Depletion of CRM alloying elements from the surface layer during hot isostatic pressing of superalloy IN100

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Introduction

**Hot isostatic pressing (HIP)** - HIP is a thermo-mechanical process, comprising of simultaneous use of the hydrostatic pressure of gas (Ar) and elevated temperatures (>1000°C). The HIP procedure causes hardening of the material and increase of density. The HIP is of great importance for superalloy castings due to the almost complete elimination of micro-porosity by a combination of plastic deformation, creep and diffusion.

**Superalloys** - Superalloys are a group of materials that can be based on Ni, Ni and Co, and are used for parts that operate at high temperatures. Superalloys have a good combination of high temperature stability, environmental resistance, excellent creep resistance and stress cracking, hardness, metallurgical stability, thermal expansion, and resistance to thermal fatigue and corrosion.

Problem

During the HIP a carbide free zone and a contaminated surface layer are formed. This leads to loss of critical row materials (CRM) alloying elements (Al, Ti, Cr, Co, V, Mo) from the surface, and loss of material due to removal of contamination layer.

Experiment

A formed contaminated surface layer was tested by measuring the thickness of the contaminated layer on samples placed in the three zones within the HIP furnace:
• 3 samples in the upper zone
• 3 samples in the middle zone
• 3 samples in the lower zone

The contaminated layer and carbide free zone has been studied on differently grinded (P240, P1000 and polished) samples made of superalloy IN100.

Results

The maximum thickness of the contaminated layer occurs for the sample prepared with grinding paper P240 and it is 1.728 µm, while the lowest layer thickness was 0.888 µm, in case of polished samples. Contaminated layer is consisted of oxides, carbides and nitrides formed due to the diffusion of chemical elements from metal matrix and their reaction with impurities in HIP atmosphere. The ressurface of the superalloy, while the polished specimens have visibly thinner contaminated layers, the thickness of the contaminated layer depends on the quality of the preparation of the samples. The largest contaminated layer occurs in samples that are sanded with grinding paper of the grain P240, while the polished specimens have the thinnest contaminated layers.

The contaminated layer is easily removed, most often by sand blasting. A formed contaminated surface layer was tested by measuring the thickness of the contaminated layer on samples placed in the three zones within the HIP furnace:
• 3 samples in the upper zone
• 3 samples in the middle zone
• 3 samples in the lower zone

The contaminated layer and carbide free zone has been studied on differently grinded (P240, P1000 and polished) samples made of superalloy IN100.

Conclusions

- The thickness of the contaminated layer depends on the quality of the surface and the preparation of the samples. The largest contaminated layer occurs in samples that are sanded with grinding paper of the grain P240, while the polished specimens have visibly thinner contaminated layers.
- The contaminated layer is consisted of oxides, carbides and nitrides formed due to the diffusion of chemical elements from metal matrix and their reaction with impurities in HIP atmosphere.
- The contaminated layer is easily removed, most often by sand blasting.

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