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Operando Metal 3D Printing at X-ray Free Electron Lasers

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While laser powder-bed fusion (LPBF) enables new design paradigms for metals manufacturing, uncertainties persist in connecting the process optimization to the apparently stochastic variability of the resulting properties. Operando X-ray radiography has revealed complex competition between multi-physics phenomena during the melt and solidification processes, resulting in variable turbulence during competition between keyholing, Marangoni flows, heat transfer, etc. Correlating these melt-pool phenomena with the fracture and phase segregation that can occur upon solidification is often not possible with the µm-resolution limits of radiographic imaging with >100-picosecond duration imaging pulses. We present the first LPBF experiments that use X-ray free electron lasers (XFELs) whose femtosecond-duration pulses and 1012 photons per pulse enable opportunities for new types of operando microscopy to reveal these critical phenomena during LPBF. The insights from our novel microscopes hold profound opportunities to access the next generations of length and timescales for LPBF physics.

I plan to submit also conference proceedings

No

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