Vacuum Soldering System
For R&D and pilot production

Innovative
Thermal Solutions
Contents

1. Technical data  page 03
2. Dimensions  page 04
3. Technical Setup – Process Chamber & Heating Plate  page 05
4. Technical Setup – Gas Lines  page 10
5. Technical Setup – Vacuum Pumps  page 19
6. Technical Setup – Media Supplies  page 23
7. Machine Safety  page 26
8. System Control and Graphical User Interface  page 29
9. Temperature Profiles & Performance  page 42
# Technical Data

## Key Data

<table>
<thead>
<tr>
<th></th>
<th>c.VACUNITE&lt;sup&gt;6&lt;/sup&gt;</th>
<th>c.VACUNITE&lt;sup&gt;12&lt;/sup&gt;</th>
<th>c.VACUNITE&lt;sup&gt;24&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Field of application</strong></td>
<td>R&amp;D, pilot production</td>
<td>R&amp;D, pilot production</td>
<td></td>
</tr>
<tr>
<td><strong>Plate size</strong></td>
<td>200x200 mm² (6)</td>
<td>300x300 mm² (12)</td>
<td>410x230 mm²</td>
</tr>
<tr>
<td><strong>Max. substrate height</strong></td>
<td>120 mm (6)</td>
<td>150 mm (12)</td>
<td>150 mm</td>
</tr>
<tr>
<td><strong>Max. load per plate</strong></td>
<td>2.5 kg (6)</td>
<td>5 kg (12)</td>
<td>15 kg</td>
</tr>
<tr>
<td><strong>No. of heating plates</strong></td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td><strong>Possible process gases</strong></td>
<td>N₂ (optional: H₂ (100), N₂H₂ (95/5), HCOOH)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Vacuum level</strong></td>
<td>0.1 mbar (option: 10⁻⁵ mbar)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Vacuum pump (oil sealed)</strong></td>
<td>24 m³/h</td>
<td>24 m³/h</td>
<td></td>
</tr>
<tr>
<td>**Heat-up</td>
<td>cool-down**</td>
<td>80</td>
<td>120 (K/min)</td>
</tr>
<tr>
<td><strong>Process temperatures</strong></td>
<td>up to 450 °C</td>
<td>up to 450 °C</td>
<td></td>
</tr>
<tr>
<td><strong>System weight</strong></td>
<td>150 kg (6)</td>
<td>180 kg (12)</td>
<td>440 kg</td>
</tr>
<tr>
<td><strong>Dimensions (L x W x H)</strong></td>
<td>1335x750x2000 mm³</td>
<td>1750x640x2230 mm³</td>
<td></td>
</tr>
</tbody>
</table>
Dimensions c.VACUNITE 06/12/24
Technical Setup – Process Chamber & Heating Plate
Swing Door: Manually or automatically operated

c.VACUNITE with manual door

c.VACUNITE with automatic door
Process Chamber Height / Max. Substrate Height

50 mm

100 mm

150 mm
Heating Plate Vacunite 6/12

**Vacunite6**
- Overall heating plate size: 210 x 210 mm
- Useable area*: 200 x 200 mm
- Heating power: 4 kW

**Vacunite12**
- Overall heating plate size: 310 x 310 mm
- Useable area*: 300 x 300 mm
- Heating power: 8 kW

*“useable area“ = area having specified cross plate temperature uniformity

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**Diagram:**
- Cooling water
- Thermocouple
- Heating element
Heating Plate Vacunite 24

heating plate, lower surface

- overall heating plate size: 430 x 252 mm
- useable area*: 410 x 230 mm
- heating power: 5.5 kW

* “useable area” = area having specified cross plate temperature uniformity

- cooling water tube
- side heater
- heating rod
- thermocouple positions
### Heating Plate Material

- **Plate Material**
  - Brass Plate, Chrome plated
  - Copper Plate, Chrome plated
  - Stainless Steel Plate

<table>
<thead>
<tr>
<th>Material</th>
<th>max. Temperature</th>
<th>Temp. Uniformity</th>
<th>Costs</th>
<th>Durability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brass</td>
<td>450°C</td>
<td>±1%</td>
<td>100 %</td>
<td>100 %</td>
</tr>
<tr>
<td>Copper</td>
<td>450°C</td>
<td>±0.5%</td>
<td>200 %</td>
<td>250 – 300 %</td>
</tr>
<tr>
<td>Stainless Steel</td>
<td>450°C</td>
<td>±2%</td>
<td>120 %</td>
<td>1000 %</td>
</tr>
</tbody>
</table>
Thermocouples

4 to 6 thermocouples, K-Type, with vacuum tight feed through

Thermocouples for direct substrate temperature measurement. Signal can be used to additionally control the process.
Technical Setup – Gas Lines

c.Vacunite12 heating plate lower surface
Gas Lines

Nitrogen – standard equipment for all systems

- additional gas lines
  - Forming Gas (N2H2 95/5)
  - Formic Acid (HCOOH)
  - 100% Hydrogen (H2)
  - Oxygen (O2)
Formic Acid (HCOOH)

- Magnetic switch / fill level sensor to MFC and process chamber
- N2 inlet
- Safety tray
- Manometric switch (opening the Bubbler lid is locked when Bubbler pressurized)
- HCOOH refill spout (for dispenser or pump see backup slides)
- Tank specially coated for chemical resistance
  2 liters HCOOH capacity
  Usage ca. 3 ml/per process run
**HCOOH => Safe Guard Level 1**

**Level 1 (HCOOH)**

**Standard Level**

- Monitoring and output hardware interlocking alarm signals
- Electrical surge protection
- Pressure monitoring of gas lines (supply)
- Temperature interlock chamber door (heating plates < 60°C)
- Temperature monitoring current transformers
- Excess temperature protection heating plate
- Level monitoring cooling water tank
- Temperature monitoring cooling water
- Phase monitoring input current

**Level 2 (100% H₂)**

- Current burn off unit monitoring
- Burn off unit monitoring
- Chamber overpressure monitoring
- N₂ exhaust flushing
- Manual emergency stop
- Vacuum leakage monitoring
- Over pressure outlet valve
- Emergency-stop routine and Restart routine after emergency stop
- Gasometry computer (gas probes)
Hydrogen

Hydrogen burn-off

Hydrogen burn-off unit (view inside)

redundant glow plugs
Hydrogen

flashback arrestor

stops a reverse flow of the torch flame upstream to the process chamber

Hydrogen option includes:

(1) H2 main gas line
(2) safe pump&purge setup with Hydrogen burn-off unit and flashback arrestor
(3) Gasometry computer with 2 Hydrogen detection sensors
(4) Safe guard level 2
Hydrogen

Gasometry computer

Hydrogen detection sensors
### Level 1 (HCOOH)

<table>
<thead>
<tr>
<th>Standard Level</th>
<th>Level 2 (100% H₂)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monitoring and output hardware interlocking alarm signals</td>
<td>Interdependent gas interlock</td>
</tr>
<tr>
<td>Electrical surge protection</td>
<td>Evacuate monitoring</td>
</tr>
<tr>
<td>Pressure monitoring of gas lines (supply)</td>
<td>Fill level monitoring bubbler (min/max)</td>
</tr>
<tr>
<td>Temperature interlock chamber door (heating plates &lt; 60°C)</td>
<td>Chamber door interlock</td>
</tr>
<tr>
<td>Temperature monitoring current transformers</td>
<td>Pressure monitoring</td>
</tr>
<tr>
<td>Excess temperature protection heating plate</td>
<td>Pump N₂ gas ballast</td>
</tr>
<tr>
<td>Level monitoring cooling water tank</td>
<td>Push button „enable operation“</td>
</tr>
<tr>
<td>Temperature monitoring cooling water</td>
<td>Pressure monitoring bubbler</td>
</tr>
<tr>
<td>Phase monitoring input current</td>
<td>Safety bolt bubbler</td>
</tr>
</tbody>
</table>

- Current burn off unit monitoring
- Burn off unit monitoring
- Chamber overpressure monitoring
- N₂ exhaust flushing
- Manual emergency stop
- Vacuum leakage monitoring
- Over pressure outlet valve
- Emergency-stop routine and Restart routine after emergency stop
- Gasometry computer (gas probes)
Microwave Plasma Source

The output of the power generator can be set between 100 and 1300 W.

Plasma provides additional activation energy for e.g. Hydrogen which finally results in a higher activation degree at lower process temperature for e.g. temperature-sensitive components. The power of the plasma generator can be set.
Technical Setup – Vacuum Pumps
Vacuum Pumps

rotary vane pump, oil sealed
(10^{-1} \text{ mbar in process})
24 \text{ qm/h for all systems}

dry pump
14 m^3/h
(10^{-1} \text{ mbar in process})

option for ultra-clean processes
not in combination with pure Hydrogen
Soft Pump

soft pump to avoid solder balls and displaced parts

Pressure

Time

fast pump

soft pump
HiVac option
turbo pump 65 l/s with gate valve
(max. $10^{-5}$ mbar with N2)
Technical Setup – Media Supplies
Electrical Power Supply

- 3~/N/PE 230/400 V  50 Hz
  - STANDARD
- 3~/N/PE 120/208 V  60 Hz
  - OPTION
- 3~/N/PE 277/480 V  60 Hz

Range of nominal voltage: < ± 10%
Range of nominal frequency: < ± 2%
Cooling Water

External Chiller (Cooling water recooler):

<table>
<thead>
<tr>
<th>System</th>
<th>Cooling Power</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vacunite 6</td>
<td>1.5 kW</td>
</tr>
<tr>
<td>Vacunite 12</td>
<td>2 kW</td>
</tr>
<tr>
<td>Vacunite 24</td>
<td>2.5 kW</td>
</tr>
</tbody>
</table>

The cooling water unit (external chiller, facility cooling water circuit) must be equipped with a venting device!
e.g. a chiller with an open water tank
Media connections

- Mains & Ethernet
- Water
- Exhaust / Door & Formic Acid
- Exhaust / Burn Off Unit
- Gases
Machine Safety
Machine Safety for c.Vacunite 6/12/24 according to

- 2006/42/EC Machinery Directive
- DIN EN ISO 13849 Safety of Machinery
For safety relevant components redundant PLC-based I/O terminals are used. These safety I/Os form the interfaces to the safety-relevant sensors and actuators.

These concepts improve the safety integrity of the system as compared to the use of a single PLC.
System Control and Graphical User Interface
Panel PC and PLC

Industry PLC for furnace control

19” Panel-PC for visualization

The furnace control uses an industry standard PLC system. Communication between Equipment-PC and control system is carried out via Ethernet connection. The PLC operates the furnace independently even in case of Visualization PC failure.
Bus System

EtherCAT is a high performance real-time Ethernet bus.

All control terminals and components communicate using this bus system.
CT Visual and CMC (Central Machine Control)

- CT-Visual allows to create, monitor, store and manage process recipes. Recipes may either be loaded and started manually (authorized user selects recipe) or automatically (automatic recipe control or recipe scheduler).

- Typical recipe parameters include temperature set points, alarm limits for temperatures, gas flows, pressure setpoints, pump valves, etc.

- Visualization charts can be customized according to analysis need, customized chart definitions can be defined, stored and loaded. Advanced zooming features allow detailed analysis.
User Access Rights

User Access Rights can individually be granted to single users or user groups.

Typical users are
- Supervisor
- Operator
- Service Technician
Recipe Editing
Available GUI Languages

and others ..
Solder Profiles & Performance
Typical Vacunite12 Solder Profile with Hydrogen (H2)
Typical Vacunite24 Solder Profile with Forming Gas

<table>
<thead>
<tr>
<th>Process Sequence</th>
<th>delta t</th>
<th>total time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Start</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>System Initialization</td>
<td>0,5</td>
<td>0,5</td>
</tr>
<tr>
<td>Vacuum (16 m3/h pump)</td>
<td>1</td>
<td>1,5</td>
</tr>
<tr>
<td>Purge with 30 slm N2</td>
<td>1</td>
<td>2,5</td>
</tr>
<tr>
<td>Vacuum (16 m3/h pump)</td>
<td>1</td>
<td>3,5</td>
</tr>
<tr>
<td>Purge with e.g. 30slm N2H2</td>
<td>1</td>
<td>4,5</td>
</tr>
<tr>
<td>Heatup to 250°C (with Load)</td>
<td>5</td>
<td>9,5</td>
</tr>
<tr>
<td>Soak</td>
<td>2,5</td>
<td>12</td>
</tr>
<tr>
<td>Heatup to 330°C (with Load)</td>
<td>2</td>
<td>14</td>
</tr>
<tr>
<td>Vacuum (16 m3/h pump) and hold vacuum</td>
<td>0,5</td>
<td>14,5</td>
</tr>
<tr>
<td>Purge with 30 slm N2</td>
<td>1</td>
<td>17</td>
</tr>
<tr>
<td>Purge w. 3slm N2 and Cool Down to 50°C</td>
<td>7</td>
<td>24</td>
</tr>
</tbody>
</table>

similar solder profile for Formic Acid (HCOOH)
Typical Vacunite24 Solder Profile Hydrogen (H2)
Temperature Uniformity Vacunite24, Brass Heating Plate, N₂

Data Logging via DataPaq® and Thermocouple Pick-Up (Dummy load, Brass, 60x30x6 mm, 93 g)

cylinder bore for TC Ø 1.5mm x 25mm

Thermocouple positions on heating plate

BL  BR  
C  
FL  FR

Loading

temperature uniformity < 1K on plateau

test ramp-up temperature profile for internal acceptance
Temperature Uniformity Vacunite24, Brass Heating Plate, N₂

ramp-up temperature profile for internal acceptance test

temperature uniformity < 1% on plateau
Temperature Uniformity Vacunite24, Brass Heating Plate, N₂

ramp-up temperature profile for internal acceptance test

dT/dt = 46 K/min

dT/dt = 51 K/min

dT/dt = 130 K/min
Images
HCOOH Refill

Electrical Dispenser

Hose Pump