MARANGONI CONVECTION IN SELECTIVE LASER MELTING (SLM) OF 316L STAINLESS STEEL

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ABSTRACT

Metal additive manufacturing (AM) produces parts by addition as compared to subtraction of material. Selective Laser Melting (SLM) is an AM technique that prints objects layer-by-layer, selectively melting powders using a focused laser. The mechanical properties of SLM parts are affected by processing parameters and powder characteristics, both of which alter the flow within the melt pool. Marangoni convection (M-flow) is a thermo-capillary mass transfer from a region of lower surface tension to a region of higher surface tension, defined as radially outward flow for SLM. However, with the presence of surface-active elements such as oxides and sulfides, the melt pool surface flow direction may shift from outward flow to radially inward flow (inverse M-flow). Balling and pores, the most common defects, have been correlated to the presence of inverse M-flow but the relation has yet to be quantified. A path to start the quantification of the relation is presented. The article is a review of existing work regarding SLM, Marangoni convection, and the use of high-speed visualization of melt/weld pool. In addition to the existing work, a strategy for continued work and expected results are contained within. The surface flow of the melt pool during SLM of 316L stainless steel will be visualized using a high-speed camera and the images will be analyzed using Particle Image Velocimetry (PIV) to determine the velocity and directions of the surface flow of the melt pool. The melt pool surface flow velocity profile development over time will be demonstrated to quantify the transition of surface flow of the melt pool direction over time.

INTRODUCTION AND BACKGROUND

Additive manufacturing (AM) is a manufacturing technique that builds an object layer-by-layer using a computer aided design (CAD) model. Additive manufacturing, also known as three-dimensional (3D) printing or rapid prototyping, is named after the method of manufacturing where components are built from the addition of materials as opposed to the removal of undesirable material using conventional