Product description

# CG Vacuum high and low temperature probe station

The first self-developed ultra-vacuum and ultra-low temperature wafer test platform in China

## 1. Product Background

The continuous growth of aerospace, military, new materials, and other technical fields poses increasingly higher requirements for the working performance in extreme environments of various semiconductor devices. Therefore, it is of particular importance to perform reliability testing for the performance of devices in preliminary research and development. During the test, we need to create high temperature, low temperature, vacuum, magnetic field, illumination, particle irradiation, and other environments for the devices, then allow the devices to work in these environments, and observe the devices to determine whether their electrical parameters are normal under different environments.

The vacuum low-temperature probe station is suitable for testing I-V, C-V, microwave, photoelectric, transport properties, and Hall effect properties of semiconductors and material devices in extremely low temperatures (vacuum is a necessary condition for extremely low temperature) or large temperature range, and studying the electrical properties of materials under different temperature conditions. For example, when the test for the electrical properties of the chip in the space environment, high vacuum, ultra-low temperature, or high-temperature environment needs to be simulated, or superconducting devices require ultra-low temperatures to exhibit their properties, it is necessary to use a probe station with a vacuum low-temperature environment.

Since SEMISHARE launched the first self-developed CG high and low-temperature probe station in China in 2012, it has been making continuous efforts in the research of vacuum low-temperature testing technology. Through the constant optimization and improvement of product performance by the technical team, the equipment now has well-established stability and reliability and has been widely used in many organizations, such as domestic first-class universities, research institutes, and semiconductor enterprises.

With its technical experience in vacuum high and low-temperature probe testing, SEMISHARE was invited to participate in designing part of the core technology of the “Space Ground Environment Simulation Device” project jointly built by Harbin Institute of Technology and China Aerospace Science and Technology Corporation in 2016. The project is designed to test the spacecraft’s ability to withstand vacuum, cold black, solar radiation, magnetic field, high-energy particle radiation, solar wind, and micrometeorites. In this project, SEMISHARE provides technical support in ultra-high vacuum, ultra-low temperature, automatic control, laser simulation, and other aspects.

# 2. Product Structure

### Microscope regulator

• Any region of the sample can be observed by regulating the scalable degree and height of the support frame and the regulatory base of the microscope.
• Different microscopes are optional to meet the requirements for observation of different customers.

### Refrigerant regulating system

• The system mainly consists of liquid nitrogen container, liquid nitrogen control system, heating control system, and liquid nitrogen transmission pipeline. It finally achieves an accurate low-temperature control function by controlling liquid nitrogen flow and heating power.

### Chuck

• The closed cycle probe station chuck adopts an oxygen-free copper surface gold plating process, and the open cycle probe station chuck is made of stainless steel with three clip-type sample holders.
• Maximum temperature 4.5K-770K;
• Anti-radiation screen design ensures uniform and accurate sample temperature.

### Shockproof system

• A low-frequency natural frequency of 1.5Hz vertical eigenfrequency and 1.2Hz horizontal eigenfrequency of the system is realized by adopting a shockproof platform with an air spring support frame.
• Excellent load capacity up to 400kg.

### CCD camera

• C/CS interface HD CCD/CMOS camera, 200 million/800 million pixels available, with resolution up to 1920*1080 and above
• SD card interface for image or video storage
• HDMI video cable, used to be connected to the display screen for real-time observation

### Vacuum cavity

• The vacuum cavity in a dual-cavity structure of an external cavity and a shielded cavity can provide a vacuum environment with an ultimate pressure of 5×10-4Pa for sample tests.
• Shield against external telecommunications interference
• In a low temperature test, it prevents water vapor in the air from condensing on the sample, so as to avoid test failure caused by excessive current leakage or the probe failing to touch the electrode.

### XYZ regulator of probe arm

• It adopts the structure of self-locking screw and cross roller guide, realizing a moving accuracy up to 2um
• The drift distance of the probe is better than ±60nm/30mins.
• It also adopts a triaxial tubular clamp and a triaxial cable with high shielding function to achieve the current leakage accuracy up to 100FA in the test.

# 3. Product Overview

CG series probe station can provide IV/CV characteristic test, RF test, photoelectric test, electromagnetic transport characteristic, and Hall effect test for device and material characterization in the environment of ultra-high vacuum and high and low temperatures.

Special Conditions™ technology provides a semiconductor device test method that effectively creates an integrated high-temperature, low-temperature, and vacuum test environment through the installation of vacuum chambers, radiation shielding screens, and other structures to provide stable test environments for manufactured semiconductor devices.

## Product Features:

- Can support 4.2K-473K temperature
- Anti-radiation screen design to improve sample temperature uniformity and accuracy
- Probe heat sink design to ensure accurate probe drop
- Upgradable loading magnetic field
- Flexible and scalable test application configuration （Chucks, Microscopes, Probes, Shielded Boxes）
- Automatic refrigerant flow control, automatic precise temperature control

# 4. Product Applications

## Academic Field:

| | | | | |
|---|---|---|---|---|
| Semiconductor (Microelectronics and Integrated Circuits) | Nanoelectronics | Magnetic & Spintronics | Organic & Molecular Electronics | Optoelectronics |
| Microwave Electronics | Quantum Devices | Superconductors | MEMS | Low Noise RF |
| Ferroelectric | Thin Film | Infrared Detectors | | |

# 5. Performance Parameters

| Model | | CG-O-2 | CG-O-4 | CG-C-2 |
|---|---|---|---|---|
| Shape (L*W*H/mm) | | 850*800*1350mm | | |
| About Weight (KG) | | 170KG | 170KG | 350KG |
| Power requirement | | AC220V,50~60HZ | | 380V |
| Chuck Normal temperature standard | Chuck size | 2" | 4" | 2" |
| | Sample fixing method | Vacuum thermal grease/spring press | | |
| | Sample stage movement | Fixed sample stage | | |
| | Vacuum level | $5x10^{-4}$Pa (with 250 L/s molecular pump) | | |
| | Chuck material | Stainless steel | | Oxygen free copper, gold plated surface |
| Optical characteristics | Microscope travel | 2*2 inch | 4*4 inch | 2*2 inch |
| | magnification | Zoom: 7:1, resolution 4μm (magnification 216X) or metallographic microscope (20X~1000X) | | |
| | observation window | 2" | 4" | 2" |
| | CCD Pixels | 50W（simulation）/200W（digital）/500W（digital） | | |
| Temperature control specifications | Cooling method | Liquid nitrogen/liquid helium | | Refrigeration Compressors |
| | Control method | Open cycle manual/automatic refrigerant flow control | | Closed loop automatic control |
| | Range | 77K~473K/4.2K~473K | | 7.3K~473K |
| | Resolution | 0.001K | | |
| | Stability | 4.2K ±0.2K | | 77K ±0.1K |
| | | ±0.1K | | |
| | Cooling time | ⩽60min（normal TEMP to 77K） | | ⩽150min（normal TEMP to 10K） |
| | Warming time | ⩽60min（77K to normal TEMP） | | ⩽90min（10K to normal TEMP） |
| | Rising time from room temperature | 100℃，⩽30min；150℃，⩽45min；200℃，⩽60min | | |
| | Heating power supply | Low voltage DC | | |
| | Sensor | PT100 | | silicon diode |
| | Number of sensors | Sample stage, radiation shield, and probe arm each | | Sample stage, radiation screen. One probe arm, one cold head |
| | Power | 50W/100W/500W/1000W | | |
| Probe specification | Probe number | The number of various probes can be expanded up to 6 | | |
| | Probe regulation | Vacuum bellows external adjustment, manual control | | |
| | Dot accuracy | 2μm | | |
| | X-Y-Z stroke | 25mm -25mm -25mm、50mm-25mm-25mm | | |
| | Current leakage | 100fA | | |
| | Connector type | Triaxial/SMA/K/fibre optic interface | | |

# 6. Temperature control system

## 6.1 CG-O Series Standard

- Liquid Nitrogen Control Units
- Heating control unit
- Liquid Nitrogen Tanks
- Refrigerant coaxial circuit
- Shielding chamber
- Chuck

The CG-O temperature control system mainly consists of liquid nitrogen container, liquid nitrogen pump, refrigerant coaxial circuit, liquid nitrogen control unit, heating control unit, and chuck.

The liquid nitrogen control unit controls the flow of refrigerant. The refrigerant enters the chuck from the middle of the refrigerant coaxial circuit, enabling the chuck to cool down rapidly. Then it flows through the bottom compartment of the shielded cavity, returns to the outer return pipe of the coaxial circuit, and finally is discharged to the outdoors through the exhaust port. The heating control unit is used with the liquid nitrogen control unit to achieve an accurate low-temperature control function with a control accuracy up to ±0.1K.

The refrigerant coaxial circuit and shielded cavity allow the refrigerant to be used in the process of discharge, creating an environment that is much lower than room temperature and inhibiting the consumption of refrigerant entering the sample table in advance. Therefore, it improves the refrigeration efficiency of the refrigerant and reduces refrigerant consumption.

## 6.2 CG-C Series Standard

- Liquid Helium Chillers
- Heating control units
- Chillers
- Chucks

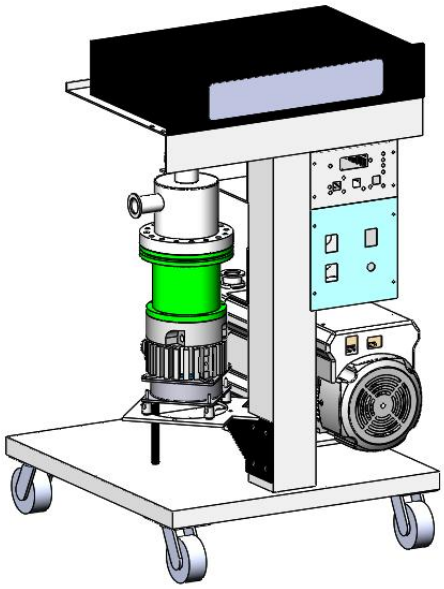
The CG-C temperature control system mainly consists of liquid helium refrigerator, heating control unit, water chiller, and chuck.

The liquid helium refrigerator is used for refrigeration, and the heating control unit stabilizes the temperature of the chuck at the required temperature by controlling the power of the heating wire, and finally realizes an accurate low-temperature control function with a control accuracy up to ±0.1K.

## Main Specifications:

- Vacuum chamber with ultimate vacuum better than $5\times10^{-4}$Pa;
- Chuck surface temperature range：4.5K~450K，Resolution 0.01°;
- Probe drift：＜±60nm/30mins;
- microwave console X-Y-Z stroke ⩾ 25mm-25mm-25mm，Repeat Positioning Accuracy ±2μm;
- Leakage of the entire system＜100fA@5V（Using DC probes）;
- Current measurement resolution ⩽0.1fA，Current measurement accuracy⩽30fA;
- Voltage measurement resolution ⩽0.1uV，Voltage measurement accuracy⩽30uV;
- 1 built-in 1/f noise test module，background noise<1e-28A2/Hz，Test frequency range：1Hz-100KHz

# 7. Vacuum System



- Vacuum chamber
- Mechanical pumps
- Molecular pumps
- Vacuum Gauges
- Bellows

The vacuum cavity in a dual-cavity structure of an external cavity and a shielded cavity can provide a vacuum environment with an ultimate pressure of $1.2\times10^{-5}$ Pa (equipped with a 250L/s molecular pump) for sample tests. In a low temperature test, it prevents water vapor in the air from condensing into dew on the sample, so as to avoid test failure caused by excessive current leakage or the probe failing to touch the electrode. At the same time, it can also provide effective refrigeration due to the vacuum insulation effect. In a high temperature test, it prevents the oxygen in the air from oxidizing the sample, thereby avoiding the electrical error of the sample as well as physical and mechanical deformation.

# 8. Product Selection Guide

## 8.1 Microscope-3 kinds of microscope options

**PSM-1000 high magnification metallurgical microscope/loadable laser** (standard)

| | |
|---|---|
| Optical magnification | 2000X (eyepiece*zoom magnification*objective lens) |
| Eyepiece | 10X |
| Zoom | 1X~2X |
| Objective lens (standard) | 5X(Operating Distance: 34.0mm,NA:0.14) |
| | 10X(Operating Distance: 33.5mm,NA:0.28) |
| | 20X(Operating Distance: 20mm,NA:0.42) |
| Objective lens (optional) | 2X(Operating Distance: 34mm,NA:0.055) |
| | 50X(Operating Distance: 13mm,NA:0.55) |
| | 100X(Operating Distance: 3mm,NA:0.8) |
| Microscope focusing mechanism | Z-axis travel 50.8 mm, coaxial knob adjustment, fine tuning accuracy better than 1μm |
| Converter | 4-hole manual objective switching nosewheel (4-hole motorized nosewheel can be customized) |
| CCD interface form | 1X C Mount |
| Illumination system | 150W high power white illumination source (sleepless brightness adjustment) |

**Note:** PSM-1000 can be equipped with a laser for FA failure analysis/laser cutting function and camera interface with laser safety positioning pins, leaving a position for mounting laser safety filters in front of the microscope binocular head and providing compensation spacers. The laser and safety filter can be easily installed without a special tool kit.

## Stereomicroscope/SS-M (optional)

| |
|---|
| Total magnification: 16X-100X |
| Continuous zoom ratio of 6.3:1 |
| Eyepiece magnification: 20X |
| Optical system, continuous zoom range 0.8X ~ 5X |
| Objective magnification: 2X, working distance: 34mm, (this is optional) |
| Binocular observation tilt 45 degrees, double pupil distance adjustment range of 52-75mm |
| Ring LED light source (sleepless brightness adjustment) |
| Microscope in the Z-axis adjustment range of 50.8 mm |
| CCD interface C MOUNT can be configured with a PC to control the CCD for sample photo acquisition and video recording. |

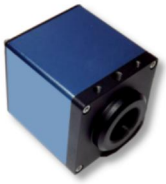
## Video Microscope/70XL (optional)

| |
|---|
| • Microscope optical magnification range: 0.75 - 5.25X, with 19inch monitor magnification can reach 216X |
| • Continuous zoom ratio: 7:1 |
| • Resolution: 72 - 240 lp/mm, highest resolution better than 4μm |
| • NA value: 0.0240 - 0.080 |
| • Depth of field: 0.98 - 0.09 mm |
| • Field of view at low magnification: 6.40 x 8.53 mm |
| • Field of view at high magnification: 0.91 x 1.22 mm |
| • Working distance: 89mm |
| • 150W high power white illumination source (sleepless brightness adjustment) |
| • Microscope focus mechanism: Z-axis travel 50.8 mm |

## 8.2 DC Probe Selection

| Specification | Triaxial probes |
|---|---|
| Maximum Voltage | 500V |
| Temperature Range | -273°C to 200°C |
| Leakage current | <100fA |
| Interface Type | Coaxial male connector |
| Characteristic impedance | 50Ω |
| Residual Capacitance | <200fF |
| Probe holder material | Oxygen Free Copper Gold Plated |
| Probe material | Beryllium/Tungsten Alloy |
| Probe tip size | 0.2μm–25μm |

## 8.3 CCD camera - 2 options

| Model Parameters |  | |
|---|---|---|
| **Model** | **O200C** | **ZX-201HC** |
| **Pixel Size** | 2.75 (H)μm * 2.75(V)μm | 3.75 (H)μm * 3.75(V)μm |
| **Optical Size** | 1/2.5 inch | 1/2.8 inches |
| **Resolution** | 1920 * 1080 | 1920 * 1080 |
| **Output Color** | 8:8:8 24-bit true color | 12/12/12 36-bit true color output |
| **Output Frame Rate** | 60fps | 60fps |
| **Output Method** | HDMI pure digital output | HDMI pure digital output |
| **Adjustment method** | OSD menu adjustment | Mouse operation UI adjustment |
| **Storage method** | SD card | U-Drive |
| **Wide Dynamic** | 3 levels of wide dynamic adjustment | 1-10 level adjustable |
| **Edge enhancement** | 3 levels of edge enhancement | 1-10 level adjustable |
| **Exposure method** | Manual/Auto | Manual / Auto |
| **White Balance** | One button white balance | One button white balance |
| **Color Adjustment** | R, G, B adjustable respectively | R, G, B are adjustable |
| **Lens interface** | C-Mount | C-Mount |
| **Power supply voltage** | DC-5V | 12V/1A |
| **Appearance size** | 61mm*61mm*72mm | 98mm*65mm*50mm |
| **Working Humidity** | 20%~80% | 20%~80% |
| **Working temperature** | 0~80°C | 0~80°C |
| **Weight** | 270g | 350g |

# 9. Product Service

## Solution consulting service

Our experienced technical experts will provide professional advice on system testing according to your application requirements to help you quickly select satisfactory equipment to purchase.

## Warranty service

All SEMISHARE’ s products have passed strict factory inspection, and we also provide you with professional warranty service.

## Technical Training

To help you better understand SEMISHARE products and execute additional application solutions, we can provide customized, systematic technical skills training according to your specific requirements. Please apply to the website or contact us by phone if you require our service.

## Product Upgrade Service

Our technology provides value-added services for your products. SEMISHARE can provide hardware and software upgrade services when your testing needs change to help you get more value out of your equipment.

## Service Promise

SEMISHARE is committed to responding quickly to your requirements. We will value your every need if you contact us by any means. Online support: 7*24h customer response supported by a professional FAE technical team.

Onsite Support：

1）For customers in Shenzhen, after-sales service personnel should arrive at the customer site within 4 hours

2） For customers in Guangdong Province, after-sales service personnel should arrive at the customer site within 24 hours

3）For customers outside Guangdong Province, after-sales service personnel shall arrive at the customer site within 48 hours

## Service Contact

You can easily reach us or our partners wherever you are.

**After-sales Service**

E-Mail: service@semishare.com

Customer Complaint

Telephone: 0755-2690 6952 to 808

E-Mail: alvin@semishare.com

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