

Production advantages using laser cladding as an additive manufacturing method



Objective

Is it possible to obtain the same material characteristics of a component using laser cladding as an additive manufacturing method compared to producing the component conventionally?

This poster describes industrial trials with laser cladding and precipitation hardening heat treatment of thinwalled structures with the 17-4 PH stainless steel alloy. Due to the great relevance of the AM production methods for the aviation industry, the mechanical strength of the alloy given by the MMPDS document is used as a baseline. In order to improve the properties of the produced specimens, hot isostatic pressing was applied

Method and Tests

The AM 17-4 PH samples are manufactured using a purpose-built and commercially available laser cladding system. The powder entering the laser focal point is melted and deposited on the sample surface. Laser powers in the range 1.4 kW to 2.1 kW were applied. Hereafter the items are heat treated as per scheme Table 1.

Table 1. Heat treatments.

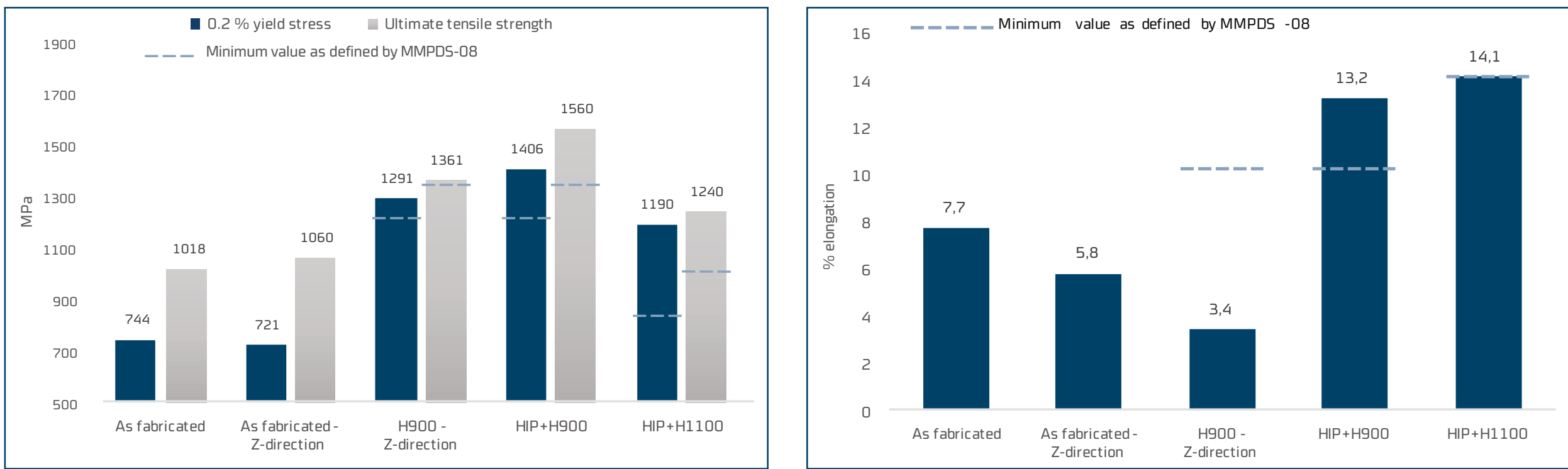
Treatment	HIP	Solution treatment	Ageing
As fabricated	-	-	-
H900	-	1030°C x ½ hour	482°C x 1 hour
HIP+H900	X	1030°C x ½ hour	482°C x 1 hour
HIP+H1100	X	1030°C x ½ hour	593°C x 4 hours

Hot Isostatic Pressing (HIP) is a common post-treatment which is routinely used on cast turbine components and on powder metallurgical parts. This treatment causes a significant improvement of the mechanical properties by closing and diffusion bonding internal pores and defects. This is accomplished at a high external pressure in the range of 800-1000 bar and at temperatures close to the melting point of the alloy.

The mechanical properties were quantified by tensile testing and elongation. The tensile test was conducted as described by ISO EN 6892-1. Samples were oriented in the build direction as well as perpendicular to the build direction. The fracture surfaces were inspected using scanning electron microscopy.

Results

The results show that a post processing treatment consisting of a HIP cycle and a conventional precipitation hardening, vastly improves the mechanical strength and elongation values of printed specimens, causing them to exceed the specified MMPDS values.



Conclusion and Outlook

- The fabricated AM 17-4 PH responds readily to conventional H900 and H1100 heat treatments.
- Poor elongation caused by a porous initial microstructure can be improved by a HIP treatment.
- With the HIP treatment, the AM 17-4 PH complies with MMPDS minimum mechanical strength and elongation values.

It would be highly relevant for the application of 17-4 PH to the aviation industry to verify whether the fatigue strength properties are also comparable to those of conventionally produced 17-4 PH.

