

Supplementary Information

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Abstract

Cracking during Laser Additive Manufacturing is a problem for many higher-strength aluminium alloys, including AA6061. Here, we used a pulsed laser with ramp-down power modulation to improve the cracking resistance by about 50% compared to the use of a rectangular pulsed laser. Using synchrotron *in situ* X-ray imaging at 100 000 images s^{-1} , ground truth data was obtained about changes in melt pool geometry, solidification rate, and thermal gradients were calculated. An analytical hot cracking model was developed to show that these changes lead to a decreased hot tear susceptibility. Therefore, laser pulse modulation can be an effective tool to reduce crack susceptibility of alloys. More fundamentally, the results demonstrate that modifying thermal conditions provides a pathway to crack elimination in LAM and the model established in our study sets the foundation for further complex laser manipulation in modifying the printability and resulting mechanical properties of hard-to-process alloys in Laser Additive Manufacturing.

Keywords: Laser Additive Manufacturing, X-ray imaging, cracking, aluminum alloy

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1. Supplementary videos

1.1. *Supplementary Video 1*

Time-resolved radiographs captured the solidification behavior of AA6061 during laser additive manufacturing under a rectangular pulse shape.

1.2. *Supplementary Video 2*

Time-resolved radiographs captured the solidification behavior of AA6061 during laser additive manufacturing under a 10 ms ramped-down pulse shape.

2. Supplementary figures

2.1. *Tomography reconstruction slices*

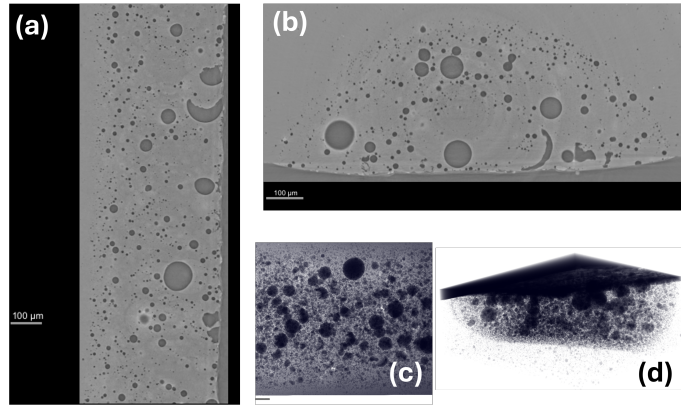


Figure 1: Tomography scan reconstructed slices of AlSi10Mg after laser additive manufacturing under a rectangular pulse shape. (a) Slice along the laser direction in the middle of the sample; (b) Slice cross the laser direction showing melt pool geometry; (c) 3D volume reconstruction top view revealing porosity distribution; (d) 3D volume reconstruction side view revealing porosity distribution.