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An integral digital twin platform for powder-bed additive manufacturing: From powder to part

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Part quality inconsistency and control is one of the major bottleneck issues in the current additive manufacturing technology. We have developed an integrated digital twin platform for powder-bed selected laser melting (SLM) with aim to predict the printing outcomes, such as porosity, grain and phase microstructures, residual stress distribution and distortion, surface roughness and mechanical properties for given printing conditions. In this platform, a discrete element method is used to describe powder bed packing and levelling, a ray-tracking method is used to predict the laser energy adsorption, a combined lattice Boltzmann-phase field method is used to describe the melt pool dynamics, solidification process and solid phase transformation, and a homogenization method is used to estimate the mechanical properties. We have used IN718 super-alloy as a model material to test the predictability of the platform. Our simulation results show that the predictions are able to reproduce many interesting features of SLM processes. It is expected that the developed digital twin platform is of the potential to significantly promote the adoption of additive manufacturing technology by industry.

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