

Q4 Titanium 6-4 Material Properties Development

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Sponsoring Program(s)

Human Exploration and Operations Mission Directorate
Space Launch System Advanced Development

Project Description

This task involves development and characterization of selective laser melting (SLM) parameters for additive manufacturing of titanium-6%aluminum-4%vanadium (Ti-6Al-4V or Ti64). SLM is a relatively new manufacturing technology that fabricates complex metal components by fusing thin layers of powder with a high-powered laser beam, utilizing a 3D computer design to direct the energy and form the shape without traditional tools, dies, or molds. There are several metal SLM technologies and materials on the market today, and various efforts to quantify the mechanical properties, however, nothing consolidated or formal to date. Meanwhile, SLM material fatigue properties of Ti64 are currently highly sought after by NASA propulsion designers for rotating turbomachinery components.

The primary objective of this task is to utilize NASA Marshall Space Flight Center's (MSFC's) existing SLM equipment (fig. 1) and knowledge base with other metal alloys to generate a reduced design allowables database of expected properties for SLM Ti64 parts. Unlike Inconel 625, Ti64 has never been used in MSFC's Concept-Laser SLM machine prior to this development effort. Therefore, we are starting with an initial build development followed by parameter optimization. Initial build development entails finding the correct general parameters, build plate materials, and build settings that yield satisfactorily dense (>99.5%) parts that will build to

completion. Initial build development also entails maintaining and further honing our safety protocols around Ti-6Al-4V. As a reactive powder, it requires vigilant grounding and safety consciousness in order to expose the minimal number of operators to the least risk for the smallest amount of time.



Figure 1: SLM machine with glovebox required for Ti64.

Notable Accomplishments

The first build plate was a set of four small material test samples built on a stainless steel 90 mm × 90 mm build plate. Four samples were run at 250 W, 1,600 mm/s with varying spot sizes in an effort to quantify the melt pool size of Ti-6Al-4V in the SLM. Part parameters were based on parameters successfully used at KU Leuven on a similar laser system. Three of the four samples failed to build due to peeling off the plate due to dissimilar λ . This has been corrected for by switching to Ti-6Al-4V build plates. The surviving part has been sent for sectioning and will be used to determine initial density. Parameters will be adjusted accordingly to achieve the highest density possible.

References

Crumbly, C.M.; Bickley, F.P.; and Hueter, U.: “Space Launch System Spacecraft/Payloads Integration and Evolution Office Advanced Development FY 2014 Annual Report,” NASA/TM—2015–218201, NASA Marshall Space Flight Center, Huntsville, AL, January 2015.