In the beginning of this section we offer complete sub-assembly packages that consist of a chamber, frame (hoist where applicable), both high vacuum and backing pump, gauging, valves, and load lock assemblies. The technical notes below focus on the individual components offered in the remainder of this section that are not included elsewhere in the catalog. These include both bakeout and sample heaters, load locks, and chamber frames.

Bakeout Heaters

When pumping a high-vacuum chamber, the pressure decreases exponentially. The reason is that the forces binding an adsorbed gas molecule to a surface depend, in part, on how many molecular layers separate that molecule from the surface. Molecules nearer the surface are bound more firmly than outer layers.

In any vacuum system, a molecule cannot be pumped until it enters the pumping mechanism, which only happens if the molecule is in the gas phase. Increasing the desorption rate is a major issue in achieving low chamber pressures in a reasonable time. The common method of increasing desorption rate is to raise the chamber temperature.

The typical bakeout temperature for a high vacuum chamber is between 150° C and near 200° C. However, to reach UHV pressures in the 10^{-11} Torr range, hydrogen diffusing from the stainless steel matrix is the major gas load source and the chamber must be baked to 400° C for many hours to speed up H atom migration through the steel's matrix.

External Bakeout Heaters

These devices are mounted outside the chamber, on a structural worktop below the chamber, and apply heat to the airside surfaces only. They are augmented, as appropriate, by a shaped insulating blanket or tent built around the system. The four heater types used for this application are resistive fin, ceramic, tape, and sleeve.

The resistive fin is, in effect, a normal cartridge heater mated to a number of fins that provide a large surface area for convection-driven heating of the chamber.

The ceramic heater is a serpentine rod heater potted in a ceramic material that relies more on radiation than convection for heat exchange.

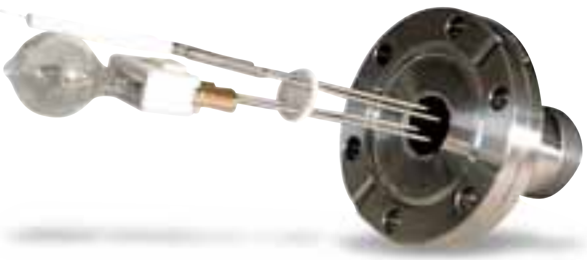
Heater tapes are resistance wires enmeshed in highly flexible woven fiberglass. They are wrapped around the chamber surfaces, transferring heat by conduction.

Sleeve heaters have resistance wires in 1/2" thick silicon rubber "boots" or sleeves that are molded to fit the size and shape of the specific ports and part of the chamber. Heat transfer is mostly conduction.

The highest chamber temperatures are probably obtained using the first two heater types. However, all types will usually give a local chamber surface temperature within the 150° C to 200° C range.

Internal Bakeout

Internal bakeout heaters are mounted inside the chamber but are designed to heat the chamber walls, not specifically a substrate or sample stage. A primary requirement for this type of heater is vacuum compatibility. They must have minimum outgassing when at temperature and cannot have volatile metals, such as cadmium or sinc, used anywhere in the structure or in the braze used to make electrical connections.



The flange mounted stab-in heaters use vacuum-compatible quartz IR lamps supported by the power feedthrough. Using a number of stab-in heaters mounted on 2 3/4" CF ports is an effective way of raising the chamber and contents to high temperatures, particularly if the exterior is well-insulated. Quartz tubular lamps with reflectors (*see below*) directed at the walls are also used as internal chamber heaters.

Sample Heaters

Quartz Lamp Heaters

The quartz tubular lamps with reflectors are popular sample heaters. Depending on the sample temperature required, two or four lamps are arranged around the sample's back-side, heating it by radiation.

Lamps are 4.75" to 6" long with a wattage from 200 to 1,000 watts, enabling them to heat multiple small samples, or larger single samples from 4" to 12" in diameter. Temperatures are controlled by thermocouple feedback to an SCR controller supplying the power to the lamps. But the actual maximum sample temperature depends on its emissivity, the distance from lamp, the illuminated area, and various geometric considerations, including the angle at which the radiation strikes the sample surface.

Temperature uniformity depends on the sample's thermal conductivity, the illuminated area, and the sample's rotational speed. With some samples, it's possible to reach backside temperatures of 900° C.

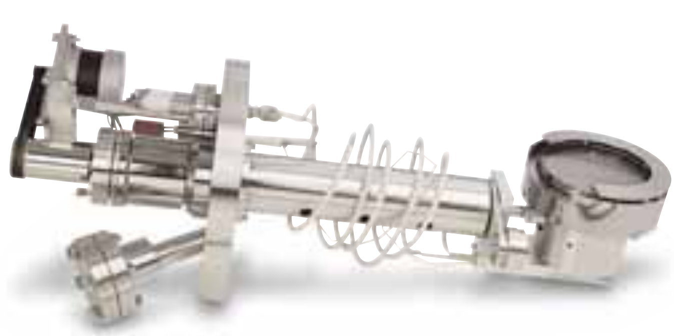
Button Heaters

These small cylindrical heaters (up to 2.5 cm diameter) have maximum surface temperatures between 950° C and 1,200° C at UHV pressures. The resistance wire is potted in alumina and sheathed in molybdenum. They are used for contact or radiation heating of small diameter samples.

Pyrolytic Boron Nitride Heaters

Discs of pyrolytic boron nitride (about 2 mm thick) are coated with a layer of pyrolytic graphite that is then cut in a (continuous) serpentine fashion to give it a long, uniform width path length. Finally, the graphite conductor is coated with a sealing layer of BN to reduce the heater chemical reactivity. The heater is capable of reaching a surface temperature of 1,200° C over disc diameters ranging from 1.8 cm to 5 cm, by applying power to each end of the serpentine.

EpiCentre® Heater & Rotator



The EpiCentre is a combined sample heater and rotator. The heater element is a serpentine machined from a graphite disc. While the heater element can reach 2,000° C, the construction of the sample holder and rotating components of the EpiCentre require the maximum operating temperature to be limited to 1,200° C to 1,400° C. The sample is heated from the back-side, and EpiCentres are constructed for sample diameters ranging from 5 cm to 15 cm.

Load Locks

The load lock is an intermediate vacuum chamber with its own pumping system and a quick opening door mounted between atmosphere and the entry point to the main chamber. It is connected to the main chamber by a gate valve large enough to allow transport of samples through it.

The load lock allows samples to be placed in the main chamber without breaking its high vacuum condition. With the gate valve closed, the load lock is vented, opened, and the sample placed on a linear motion device (LMD). The load lock's door is closed and it volume evacuated into the high vacuum range. When the gate valve is then opened the sample is moved into the main chamber by the LMD. Since both chambers are in the high vacuum range, only a small quantity of gas is transferred (usually from load lock to main chamber). Once the sample is in its correct position, the LMD is detached and removed from the main chamber. The gate valve is then closed and the main chamber returns to its base pressure.