Precision Thermal Solutions for the Semiconductor Industry

Overview

In semiconductor manufacturing, precision is everything. Every step of the process—from wafer fabrication to assembly and testing—depends on highly controlled environments where even the smallest thermal fluctuations can impact performance, yield, and reliability.

For over 70 years, Minco Products has partnered with leading technology companies to deliver custom-engineered flexible heaters, temperature sensors, and integrated thermal solutions that meet the demanding needs of the semiconductor industry.

Our Expertise in Semiconductor Applications

Minco's solutions are engineered to meet or exceed the high reliability and long-term repeatability needs of cleanroom, testing, and wafer processing environments. Our products help control temperature at the point of use, improving process consistency, tool uptime, and throughput.

Applications Include:

Wafer processing tools – Lithography, deposition, etching, ion implantation. Thermal control ensures precise regulation for critical wafer fabrication steps, enabling uniform results and higher yields.

Process chambers – Temperature uniformity, rapid thermal cycling. Consistent heating across chamber surfaces reduces variability and supports advanced semiconductor processes, including in vacuum environments.

Chemical delivery systems – Prevent condensation and maintain fluid stability. Controlled heating keeps gases and chemicals at optimal temperatures, ensuring reliable delivery and minimizing process interruptions.

Probe stations and test equipment – Accurate, stable measurements. Thermal feedback enables reliable electrical and functional testing of devices. Uniform heating reduces mechanical warping or distortion due to minimizing temperature gradients – ensuring precise dimensional verification.

Metrology and inspection systems – Temperature-stabilized platforms reduce measurement drift, delivering consistent dimensional and defect analysis in precision inspection tools.

Minco Flexible Heaters for Semiconductor Equipment

Minco engineers a full range of flexible heaters tailored to the demanding requirements of semiconductor fabs and OEMs. Each heater type offers distinct benefits in performance, durability, and cleanroom compatibility.

POLYIMIDE (KAPTON®) FLEXIBLE HEATERS

Minco's polyimide flexible heaters are thin, lightweight, and built with etched-foil circuits embedded in durable polyimide film. Using adhesive layers between films, they deliver controlled, uniform heat while polyimide's dielectric strength and dimensional stability ensure reliable performance in compact semiconductor applications.

Applications

- Wafer chuck heating in lithography and etching tools.
- Anti-condensation heating in robotics, optics, and metrology systems.
- Gas lines and valves requiring flexible, clean, and uniform heating.

Advantages

- Ultra-thin (<0.01 in / 0.25 mm) for tight-space integration.
- Good chemical and radiation resistance.
- Operates up to ~200 °C.
- Cleanroom-friendly with low outgassing.

ALL-POLYIMIDE FLEXIBLE HEATERS

Minco's all-polyimide flexible heaters are constructed entirely of polyimide, with no adhesives or bonding agents, making them ideal for contamination-sensitive semiconductor environments. The resistive foil is sandwiched between directly bonded polyimide films, eliminating adhesive-related risks such as outgassing and delamination while ensuring reliable, clean performance.

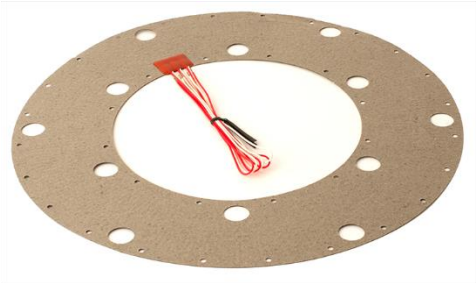
Applications

- Wafer processing equipment where cleanliness is critical.
- Burn-in and reliability testing sockets.
- Fluid delivery lines in high-purity gas/chemical systems.

Advantages

- Lowest contamination risk — all-polyimide design.
- Excellent dimensional stability and reliability under thermal cycling. Thin, flexible, and highly customizable for irregular geometries.
- Fast response with precise uniform heating.

MICA FLEXIBLE HEATERS



Minco's mica flexible heaters use etched-foil circuits sandwiched between thin mica insulation layers, delivering excellent dielectric strength and heat resistance. Designed for high-temperature stability, they can operate at higher watt densities than polymer-based heaters, making them a reliable choice for demanding semiconductor applications.

Applications

- Process chambers requiring elevated temperatures.
- Heaters for deposition and etching tools where thermal stability is critical.
- Custom fixtures that must operate above the limits of silicone or polyimide.

Advantages

- Operates up to ~600 °C in dry environments.
- Thin, rigid, and durable in high-heat applications.
- High watt density capability for fast heat-up.
- Resistant to many chemicals used in fabs.

SILICONE RUBBER FLEXIBLE HEATERS

Minco's silicone rubber flexible heaters feature wire-wound or etched-foil circuits laminated in durable silicone rubber, offering both ruggedness and mechanical flexibility. The silicone encapsulation protects the heating elements from moisture, abrasion, and vibration, providing reliable performance in semiconductor applications where contamination sensitivity is less critical.

Applications

- Chemical delivery lines and gas cabinets where flexibility and ruggedness are needed.
- Equipment enclosures requiring frost/condensation protection.
- Subassemblies with moderate temperature requirements.

Advantages

- Wide operating range (up to ~200 °C).
- Flexible and durable against mechanical wear.
- Moisture and chemical resistant.
- Cost-effective for larger-area heating.

Minco Feature Technology

SMARTHEAT® FLEXIBLE HEATERS

Minco's proprietary SmartHeat® flexible heaters provide an advanced, self-limiting thermal solution ideal for semiconductor applications requiring precise and reliable temperature control. Built with a positive temperature coefficient (PTC) material, SmartHeat® technology automatically adjusts power output in response to local temperature conditions. At low temperatures, the heaters deliver maximum wattage for rapid warm-up, while at higher temperatures, resistance increases, reducing current draw and preventing overheating. As the surface approaches its target range, the heater naturally lowers power input, maintaining safe and consistent performance. This self-regulating behavior often eliminates the need for complex external control systems, simplifying integration while ensuring efficiency, safety, and long-term reliability in sensitive semiconductor processes.

Applications

- **Wafer handling and robotics** — maintains components above dew point without risk of overheating.
- **Condensation prevention** in optics, sensors, and enclosures.
- **Gas lines and fittings** — ensures stable heat distribution across complex geometries.
- **Safety-critical or space-limited systems** where overheating could damage sensitive electronics or wafers.

Advantages

- **Built-in safety** — self-limiting technology reduces risk of thermal runaway.
- **Uniform heating** even in applications with varying thermal loads.
- **Reduced system complexity** — often eliminates need for external temperature controllers.
- **Energy efficient** — delivers only the power required to maintain stable operating temperatures.
- **Thin, flexible, and customizable** for semiconductor-grade applications.

With this expanded portfolio, Minco delivers the right heating solution for every stage of semiconductor manufacturing — from wafer processing to test and fluid delivery systems.

Temperature Sensors for the Semiconductor Industry

Minco offers a full portfolio of precision temperature sensors engineered for the accuracy, cleanliness, and reliability demanded by semiconductor OEMs and fabs. Each sensor type provides unique benefits depending on performance, environment, and integration needs.

BOLT-ON SURFACE SENSOR

Minco's Bolt-On Surface Sensors provide reliable temperature monitoring in semiconductor tools where easy installation and durability are essential. These sensors feature a rugged, flat metal tab design that mounts securely with standard fasteners. Built to withstand vibration, vacuum, and high-temperature conditions, Bolt-On Sensors are ideal for chamber, platen, and system-level temperature control in demanding wafer fabrication environments. Also available in bolt style cases for screw-in mounting.

Applications

- Chamber wall and platen temperature monitoring in CVD, PVD, and etch tools
- Heater and cooling system temperature feedback
- Process exhaust systems and gas lines
- Thermal management of support equipment (e.g., chillers, pumps, sub-systems)
- Preventive maintenance and external system diagnostics

Advantages

- Easy-to-install design with standard screw or screw-in mounting
- Provides rugged, long-term performance in harsh process environments
- Compact form factor allows placement in space-constrained tool areas
- Delivers stable, repeatable measurements for closed-loop thermal control
- Compatible with RTDs, thermocouples, or thermistors for application flexibility
- Easily serviced or replaced without major system disassembly

SPRING-LOADED MINIATURE SENSORS

Minco's Spring-Loaded Miniature Sensors are designed for precision temperature measurement in the demanding environments of semiconductor tools. The spring-loading mechanism ensures consistent contact with the sensing surface, delivering fast thermal response and highly accurate readings. Their compact form factor allows integration into tight spaces such as test sockets and burn in sockets.

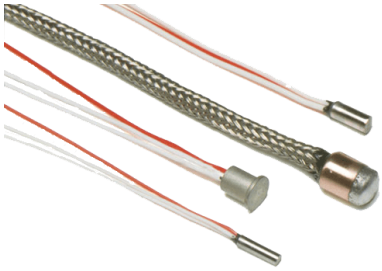
Applications

- Semi-conductor test sockets
- Semi-conductor burn-in sockets

Advantages

- Spring-loaded design ensures continuous thermal contact and improved measurement accuracy
- Compact size allows installation in confined spaces without compromising performance
- Fast response time supports precise thermal control and stability
- Rugged construction withstands vibration, vacuum, and thermal cycling
- Compatible with RTD, thermocouple, or thermistor elements depending on process needs
- Customizable designs for unique tool integration requirements

EMBEDMENT POTTED SENSORS



Minco's Embedment and Potted Probe Sensors deliver precise, reliable, temperature measurements directly at the heat source. These sensors are encapsulated in protective materials and designed for insertion into drilled holes, heater blocks, or platen assemblies, ensuring excellent thermal coupling. Their miniature size and rugged construction make them well-suited for semiconductor environments.

Applications

- Wafer chucks and heater blocks in CVD, PVD, and ALD tools
- Electrostatic chuck (ESC) assemblies with embedded heaters
- Process chamber components exposed to high heat or vacuum
- Thermal control of RF and microwave subsystems
- High-precision wafer stage temperature monitoring
- Gas delivery systems and cooling circuits
- Wafer annealing

Advantages

- Direct embedment provides superior thermal contact and fast response
- Potted construction improves durability against vibration, vacuum, and thermal cycling
- Compact design enables installation in tight or complex geometries
- Available with RTD, thermocouple, or thermistor elements
- Long-term stability and repeatability support advanced process control
- Customizable designs for unique semiconductor tool integration

From Concept to Control: Minco Integrated Assemblies

Integrated Sensor Assemblies

Minco's integrated sensor assemblies are custom-engineered solutions that combine RTDs, thermocouples, or thermistors with flexible heaters or circuits in a single package. By bonding sensors directly into the heater or flex design, these assemblies deliver accurate, real-time temperature feedback at the precise point of heating. This integration simplifies installation, reduces system complexity, and ensures optimized performance in demanding semiconductor applications.

Applications

- Wafer chucks, deposition tools, and etchers where space is limited.
- Chemical delivery lines requiring both heating and sensing.
- High-volume automated test systems.

Advantages

- Reduced component count for easier integration.
- Optimized sensor placement for precise closed-loop control.
- Cleanroom-ready materials and low outgassing designs.
- Increased reliability with fewer interconnects and assembly steps.

Why Minco for Semiconductor Heaters and Temperature Sensors

Minco is the trusted partner for precision thermal management in the semiconductor industry. With decades of expertise in designing and manufacturing high-quality heaters, temperature sensors, and integrated assemblies, Minco delivers solutions that meet the industry's most demanding requirements for accuracy, stability, and reliability. Our products are engineered to withstand vacuum, plasma, and high-temperature environments while providing fast response and repeatable control. From wafer chucks and heater blocks to chamber walls and gas delivery systems, Minco's expert engineering services and custom integration capabilities ensure optimized performance, reduced downtime, and greater process yield.