Origins of melt ejection and spatter in laser powder bed fusion additive manufacturing

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Description

The research team at Lawrence Livermore National Laboratory has studied the origins of melt ejection and spatter in laser powder bed fusion system including a 600 W fiber laser.

The full article was published in Nature Scientific Reports 7, Article number: 4085 (2017) under the title “Metal vapor micro-jet controls material redistribution in laser powder bed fusion additive manufacturing”. The publication was nominated as part of Nature Sci Reports “Top 100 in Materials Science” collection. The article can be found from: https://www.nature.com/articles/s41598-017-04237-z.

The study showed that the dominant mechanism for micro-droplet ejection in a laser powder fusion bed is the vapor driven entrainment of micro-particles by an ambient gas flow. This result is contrary to the current believe that the ejections result mainly from the laser induced recoil pressure.

The team captured the experiments with a high-speed camera with microscope optic for frame rates up to 100.000 frames per second and an ultra-high-speed camera for frame rates up to 1 Million fps. As light source the customer chose CAVILUX HF laser illumination which allows elimination of the process light while enabling a well illuminated are. The short pulses help in reducing motion blur which is beneficial during the study of fast moving powders and melt particle.

The following images show parts of the laser scanning through powder. In Figure 1 you can see small protuberance forming at the surface of the melt. Then a neck sticks out (Figure 2), and liquid particle is ejected (Figure 3). The particles being swept upward and away are entrained particles.

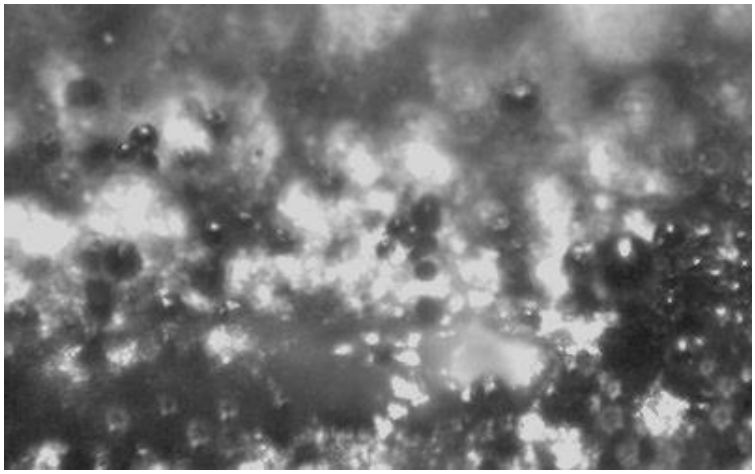

Figure 1: Formation of a small protuberation

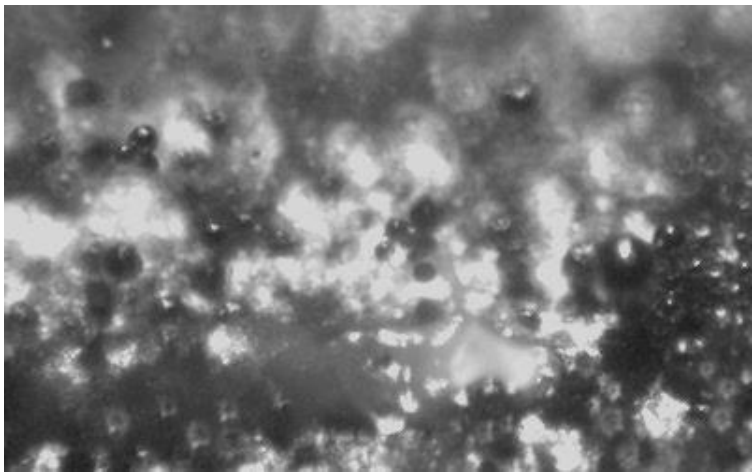

Figure 2: Neck formation

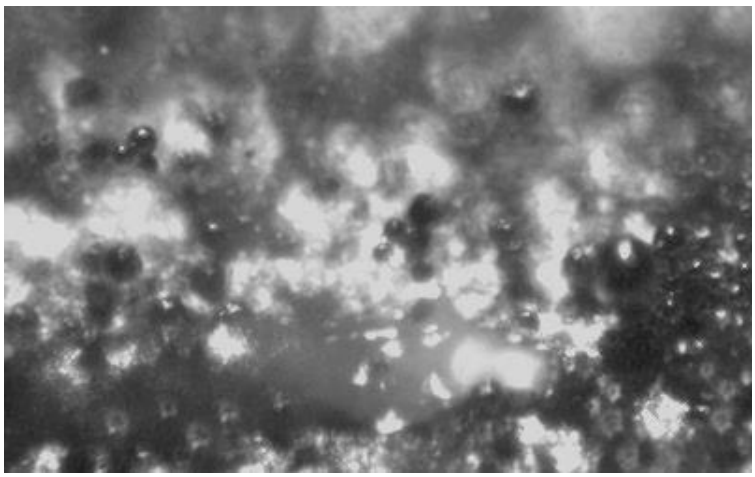

Figure 3: Ejection of liquid particle

Measurement setup

Ablation Laser:	1064nm, 250W, travelling speed of 500 mm/s
Material:	Ti64 powder
Camera:	666kfps, 300ns exposure
Illumination:	CAVILUX HF 100ns pulse length

Imaging technology

Camera up to 100 kfps: Photron SA-X2
Camera up to 1 Mfps: Shimadzu HPV-2
Illumination: CAVILUX HF System by Cavitar

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Auspices Statement

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