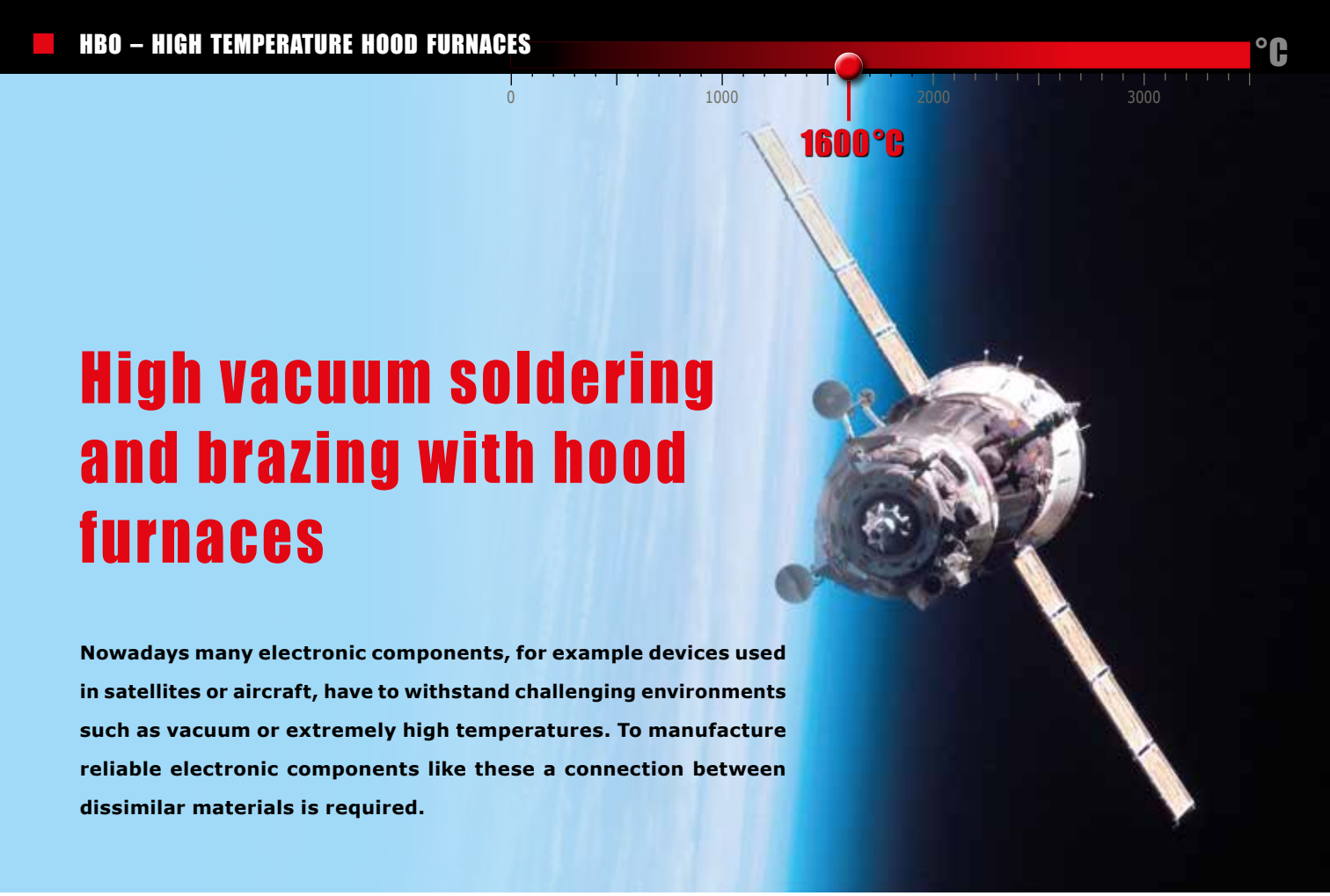


High vacuum soldering and brazing with hood furnaces

Nowadays many electronic components, for example devices used in satellites or aircraft, have to withstand challenging environments such as vacuum or extremely high temperatures. To manufacture reliable electronic components like these a connection between dissimilar materials is required.

FEATURES

- Flux-free connecting process
- Manufactured components withstand extreme conditions (vacuum, high temperatures)
- No chemical cleaning or sand-blasting necessary
- Lead-free solders
- Very economical method
- Metal gas interactions completely eliminated because of HV / UHV environment
- No absorption of embrittling gases
- Porosity-free

Connecting dissimilar materials

This connection can be metal-to-metal or even insulator-to-metal. It has to be strong, high temperature resistant and suitable for use in vacuum, as outgasing of flux material is not acceptable. The purpose of flux material is to remove remaining oxides and to reduce the surface tension in order to promote wetting of the dissimilar materials' surfaces. However, if exposed to vacuum or a high temperature environment, the effects of the flux on the electronic component are harmful. The flux material, which contains acid and salts, changes into the gaseous phase due to its high vapor pressure. The resulting condensation of the flux material on the insulators may produce conductive paths causing a leakage current. This process will destroy the expensive component. Unfortunately, the most active (and therefore corrosive) fluxes also form the strongest connections. Some material properties, for example vacuum resistance, cannot be obtained when manufacturing under conventional atmosphere conditions. One other problem with conventional atmospheres is that gas impurities are always embedded in the connecting surface.

The solution to this problem is high vacuum soldering and brazing. For both processes the connection between the two dissimilar materials is made by a third metallic material, the so called solder or brazing filler material. The exact distinction between soldering and brazing is that in the case of soldering (reversible) adhesion is predominant, whereas brazing (irreversible) produces diffusion of the materials, leading to a much stronger connection. The complete process takes place in a high vacuum (HV) or even ultra high vacuum (UHV) environment. These environments prevent oxidation and allow the usage of a solder made of flux-free material. The requirements for components used in vacuum environment are fulfilled.

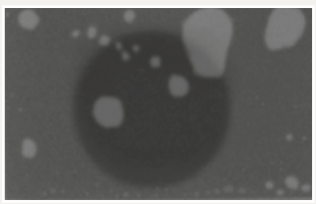
Soldering and brazing in a vacuum

To produce components which need to withstand extreme conditions, a furnace with special features is required. **The furnace needs to be completely sealed to permit heat treatment in a vacuum environment.** Depending on the materials and the solder involved, the temperature has to be adjustable **up to approximately 1200°C with superior temperature homogeneity and stability** throughout the entire sample. Data logging is another important factor: the dissimilar materials, for example, must have a certain temperature before the filler turns into a liquid. Therefore, the furnace should permit controllable and reproducible data logging.

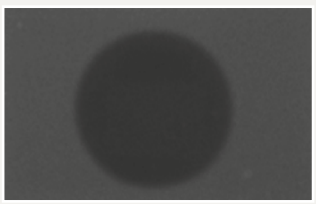
All these requirements are fulfilled by CARBOLITE GERO's HBO hood furnace, a metallic furnace based on tungsten or molybdenum for vacuum applications (HV or UHV) with a usable volume of 10, 25 or 60 l. Depending on the customer's vacuum requirement the leakage rate can be reduced (down to $< 10^{-3}$ mbar l/s) and a high vacuum pumping system attached.

In vacuum the heat transfer is only possible by heat radiation (Planck's radiation law) which yields the best temperature homogeneities, i. e. a temperature gradient in the hot zone of ± 3°C.

The thyristor-controlled power supplies of the heating zones inside the HBO provide superior temperature stability, i. e. a derivation with respect to time smaller than ± 1°C. Vibration-free operation is ensured to achieve a bright connection interface free of any distortion.



Conventional connection: gas impurities are clearly visible



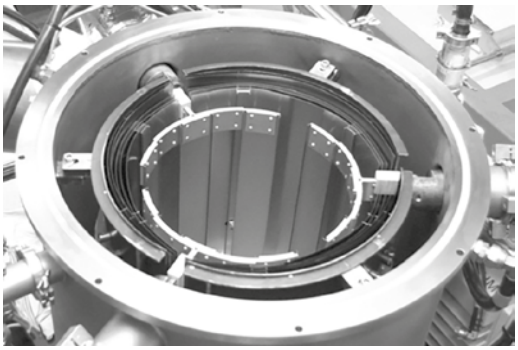
Connection with high vacuum soldering and brazing: hardly any impurities

Image source: EADS Deutschland GmbH

CARBOLITE GERO hood furnace range HBO

The automated up and down movement of the furnace hood facilitates loading and unloading and makes the sample easily accessible. The furnace body and the current feedthroughs are water-cooled and each water outlet is temperature controlled for increased safety. The operator enters a step program in a program table. The table is then loaded into the stored program control and the process runs fully automatically without user supervision. Before every start-up the furnace automatically runs through a short start routine which involves a test for major leaks and checks whether the required pressure is achieved.

HBO hood furnaces are equipped with a turbo molecular pump in combination with a pre-pump as standard. The vibration of the pumping system is decoupled from the furnace body. Before loading and unloading the furnace is vented with inert gas for particularly pure atmospheres.



View inside the heating chamber of an HBO furnace

Examples of electronic components

- Components for EDX devices
- Soldering of transmitting tubes / laser tubes
- Aircraft engines and components
- Radiators attached to anodes and collectors
- Circuit boards in jet planes
- Electron tubes

Application Example

Navigation systems are increasingly used in cars, mobile phones or other electronic devices. Speed measurement and a positioning accuracy of a few meters are common features of these systems. The data for the Global Positioning System (GPS), on which most navigation systems are based, is provided by satellites. In 2014 as many as 31 satellites are moving in their orbit around the earth. At a height of 20,000 km the **satellites are exposed to vacuum and extreme temperatures and the electronic devices which are part of the satellite need to withstand this environment.** High vacuum soldering and brazing is the most effective method for producing electronics that meet these demands.