Observing Molten Pool Surface Oscillations During Keyhole Processing in Laser Powder Bed Fusion

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Description

The research team at the Department of Mechanical Engineering of the Politecnico di Milano has studied a method to estimate the penetration depth of the molten pool during the LPBF process, i.e. laser powder bed fusion process. The results show that it is possible to correlate molten pool surface oscillations to the penetration depth when measured using high-speed imaging. This method can lead the way to the extraction of new process stability indicators and possibly be applied to other laser manufacturing processes.

The principle is based on the observation of molten pool surface ripples through the measurement of probe light reflections in the melt area. A monitoring system consisting of a high-speed camera and CAVILUX HF laser illumination was used to view the process. Both bead-on-plate material remelting and single track powder bed fusion depositions of AISI316L at different levels of laser emission power were realized. Oscillation frequencies were extracted from the high-speed imaging acquisitions after image processing and signal analysis. The surface wave oscillations were measured to be in the range of 3.5–5.5 kHz in keyhole conditions. Metallographic cross-sections allowed the observation of the effective molten pool penetration depth as well as cross-sectional area, and were correlated to oscillation frequencies. Higher values of oscillation indicated shallower penetration and consequently a smaller mass of molten material.

The full scientific article with more information on the research can be found from:
https://www.sciencedirect.com/science/article/pii/S2214860420308423

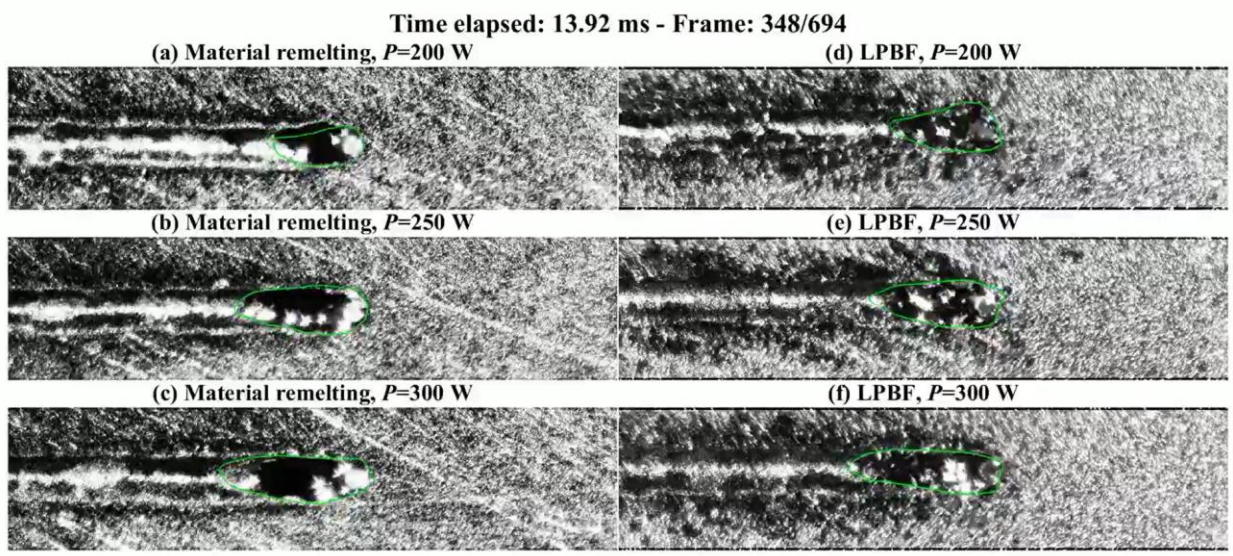

Figure 1: Reflections in the melt pool surface ripples

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Video under: https://youtu.be/pilpaqg4tFk

Measurement setup

Process laser:	nLight Alta 1 kW single mode fiber laser
Material:	AISI316L
Camera:	25.000 fps, 666 ns exposure, Spatial resolution 4 µm/pixel, Field of view 4.096mm x 1.096mm
Illumination:	CAVILUX HF 600 ns pulse length

Imaging technology

Camera:	Fastcam AX200
Illumination:	CAVILUX HF Laser Illumination System by Cavitar

Acknowledgments

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References

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