Advances in Printability of Aluminium AM Powders:

Solution to Hot Tearing in LBPF Printing of AM Structural Parts.

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ABSTRACT

Aluminium 2024 and 6061 grades are frequently chosen as a cost-effective structural material for their high strength to weight ratio in many aerospace applications. However, aluminium AM parts built from the laser powder bed fusion (L-PBF) process using conventional aluminium 2024 and 6061 compositions suffer from hot tearing defects that compromise their strengths and diminish their AM applications in structural engineering.

The application of a patented reactive additive manufacturing (RAM) technology to nonweldable ubiquitous Al 2024 aerospace grade aluminum powder has solved these mechanical defects. It has been found that Al2024 powders with RAM constituents can now be used successfully to build structural AM parts in the L-BPF process, possessing mechanical properties that are also superior to wrought parts. This difference can be attributed to the uniform grain refinement and particle reinforcements that result from the formation of submicron inoculants associated with the RAM additive reacting within the laser melt pool, which lead to a dense heterogeneous nucleation process. As can be explained by the Hall-Petch model, this grain refinement and particle reinforcement lead to enhancement in AM build yield strength and in material ductility.

To further adopt this RAM technology across a broad range of alloy compositions, a simple but novel technique is proposed to enable qualitative evaluation if any of over 5,000 commercial wrought alloys are suitable candidates for this RAM technology. The microstructure of a single-laser pass across the wrought alloy surface can provide qualitative insight to this possibility. Therefore, a targeted strategic AM powder material development approach can be successfully conceived to apply the RAM technology for broader range of L-BPF metal alloyed AM powders.

INTRODUCTION

Although the availability of the number of additively manufacturable 3D printable alloy powders is growing, most of these 3D alloyed powders are limited to known easily weldable wrought materials. For the L-BPF process, there are few conventional alloys such as AlSi10Mg, TiAl6V4, CoCrMo, and Inconel 718 that can be reliably printed.