surface technologies

aalberts

hot isostatic pressing

for the improvement of mission critical parts

Hot Isostatic Pressing (HIP)

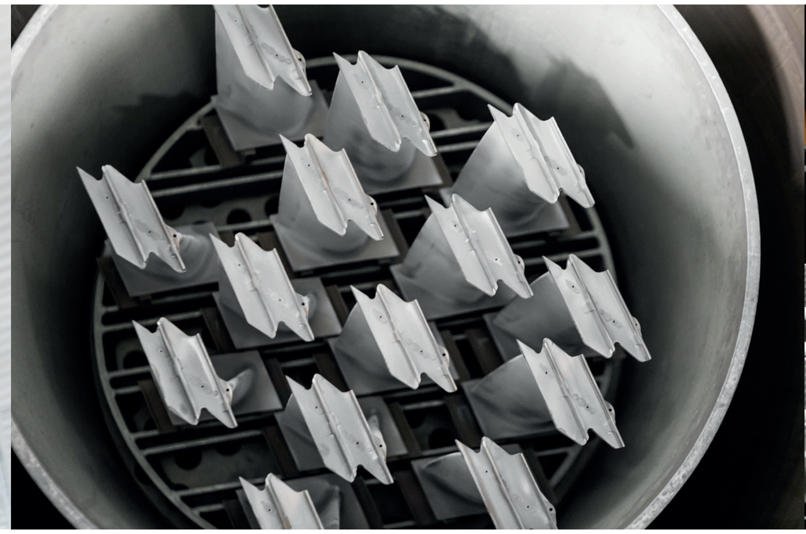
HIP involves the simultaneous application of a high-pressure inert gas and an elevated temperature in a specially constructed vessel. The pressure applied is isostatic because it is developed with a gas. Under these conditions of heat and pressure, internal pores or defects collapse and weld up. HIP can be applied to castings and additively manufactured parts, to consolidate powder metallurgy materials into fully dense components and to bond dissimilar materials together. HIP gives improved mechanical properties and a reduction in the scatter band of properties.

Proven benefits

- Superior material properties
- Reduced property scatter
- Improved machined & polished surface
- Low weight design
- No internal defects
- Lower production cost

Suitable materials

- NI base alloys, Inconell®, Hasteloy®
- Steel
- Toolsteel
- Copper alloys
- Titanium
- Aluminium



How does HIP work?

The simultaneous application of heat (up to 1400°C) and pressure (up to 207 MPa) eliminates internal voids and microporosity through a combination of plastic deformation, creep, and diffusion bonding; The furnace chamber is heated, causing the pressure inside the vessel to increase. Many systems use associated gas pumping to achieve the necessary pressure level. Pressure is applied to the material from all directions (hence the term “isostatic”).

What technology it uses?

HIP significantly increases the chances of success in mission-critical, high-risk applications such as aerospace, nuclear power and orthopedic implants. Hot isostatic pressing originated some seventy years ago in the development of industrial diamond (Quintus) and cladding for nuclear fuel rods (Battelle Institute) and has since become a standard process for cast and powdered parts in applications where the performance is essential. HIP provides material properties and design safety factors close to theoretical values, allowing for lean designs and reducing the need for non-destructive testing and evaluation.

Our quality accreditations

- ISO 9001
- AS/EN 9100
- NadCap
- ISO 14001

Advantages

HIP allows developers to optimize component design and manufacture, whilst simultaneously improving microstructural homogeneity and material properties.

Improved properties

HIP gives improved mechanical properties, a general reduction in scatter of these properties, as well as the possibility to polish also cast, welded or powder metal parts, to the highest surface finish offering more predictive properties.

Steering the HIP cycle

Set-up specific heating, densification and cooling regimes to ensure repeatable performance. This enables the design of desired microstructures and properties. Heat treatment (stress relief, solution annealing) and HIP can be done in one tailored HIP process step.

Clean HIP operations

High purity Argon as process gas together with special equipment programming and hardware allows to achieve clean processing results reducing discoloration.

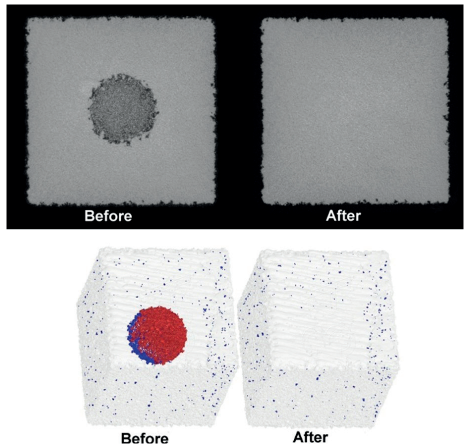
Efficient production

High speed production of components (e.g. fast printing in AM) in combination with defect removal and heat-treatment using HIP, can reduce energy significantly whilst reducing overall cost.

A process for many industries

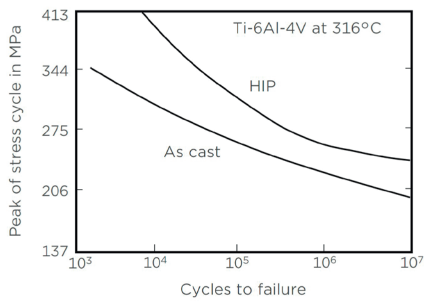
- Additive Manufacturing
- Aerospace & Defense
- Automotive
- Diffusion bonding
- Energy / Industrial Gas Turbine
- Firearms
- Investment Casting
- Medical
- Nuclear
- Oil & Gas
- Powder metallurgy / Near-Net-Shape

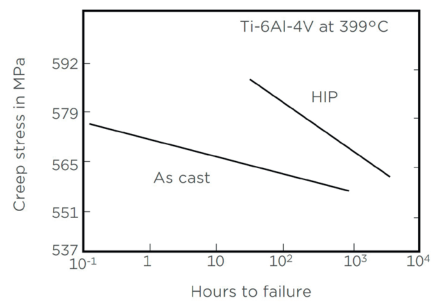
Microstructure pre HIP vs. post HIP



X-ray tomography reveals pore closure. The same cube with an artificially designed spherical cavity imaged before and after HIP, showing how metal powder is consolidated and no pores remain after HIP in the centre of the cube. Source: A. du Plessis et al. Addit. Manuf. Vol. 34, 2020.

Improved material properties





Influence of HIP on fatigue properties (left) and creep life (right) of Ti-6Al-4V. Source: Atkinson et al. 1991.

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