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In-situ Modelling and Quantification of Melt Pool Variation In Laser Powder Bed Fusion (LPBF) of In718 and the Impact Of Pre-heating At 500° C and 1000° C

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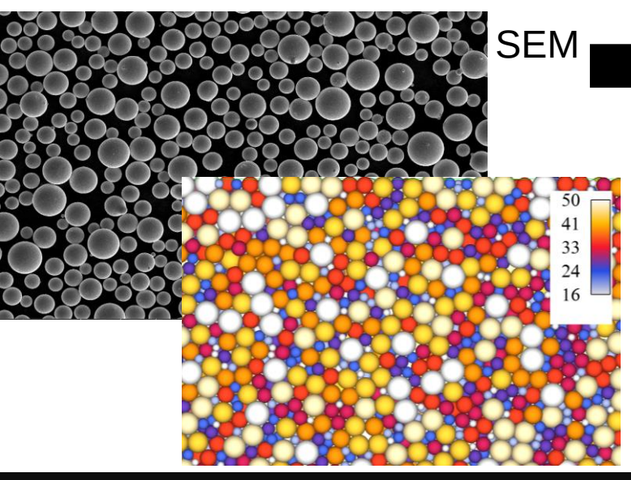
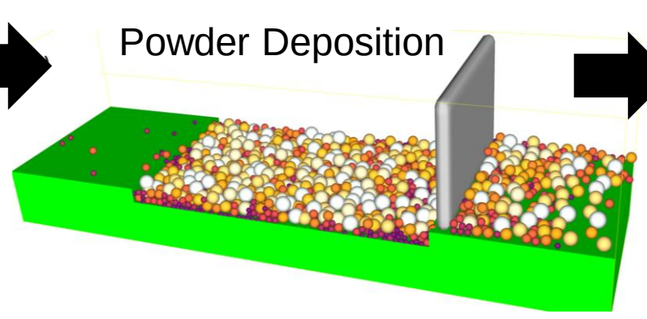
ABSTRACT: Laser powder bed fusion relies heavily on melt pool morphology (LPBF). However, it is very difficult to characterize the melt pool directly during LPBF. We use mesoscopic simulation models to show the melt pool's overall flow in three dimensions. Various physical processes that take place in the melt pool have been identified. The velocities and patterns of the fluid in the area are made visible and quantified. Pre-heating at 500°C and 1000°C has been shown to have an influence. The results of the research shed light on LPBF. The insights given here are crucial for understanding the LPBF and leading the development of superior measures for process parameter optimization. They're vital for that.

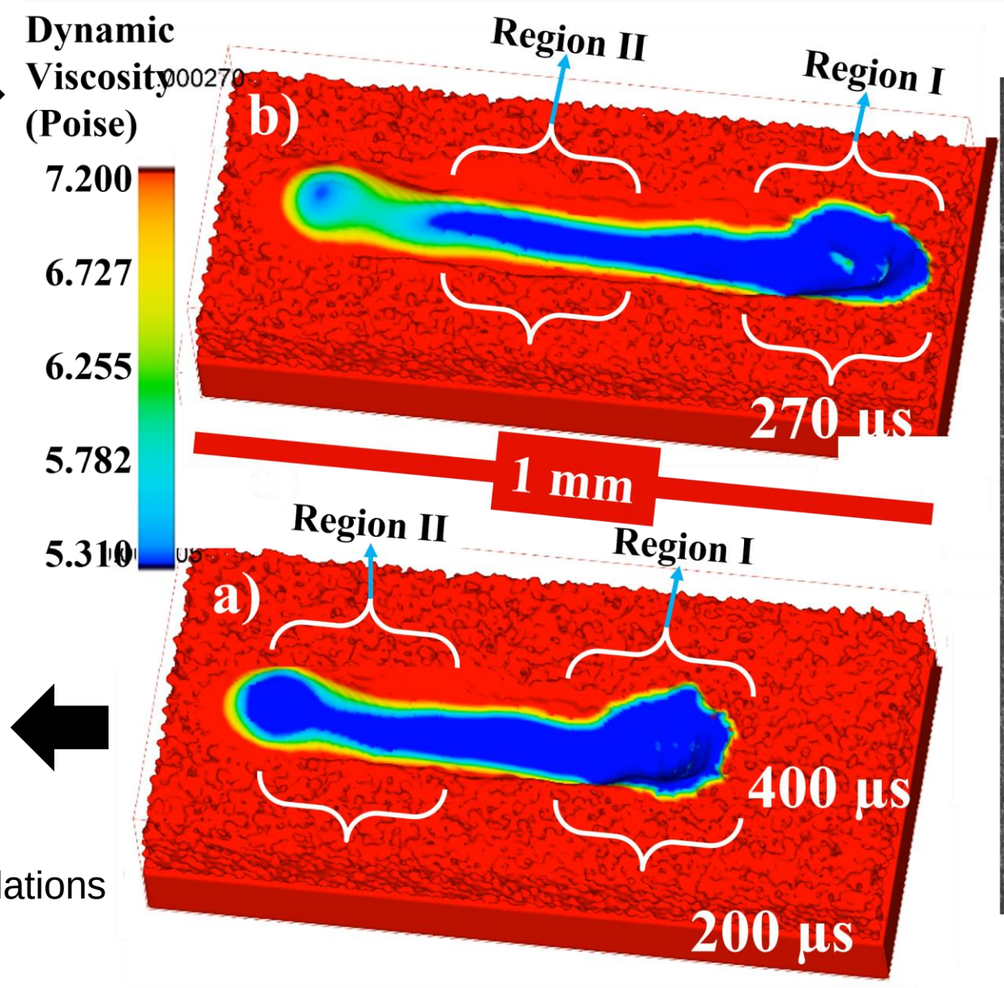
Discrete Element Modelling (DEM)



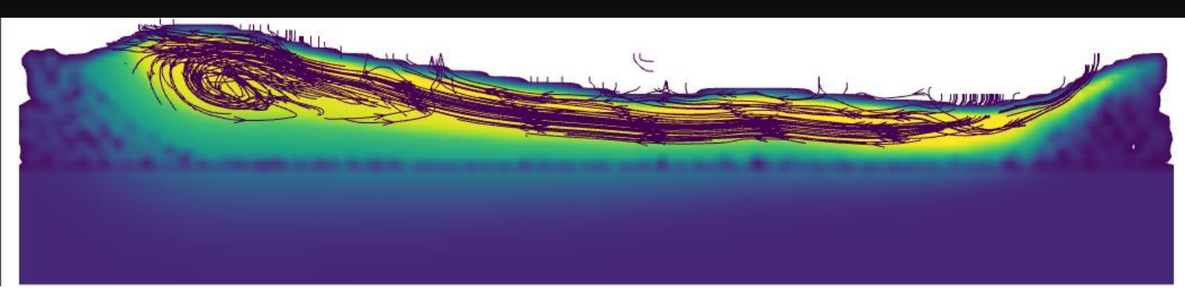
Deposition Modeling



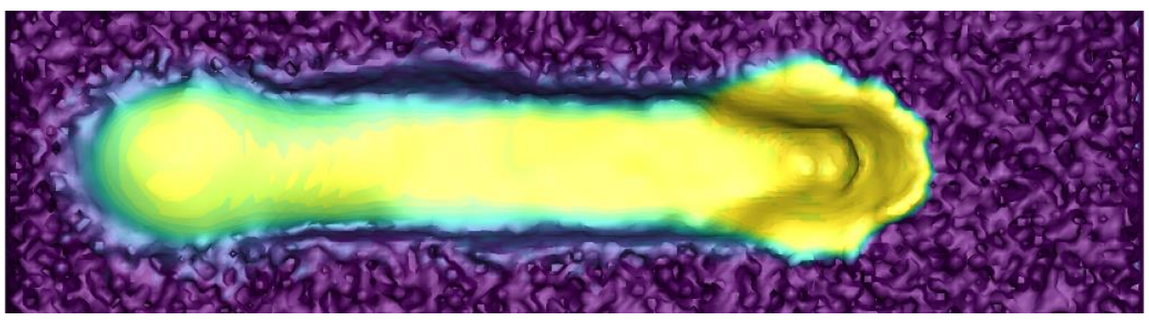
Laser Powder Bed Fusion (LPBF) Process Modelling Model



Full-Field 3D Models

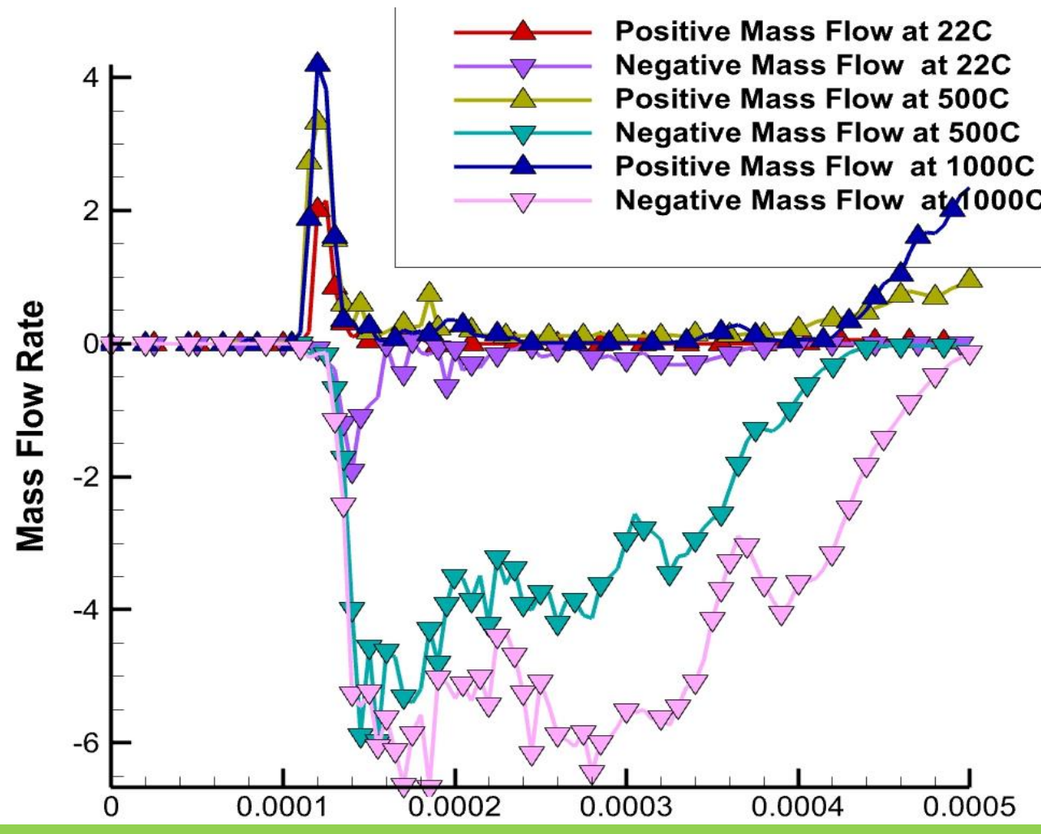


Simulations

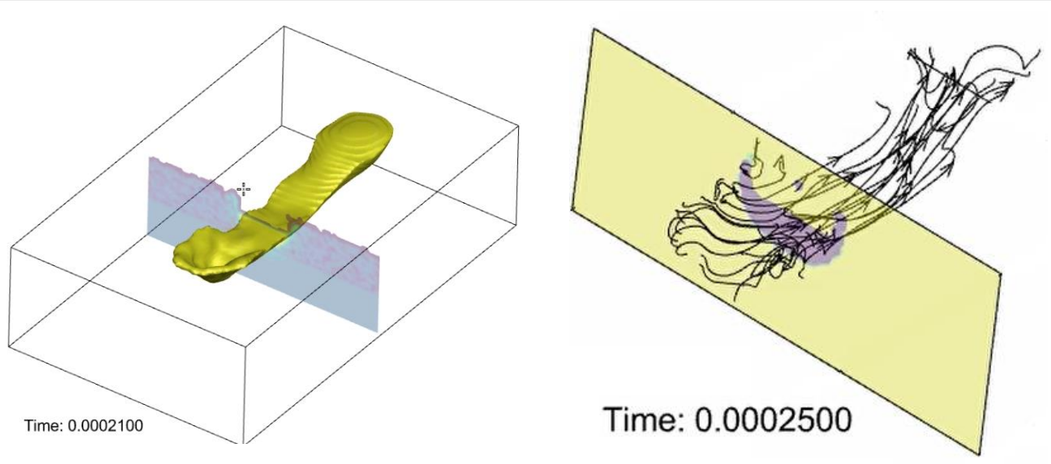


3D Optical Micrograph

Positive and Negative Mass flow quantification



Mass flow quantification at Room Temp. 500C and 1000C



Mass Flow from the Cross Section

Conclusions

- •Through the use of velocity vectors at various sites, fluid movement stream traces, and mass flow rate forward and backward movement, we have revealed and quantified the melt pool's flow dynamics. for the first time in this research, in the LPBF. In the depression zone, we observed a decline in flow velocity that we deduced from equations. With low surface tension coming from a melted surface and rising with it, a high surface tension is created. This is known as the Marangoni effect. Evaporation dominates fluid transport along the depression zone sidewalls. As a result of hydraulic pressure, liquid moves from a high-pressure zone to a low-pressure zone quickly. Convection of fluids between low- and high-density areas is caused by buoyancy pressure.

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