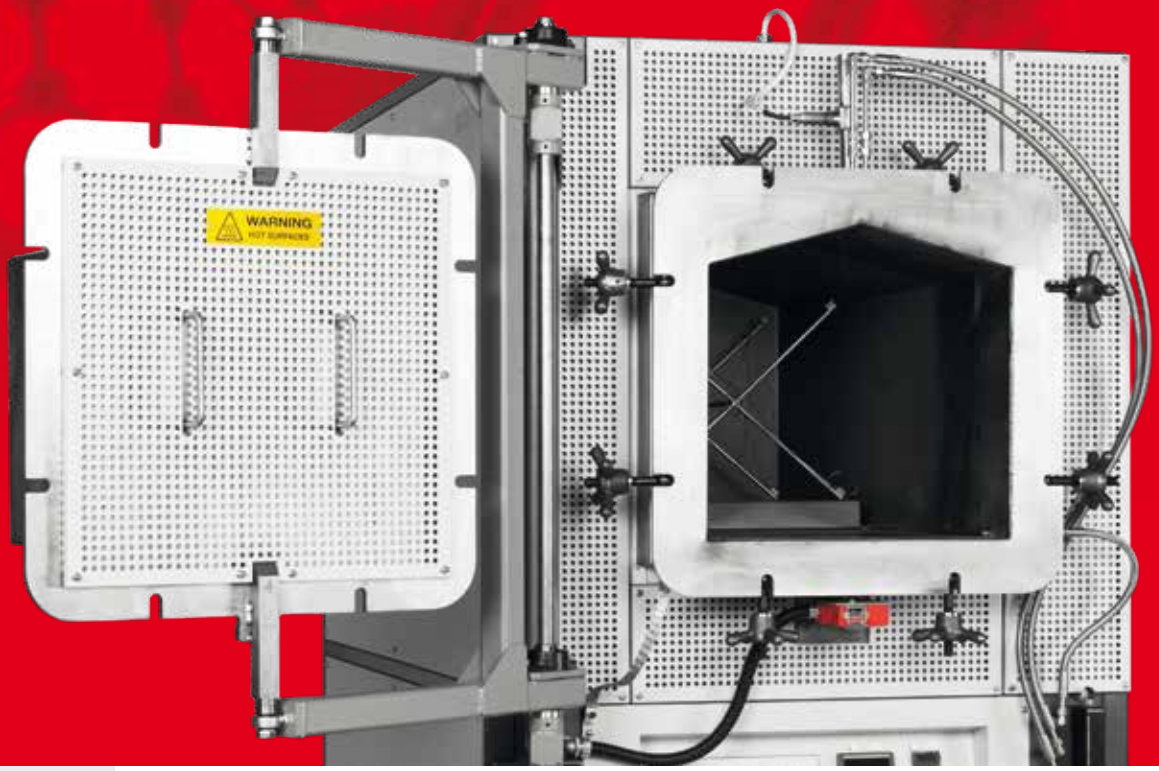
CARBOLITE GERO 30-3000°C

Heat Treating
3D Additive Manufactured Parts

GPCMA/174 Retort Furnace



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Introduction

At present there are two main techniques used in the additive manufacturing of 3D metal parts. These take time but are outstanding for creating complex or 'impossible' parts which cannot be created using traditional casting or machining methodologies. This has already resulted in the creation of a multitude of prototype pieces as well as countless 'impossible parts' for the aerospace, automotive, tooling and medical sectors.

Electron Beam Manufacturing (EBM) when metal powders or wire are welded using an electron beam in a vacuum chamber. This avoids oxidisation and does not require the subsequent heat treatment of manufactured parts.

Direct Metal Laser Sintering (DMLS) uses a laser in a pure inert Argon atmosphere. The process is digitally driven, direct from 3D CAD data. For each slice of CAD data a thin even layer of fine sieved metal powder (titanium alloy Ti6Al4V, cobalt chromium, stainless steel, nickel alloys Inconel 625 and Inconel 718 and aluminium alloy AlSi10Mg) is deposited on the build plate, before the selected areas of the powder are precisely melted by the laser. This precision process is repeated building up, layer by layer, until the finished part is complete.

DMLS can be used for very small parts and features. It can reproduce geometries that would otherwise be impossible to machine such as enclosed spaces. Layers can be as thin as 20 microns and tolerances on small features can be as small as ±50 microns.

At present build rates for components using a DMLS process are slow. Costs are also high as raw metallic powders must be produced using a ball-mill/grinder and then sieved and tested prior to usage. Current DMLS machinery requires a substantial investment. However, if the required part has dimensions up to 250 mm x 250 mm x 350 mm the process could well be perfect for organisations who require rapid prototyping or small quantities of complex or 'impossible' parts that can subsequently be machine drilled, slotted, milled, reamed, powder coated, painted, polished or anodised.

The market for 3D Additive Manufacturing is growing rapidly. Journals, websites and tradeshows have blossomed as 3D manufacturing times continually reduce, maximum part sizes have increased, powder alloys have become more available and components manufactured for the aerospace, medical, tooling and automotive sectors in this way have gained standards approval in increasing quantities.

Heat treatment using a Carbolite Gero furnace

The Direct Metal Laser Sintering process requires a heat-treatment solution with precise temperature uniformity. This ensures the manufactured parts adhere to the proper metallurgical properties of the selected metal alloy and stresses which build up in the component during the DMLS process are effectively relieved.

The heat treatment stage occurs in an inert (typically Nitrogen and Argon [for Titanium]) atmosphere to ensure the sintered part is not contaminated by oxygen molecules which can alter the chemical and physical properties (porosity) of the final component. This inert process must be repeatable with a well measured gas flow monitored to achieve an **AMS 2750E Classification** specified by the customer. In fact, in one specific example throughout the entire manufacturing process the atmosphere is maintained at <1000 ppm (0.1%) oxygen which can be reduced to as low as 100 ppm (0.01%) oxygen if a reactive metal such as titanium is employed.

The **General Purpose Chamber Modified Atmosphere (GPCMA)** furnaces from CARBOLITE GERO with Type B instrumentation meet the requirements of AMS 2750E Class 1 when used with an Inconel or Haynes 230 retort. Various sizes are available **(GPCMA/37, GPCMA/56, GPCMA/117, GPCMA/174, GPCMA/208 & GPCMA/245)** with capacities for between 1 and 4 build plates which are ideal for those involved in DMLS Additive Manufacturing.

A recent **GPCMA/174 retort furnace** with a working volume of 400 mm x 400 mm x 350 mm, automatic on/off gas control using a Eurotherm 3504 controller and 6180 XIO data logger. Argon/Nitrogen gas flow and trace levels of oxygen in the retort's modified atmosphere are constantly monitored. The CARBOLITE GERO GPCMA range has under hearth heating along with heating from the top and sides to improve temperature uniformity inside the retort where temperature thermocouples are located. The positioning of the Cascade Controls inside the retort enables faster heating times which can substantially reduce customer cycle times when used in conjunction with optional forced cooling.

To further shorten cycle times, the GPCMA/174 furnace has a temperature interlocked swing-out door facilitating quick, safe and easy access for loading / unloading with a water-cooled silicon rubber door seal which maintains a modified atmosphere inside the chamber throughout the entire heat treatment process.

In conclusion

CARBOLITE GERO has intentionally designed their GPCMA range with retorts for 3D Additive Manufacturing to the highest specifications. They avoid the issues that are frequently experienced with furnaces from other manufacturers.

The most common issues reported by users with other furnaces are their inability to maintain an inert atmosphere, their requirement for large volumes of expensive inert gases or the need for extra equipment to remove the retort when loading / unloading parts. All of these detracting issues have been overcome by CARBOLITE GERO to ensure everyday operating costs for our customers are minimised; unwanted oxidisation is eliminated and temperature uniformity is "best in class". Most importantly, production cycle times are significantly reduced thanks to heating on four sides, a forced cooling option and easy loading / unloading through our unique water-cooled silicon sealed swing out door.

To best demonstrate our capabilities, CARBOLITE GERO is now offering **customer trials** for any organisation wishing **to validate a heat treatment process for their DMLS components**. This paid-for testing is charged at just £800 per part and is fully refundable on placing an order for a GPCMA/174 specified to a required AMS 2750E classification.

For further information or to discuss heat treatment for your specific DMLS parts, please call Richard Bilson or Paul Haigh at CARBOLITE GERO on +44 (0)1433 620011.