CQFA CARREFOUR QUÉBÉCOIS DE LA FABRICATION ADDITIVE

CASE STUDY

TI-6AL-4V VALVE BONNET REPAIR

Project duration

From 2018 to 2019

Partners

Centre de métallurgie du Québec (CMQ)

Materials

Metal (Titanium: Ti-6Al-4V)

Processes

DED (Directed Energy Deposition) – Optomec's LENS process (Laser Engineered Net Shaping)

Application fields

Industrial sector in general, oil and gas, chemical, petrochemical, electrical, pharmaceutical and mining industries in particular.

OBJECTIVES

To repair cast parts while minimizing the impact on the final part's properties.

BACKGROUND

The lost-wax casting process produces high-quality, high-value-added titanium parts. But rare defects can occur, even with a controlled process. This can result in the part's rejection. An interesting alternative involves repairing the cast part rather than rejecting it to recover the metal. To achieve this, Fluorseal Inc. contacted the Centre de métallurgie du Québec (CMQ) to develop a repair process for a Ti-6Al-4V valve bonnet through a research project funded by the Natural Sciences and Engineering Research Council (NSERC).

THE CHALLENGE

Parts are typically repaired through welding. In certain cases, however, like those involving smaller parts, the energy transmitted through welding often becomes very high and can distort the part's final geometry. Significant thermal stresses and the presence of heat-affected zones can also occur, increasing the risk of cracks in the alpha case over a longer range. This alpha case is always present because the heat treatment, along with the chemical and mechanical machining steps, are performed after the repair to avoid having to repeat these steps.

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Valve bonnet with defect.

Valve bonnet repaired

THE SOLUTION

These issues required a repair technology that produces very low induced heat. The solution involved Directed Energy Deposition (DED) or, more specifically, the Optomec's LENS process. Here, Ti-6Al-4V powder was projected into the laser beam in an inert argon atmosphere. Six hundred-µm-wide and 450-µm-thick passes with low laser power helped minimized the thermal stress, distortion and risk of cracking. Parts repaired in this way can be returned to their regular post-treatment process, thus minimizing external additive manufacturing costs.

BENEFITS/RESULTS

The case study that was conducted in partnership with Fluoroseal Inc. demonstrates the ability of Directed Energy Deposition technology to repair titanium parts with casting defects by minimizing the repair's impact on the part's tolerance while preventing new defects caused by eventual repairs. The study also reveals mechanical part properties that are superior to those observed in cast parts. When compared to single-unit production costs, this study shows that the loss of almost one unit can be transformed into a profit of 0.25 units. More details on this study can be found in *Titanium Today, November 2019*.

CONTACTS

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