>
</tr>
<tr>
<td>Propane</td>
<td>C₃H₈</td>
<td>0.36</td>
</tr>
<tr>
<td>Silane</td>
<td>SiH₄</td>
<td>0.60</td>
</tr>
<tr>
<td>Sulfur hexafluorine</td>
<td>SF₆</td>
<td>0.26</td>
</tr>
</tbody>
</table>

5. Don’t forget to save the changing!

In case that your gas is not listed here, contact the company MKS, our supplier of MFC’s.
8. Information According Plasma Processes

8.10 Process parameters in general:
Following parameters can be adjusted:

- Process duration
- Gas
- Pressure (process pressure)
- Power (is shown in %)
- (Temperature, only if chamber heating is installed)
Detailed process parameters

8.10.1 Cleaning

<table>
<thead>
<tr>
<th>Application</th>
<th>Group</th>
<th>Material</th>
<th>Gas</th>
<th>Pressure [mbar]</th>
<th>Power [%]</th>
<th>Time [min.]</th>
</tr>
</thead>
<tbody>
<tr>
<td>CLEANING</td>
<td>Metal</td>
<td>Aluminium</td>
<td>O₂</td>
<td>0,2-0,5</td>
<td>50-100</td>
<td>1-60</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Copper</td>
<td>H₂/Ar</td>
<td>0,3-0,8</td>
<td>50-100</td>
<td>1-60</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Gold</td>
<td>O₂/Ar</td>
<td>0,2-0,5</td>
<td>50-100</td>
<td>1-60</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Silver</td>
<td>H₂/Ar</td>
<td>0,3-0,8</td>
<td>50-100</td>
<td>1-60</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Stainless steel</td>
<td>O₂</td>
<td>0,2-0,5</td>
<td>50-100</td>
<td>1-60</td>
</tr>
<tr>
<td></td>
<td>Plastic</td>
<td>ABS</td>
<td>O₂</td>
<td>0,2-0,5</td>
<td>30-70</td>
<td>1-20</td>
</tr>
<tr>
<td></td>
<td></td>
<td>PA</td>
<td>O₂</td>
<td>0,2-0,5</td>
<td>70-100</td>
<td>1-30</td>
</tr>
<tr>
<td></td>
<td></td>
<td>PE</td>
<td>O₂</td>
<td>0,2-0,5</td>
<td>50-100</td>
<td>1-30</td>
</tr>
<tr>
<td></td>
<td></td>
<td>POM</td>
<td>O₂</td>
<td>0,2-0,5</td>
<td>100</td>
<td>10-40</td>
</tr>
<tr>
<td></td>
<td></td>
<td>PP</td>
<td>O₂</td>
<td>0,2-0,5</td>
<td>70-100</td>
<td>1-20</td>
</tr>
<tr>
<td></td>
<td></td>
<td>PTFE</td>
<td>H₂</td>
<td>0,3-0,5</td>
<td>100</td>
<td>20-60</td>
</tr>
<tr>
<td></td>
<td>Other</td>
<td>Al₂O₃</td>
<td>O₂</td>
<td>0,2-0,5</td>
<td>50-100</td>
<td>1-60</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SiO₂</td>
<td>O₂</td>
<td>0,2-0,5</td>
<td>50-100</td>
<td>1-60</td>
</tr>
</tbody>
</table>

8.10.1.1 Cleaning of metals

Removing of oils, fat and releasing agents:
Some parts are covered with oils, fat, releasing agents and other organic and inorganic (also oxides) pollutions.
With plasma it is only possible to remove some nm/s. Are the layers too thick, the pollutions may be hardened.
Fat contains e.g. lithium connections, from those only the organic compounds can be removed. The same applies to fingerprints.

<table>
<thead>
<tr>
<th>Group</th>
<th>Material</th>
<th>Gas</th>
<th>Pressure [mbar]</th>
<th>Power [%]</th>
<th>Time [min.]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Metal</td>
<td>Aluminium</td>
<td>O₂</td>
<td>0,2-0,5</td>
<td>50-100</td>
<td>1-60</td>
</tr>
<tr>
<td></td>
<td>Copper</td>
<td>H₂/Ar</td>
<td>0,3-0,8</td>
<td>50-100</td>
<td>1-60</td>
</tr>
<tr>
<td></td>
<td>Gold</td>
<td>O₂/Ar</td>
<td>0,2-0,5</td>
<td>50-100</td>
<td>1-60</td>
</tr>
<tr>
<td></td>
<td>Silver</td>
<td>H₂/Ar</td>
<td>0,3-0,8</td>
<td>50-100</td>
<td>1-60</td>
</tr>
<tr>
<td></td>
<td>Stainless steel</td>
<td>O₂</td>
<td>0,2-0,5</td>
<td>50-100</td>
<td>1-60</td>
</tr>
</tbody>
</table>

(The process parameters power and time have to be adapted according to the specification of the machine (type of generator, power of generator, type of electrode) and according to the properties of the product/sample.)
8. Information According Plasma Processes

There are two methods to measure the cleaning effect:

1. Measuring the surface energy with test inks (see also brochure ‘Plasma Technology’)
2. Perform a LABS – Test (german: Lack Benetzung斯 Stoerung; english: lacquer wetting fault)

LABS-Test performance:

Place the sample parts on a clean glass plate and flush the part with acetone. After evaporating of the acetone paint the glass plate with a silicone free lacquer. In case that the sample contains silicone, the painting will not bond on the surface (see pictures below).

![Images of ideal and silicon containing paint]

At the reduction of oxides the metal oxide reacts chemical with the process gas. As process gas pure hydrogen or a mixture with argon is used. The mode of action of plasma can be read in the brochure ‘Plasma Technology’.

General parameter (valid for all machines):

<table>
<thead>
<tr>
<th>Material</th>
<th>Gas</th>
<th>Pressure [mbar]</th>
<th>Power [%]</th>
<th>Time [min.]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Copper</td>
<td>H2/Ar</td>
<td>0.3-0.8</td>
<td>50-100</td>
<td>1-60</td>
</tr>
<tr>
<td>Silver</td>
<td>H2/Ar</td>
<td>0.3-0.8</td>
<td>50-100</td>
<td>1-60</td>
</tr>
</tbody>
</table>

(The process parameters power and time have to be adapted according to the specification of the machine (type of generator, power of generator, type of electrode) and according to the properties of the product/sample.)

8.10.1.2 Cleaning of plastic parts

At the cleaning of plastic parts there is always an activation of the surface at the same time included. As process gas oxygen with technical purity is used, sometimes air as process gas is enough. The plasma treatment can be repeated. The principle of the process is conform to the cleaning of metals.

<table>
<thead>
<tr>
<th>Group</th>
<th>Material</th>
<th>Gas</th>
<th>Pressure [mbar]</th>
<th>Power [%]</th>
<th>Time [min.]</th>
</tr>
</thead>
<tbody>
<tr>
<td>plastic</td>
<td>ABS</td>
<td>O2</td>
<td>0.2-0.5</td>
<td>30-70</td>
<td>1-20</td>
</tr>
<tr>
<td></td>
<td>PA</td>
<td>O2</td>
<td>0.2-0.5</td>
<td>70-100</td>
<td>1-30</td>
</tr>
<tr>
<td></td>
<td>PE</td>
<td>O2</td>
<td>0.2-0.5</td>
<td>50-100</td>
<td>1-30</td>
</tr>
<tr>
<td></td>
<td>POM</td>
<td>O2</td>
<td>0.2-0.5</td>
<td>100</td>
<td>10-40</td>
</tr>
<tr>
<td></td>
<td>PP</td>
<td>O2</td>
<td>0.2-0.5</td>
<td>70-100</td>
<td>1-20</td>
</tr>
<tr>
<td></td>
<td>PTFE</td>
<td>H2</td>
<td>0.3-0.5</td>
<td>100</td>
<td>20-60</td>
</tr>
</tbody>
</table>

(The process parameters power and time have to be adapted according to the specification of the machine (type of generator, power of generator, type of electrode) and according to the properties of the product/sample.)
8. Information According Plasma Processes

8.10.1.3 Cleaning of glass and ceramics

The cleaning of glasses and ceramics happens in the same way as the cleaning of metals. As process gas for the cleaning of glasses argon or oxygen is advisable.

<table>
<thead>
<tr>
<th>Group</th>
<th>Material</th>
<th>Gas</th>
<th>Pressure [mbar]</th>
<th>Power [%]</th>
<th>Time [min.]</th>
</tr>
</thead>
<tbody>
<tr>
<td>other</td>
<td>Al₂O₃</td>
<td>O₂</td>
<td>0,2-0,5</td>
<td>50-100</td>
<td>1-60</td>
</tr>
<tr>
<td></td>
<td>SiO₂</td>
<td>O₂</td>
<td>0,2-0,5</td>
<td>50-100</td>
<td>1-60</td>
</tr>
</tbody>
</table>

(The process parameters power and time have to be adapted according to the specification of the machine (type of generator, power of generator, type of electrode) and according to the properties of the product/sample.)

8.10.2 Activation

General Parameters

<table>
<thead>
<tr>
<th>Application</th>
<th>Group</th>
<th>Material</th>
<th>Gas</th>
<th>Pressure [mbar]</th>
<th>Power [%]</th>
<th>Time [min.]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Metal</td>
<td></td>
<td>Aluminium</td>
<td>O₂</td>
<td>0,2-0,5</td>
<td>50-100</td>
<td>1-10</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Copper</td>
<td>H₂</td>
<td>0,3-0,8</td>
<td>50-100</td>
<td>1-10</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Gold</td>
<td>O₂/Ar</td>
<td>0,2-0,5</td>
<td>50-100</td>
<td>1-10</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Silver</td>
<td>H₂</td>
<td>0,3-0,8</td>
<td>50-100</td>
<td>1-10</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Stainless st.</td>
<td>O₂</td>
<td>0,2-0,5</td>
<td>50-100</td>
<td>1-10</td>
</tr>
<tr>
<td>Plastic</td>
<td></td>
<td>ABS</td>
<td>O₂</td>
<td>0,2-0,5</td>
<td>30-70</td>
<td>1-20</td>
</tr>
<tr>
<td></td>
<td></td>
<td>PA</td>
<td>O₂</td>
<td>0,2-0,5</td>
<td>70-100</td>
<td>1-30</td>
</tr>
<tr>
<td></td>
<td></td>
<td>PE</td>
<td>O₂</td>
<td>0,2-0,5</td>
<td>50-100</td>
<td>1-20</td>
</tr>
<tr>
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<td></td>
<td>POM</td>
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<td>100</td>
<td>1-40</td>
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<tr>
<td></td>
<td></td>
<td>PP</td>
<td>O₂</td>
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<td>70-100</td>
<td>1-20</td>
</tr>
<tr>
<td></td>
<td></td>
<td>PTFE</td>
<td>H₂</td>
<td>0,3-0,5</td>
<td>100</td>
<td>20-60</td>
</tr>
<tr>
<td></td>
<td>other</td>
<td>Al₂O₃</td>
<td>O₂</td>
<td>0,2-0,5</td>
<td>50-100</td>
<td>1-60</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SiO₂</td>
<td>O₂</td>
<td>0,2-0,5</td>
<td>50-100</td>
<td>1-60</td>
</tr>
</tbody>
</table>

8.10.2.1 Activation of metals

As a matter of principle it is possible to activate metals, but the activation is very unsteady and therefore just of short shelf life. Activated metal has to be processed very fast (within half an hour, max. one hour), because the adherent radicals and ions react fast with the particles of the air.

Nearly any material can be treated with oxygen, except easily corrosive materials as f.e. copper.

<table>
<thead>
<tr>
<th>Group</th>
<th>Material</th>
<th>Gas</th>
<th>Pressure [mbar]</th>
<th>Power [%]</th>
<th>Time [min.]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Metal</td>
<td>Aluminium</td>
<td>O₂</td>
<td>0,2-0,5</td>
<td>50-100</td>
<td>1-10</td>
</tr>
<tr>
<td></td>
<td>Copper</td>
<td>H₂</td>
<td>0,3-0,8</td>
<td>50-100</td>
<td>1-10</td>
</tr>
<tr>
<td></td>
<td>Gold</td>
<td>O₂/Ar</td>
<td>0,2-0,5</td>
<td>50-100</td>
<td>1-10</td>
</tr>
<tr>
<td></td>
<td>Silver</td>
<td>H₂</td>
<td>0,3-0,8</td>
<td>50-100</td>
<td>1-10</td>
</tr>
<tr>
<td></td>
<td>Stainless st.</td>
<td>O₂</td>
<td>0,2-0,5</td>
<td>50-100</td>
<td>1-10</td>
</tr>
</tbody>
</table>
8.10.2.2 Activation of plastics

Plastics like polypropylene or PTFE are covalent. That means, that those materials have to be pretreated before printing, painting and bonding.

The common process gas for this application is oxygen with technical purity. Exceptions are fluorine containing plastics like PTFE, FEP, ...

Most of the activations can be performed with air as process gas.

The durability of the activation varies between some minutes (e.g. on rubber) and several weeks (e.g. on PA, PE, ...) Some plastics have to be etched for a better adhesion, see chapter ‘Etching’.

### General Parameters

<table>
<thead>
<tr>
<th>Group</th>
<th>Material</th>
<th>Gas</th>
<th>Pressure [mbar]</th>
<th>Power [%]</th>
<th>Time [min.]</th>
</tr>
</thead>
<tbody>
<tr>
<td>plastic</td>
<td>ABS</td>
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<td>1-20</td>
</tr>
<tr>
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<td>PA</td>
<td>O₂</td>
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<td>1-30</td>
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<td>POM</td>
<td>O₂</td>
<td>0,2-0,5</td>
<td>100</td>
<td>1-40</td>
</tr>
<tr>
<td></td>
<td>PP</td>
<td>O₂</td>
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<td>1-20</td>
</tr>
<tr>
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<td>PTFE</td>
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<td>20-60</td>
</tr>
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</table>

(The process parameters power and time have to be adapted according to the specification of the machine (type of generator, power of generator, type of electrode) and according to the properties of the product/sample.)

untreated plasma treated

8.10.2.3 Activation of glasses and ceramics:

Glasses and ceramics have similar activation attributes as metals (see chapter above) and are not easy to activate (long-term durable), but be etched. (See chapter ‘Etching of glasses and ceramics’.)

<table>
<thead>
<tr>
<th>Group</th>
<th>Material</th>
<th>Gas</th>
<th>Pressure [mbar]</th>
<th>Power [%]</th>
<th>Time [min.]</th>
</tr>
</thead>
<tbody>
<tr>
<td>other</td>
<td>Al₂O₃</td>
<td>O₂</td>
<td>0,2-0,5</td>
<td>50-100</td>
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<tr>
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<td>SiO₂</td>
<td>O₂</td>
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<td>1-60</td>
</tr>
<tr>
<td></td>
<td>Powder</td>
<td>O₂</td>
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</tr>
</tbody>
</table>

(The process parameters power and time have to be adapted according to the specification of the machine (type of generator, power of generator, type of electrode) and according to the properties of the product/sample.)
9. Index

A  Aggressive Liquids .......................................................... chap. 3
    Animals .............................................................................. chap. 3

C  Chamber volume ............................................................... chap. 1.2
    Chamber seals ................................................................... chap. 6
    Circuit diagram ................................................................... Attachment
    Cleaning ............................................................................... chap. 4
    Connections .......................................................................... chap. 1.3
    Connecting the machine .................................................... chap. 2
    Control .................................................................................. chap. 1.4

D  Damp rooms .......................................................................... chap. 3
    Door .................................................................................. chap. 1.3, 5
    Door seal ............................................................................. chap. 4
    Door switch .......................................................................... chap. 4

E  Electric circuit ........................................................................ chap. 5
    EG- Declaration of Conformity ............................................ chap. 7
    Exhausts ............................................................................... chap. 1.3, 3
    Exhaust tube ......................................................................... chap. 1.3

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    Gas ballast ........................................................................... chap. 3
    Generator .............................................................................. chap. 5

K  KF-seals ................................................................................ chap. 6

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    Main power switch ............................................................. chap. 1.4

N  Needle valve .......................................................................... chap. 1.6, 4.1

O  Oil for vacuum pump ........................................................... chap. 4, 6
    Options .................................................................................. chap. 1.7

P  Pollutions ............................................................................... chap. 3
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    Power supply connection ................................................... chap. 1.3
    Power Supply Switch .......................................................... chap. 1.3
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R  Relais ..................................................................................... chap. 4
    Repairs .................................................................................. chap. 3
    Recipient material ............................................................... chap. 1.1.2
    Room temperature .................................................................. chap. 5
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   Sealing ................................................................. chap. 4.4
   Spare parts .............................................................. chap. 6
   Suction pipe for vacuum chamber .................................. chap. 1.3
   Suction silter .......................................................... chap. 6

T  Technical data .............................................................
   Thermal danger ........................................................ chap. 3
   Timer ....................................................................... chap. 1.3, 1.4
   Type label .................................................................... chap. 1.3, 3
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   Vacuum pump oil ....................................................... chap. 1.6, 4.1
   Vacuum switch .......................................................... chap. 6
   Valves ....................................................................... chap. 1.3
   Ventilation ................................................................. chap. 1.3
   Voltage ...................................................................... chap. 1.3
   Voltage connection .................................................... chap. 1.3

W  Warranty ..................................................................... chap. 8
   Working pressure ....................................................... chap. 3
Customer: Umea Universitet
Location: 90187 Umea
Project: Atto-BRS

<table>
<thead>
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<th>V</th>
<th>phases</th>
<th>Hz</th>
<th>A</th>
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</thead>
<tbody>
<tr>
<td>230</td>
<td>1</td>
<td>50/60</td>
<td>16</td>
</tr>
</tbody>
</table>

Cable colours:

- Mains voltage:
  - Other conductor: black
  - Neutral conductor: light blue
  - Protective conductor: green/yellow

- Control voltage:
  - +24V: dark blue
  - -24V: violet
  - GND: blue/white
  - +15V: grey
  - -15V: green
  - Actual value: white
  - Set value: brown
  - Other control voltage: pink

This document is the property of company Diener Electronic GmbH & Co. KG. Duplication and passing on third only with our express written permission. This document consists of 5 pages including first page.
-QB1  main switch
-QB1  main switch
-X15  PE strip terminal
-G10  caution 230V
-FZ1  line filter T 6,3 A
-GU1  fan 230V

Diener Electronic
13,56 MHz generator 50W
Norosilicate glass RF electrode
-PU1  PE strip terminal

Diener Electronic
Hagelsdor Str. 41
72234 Ebbhausen

Pumps
1. pump 3.1A
2. pump 3.1A

Exhaust
PE pump -XU2:1 PE

Generator
k1

Door switch
RC

Vacuum switch
EI

Potentiometer
generator power set value
18 kOhm
2/2-Wege Magnetventil
2/2-way solenoid valve

direktgesteuert
direct acting

Bauart
Sitzventil
Nennweite
DN 1,0 – 2,5
Druckbereich
0 – max. 16 bar (siehe Tabelle)
Gehäusewerkstoff
Messing, 1.4305
Dichtwerkstoff
NBR, FKM
Temperatur
Medium: bei NBR - 10 bis + 90°C
bei FKM - 10 bis + 130°C
Umbgebung: max. + 50°C
Anschlüsse
G 1/8
Elektr. Anschluss
Gerätesteckdose nach DIN EN 175301-803
Anschlussspannung
230V 50Hz, 24V DC, Sonderspannungen
Spannungstoleranz
+/- 10 % nach VDE 0580
Leistungsaufnahme
230V 50Hz: 9,2 VA
24V DC: 6 Watt
Einschaltdauer
100 % ED
Schutzart
IP 65 mit montierter Gerätesteckdose
Einbautrage
beliebig
design
seat valve
diameter
DN 1,0 – 2,5
pressure range
0 – max. 16 bar (see table)
body material
brass, AISI 304
seals
NBR, FKM
temperature
media: with NBR - 10 up to + 90°C
with FKM - 10 up to + 130°C
ambient: max. + 50°C
connection
G 1/8
electr. connection
cable plug acc.
DIN EN 175301-803
nominal voltage
230V 50Hz, 24V DC, special voltages
voltage tolerance
+/- 10 % acc. VDE 0580
power consumption
230V 50Hz: 9,2 VA
24V DC: 6 Watt
duty factor
100 % ED
protection class
IP 65 with cable plug mounted
mounting
in any position

<table>
<thead>
<tr>
<th>DN [mm]</th>
<th>Druck pressure range [bar]</th>
<th>Anschluss connection</th>
<th>Kv-Wert flow rate [l/min]</th>
</tr>
</thead>
<tbody>
<tr>
<td>1,0</td>
<td>0 – 16</td>
<td>G 1/8</td>
<td>0,5</td>
</tr>
<tr>
<td>1,5</td>
<td>0 – 13</td>
<td>G 1/8</td>
<td>1,2</td>
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<td>2,0</td>
<td>0 – 10</td>
<td>G 1/8</td>
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<tr>
<td>2,5</td>
<td>0 – 8</td>
<td>G 1/8</td>
<td>2,8</td>
</tr>
</tbody>
</table>

Technische Änderungen vorbehalten. Modifications reserved.
Stand: 06/2005
2/2-Wege Magnetventil
2/2-way solenoid valve

Maßzeichnung
dimension drawing

Bestellbezeichnungen
order specifications

<table>
<thead>
<tr>
<th>DN [mm]</th>
<th>Werkstoffe Gehäuse / Dichtung material body / seal</th>
<th>Druck pressure range [bar]</th>
<th>Anschluss connection</th>
<th>Typenbezeichnung order specifications 230V 50Hz</th>
<th>Typenbezeichnung order specifications 24V DC</th>
</tr>
</thead>
<tbody>
<tr>
<td>1,0</td>
<td>Messing / brass / NBR</td>
<td>0 – 16</td>
<td>G 1/8</td>
<td>210A0000/1,0/MOG18N 23050</td>
<td>210A0000/1,0/MOG18N 2400</td>
</tr>
<tr>
<td>1,5</td>
<td>Messing / brass / NBR</td>
<td>0 – 13</td>
<td>G 1/8</td>
<td>210A0000/1,5/MOG18N 23050</td>
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</tr>
<tr>
<td>2,0</td>
<td>Messing / brass / NBR</td>
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<td>210A0000/2,0/MOG18N 23050</td>
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<td>210A0000/2,5/MOG18N 23050</td>
<td>210A0000/2,5/MOG18N 2400</td>
</tr>
<tr>
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<td>210A0000/1,0/MOG18F 23050</td>
<td>210A0000/1,0/MOG18F 2400</td>
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<td>210A0000/1,5/MOG18F 23050</td>
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<td>210A0000/2,0/MOG18F 2400</td>
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<td>0 – 8</td>
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<td>1,5</td>
<td>1.4305 / ANSI 304 / FKM</td>
<td>0 – 13</td>
<td>G 1/8</td>
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<td>210A0000/1,5/V2G18F 2400</td>
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<td>1.4305 / ANSI 304 / FKM</td>
<td>0 – 10</td>
<td>G 1/8</td>
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<td>210A0000/2,0/V2G18F 2400</td>
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<td>210A0000/2,5/V2G18F 23050</td>
<td>210A0000/2,5/V2G18F 2400</td>
</tr>
</tbody>
</table>

Technische Änderungen vorbehalten. Modifications reserved.
Stand: 06/2005
2/2-Wege Magnetventil
2/2-way solenoid valve

Typenschlüssel
_type code_

Die Typenbezeichnung setzt sich zusammen aus:
Structure of the order specification:

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<th>Code</th>
<th>Description</th>
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</tr>
<tr>
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</tr>
<tr>
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</tr>
<tr>
<td>/2.0/</td>
<td></td>
</tr>
<tr>
<td>M0</td>
<td></td>
</tr>
<tr>
<td>G18</td>
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<tr>
<td>F</td>
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<tr>
<td>23050</td>
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</tr>
</tbody>
</table>

Anschlussspannung 230V 50Hz
Voltage

Dichtung: FKM
Seal

Anschluss: G 1/8
Connection

Werkstoff: Messing
Material: Brass

Nennweite: DN 2,0
Diameter

Elektrische Option
electrical option

Mechanische Option
mechanical option

Schaltfunktion: A = „NC“
Function

Baureihe: 210
Type

Technische Änderungen vorbehalten. Modifications reserved.
Stand: 06/2005