Manufacturing, Remanufacturing and Reconfiguration of Aerospace Components with Direct Metal Deposition (DMD)

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Introduction

Titanium alloys are used in aerospace industry due to their high strength to weight ratio [Murat, 2018]. Nickel based superalloys are used by the aerospace industry for their excellent high temperature mechanical and physical properties. They exhibit great thermal fatigue and oxidation resistance and are frequently used in applications where they are exposed to temperature range of 540˚C to 1000˚C [Attallah 2016]. Ferrous alloys are used because for their relatively low cost.

This article explores the use of an additive manufacturing technique called Direct Metal Deposition (DMD) for manufacturing, remanufacturing and reconfiguration of components made out of alloys commonly used for aerospace applications. Since additive manufacturing creates near-net shape components, the necessity to use material removal techniques is minimized and the overall manufacturing cost can be greatly reduced [Garybill 2018]. This technique can also be coupled with conventional manufacturing processes to reduce the cost of the overall component. Furthermore, this technique is very well suited for large components. This article compares the merits and limitation of DMD to conventional and other additive manufacturing/welding techniques through a series of case studies.

Background

As shown by Figure 1, DMD uses an especially designed laser nozzle to create a melt pool on a substrate that is mounted on a CNC platform. The nozzle then injects metallic powder into the melt pool. The increase in volume due to the powder creates a bead. By either moving the substrate or the nozzle, 2D shapes can be formed. By stacking these shapes, 3-dimensional features can be created. The nozzle creates a shroud of shielding gas around the melt pool to protect it from oxidation. For reactive materials like Titanium, the process is enclosed in an inert chamber [Froes 2014, Dutta 2013].

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