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Multi-Physics Modeling of Single/Multiple-Track Defect Mechanisms in Electron Beam Selective Melting

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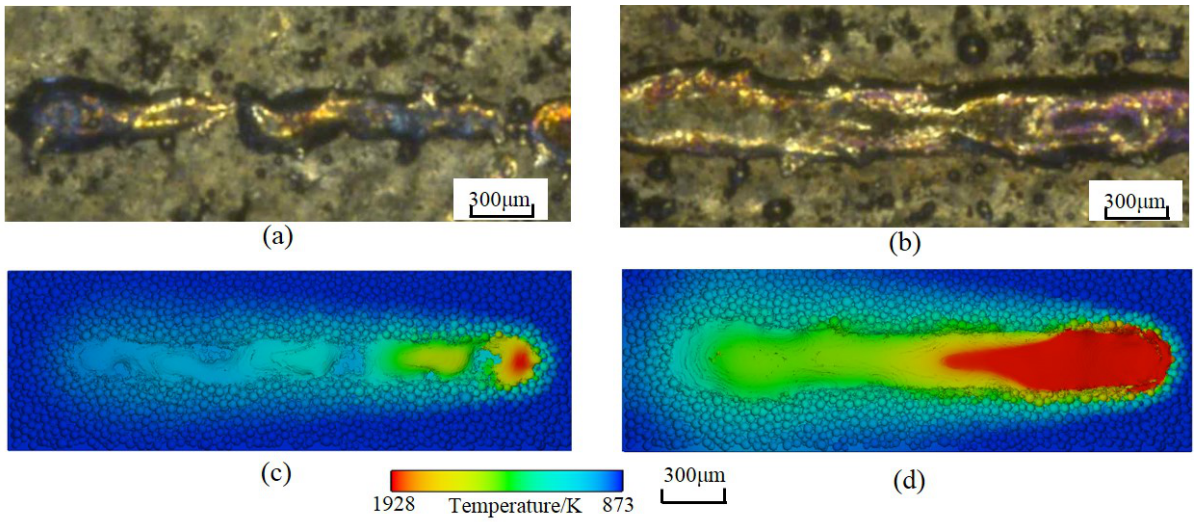

Caption: *Experimental and simulation results of (a)(c) balling effect and (b)(d) single-track non-uniformity.*

Scientific Achievement

A high-fidelity powder-scale model is developed to predict the detailed formation processes of single/multiple-track defects, including the balling effect, single track nonuniformity and inter-track voids. This study clarifies the underlying formation mechanisms, reveals the influence of key factors (power, scan speed, layer thickness, hatching distance), and guides the improvement of fabrication quality of single/multiple tracks. The simulations demonstrate that the hatching distance should be no larger than the width of the remelted region within the substrate rather than the width of the melted region within the powder layer, which should be incorporated into the design guidelines.

Significance

The high-fidelity powder-scale model for powder-bed-based additive manufacturing processes is one of the best models in the world. The 3D simulation results of single track defects provide a convincing explanation helping end the argument lasting for more than 10 years. The manufacturing processes of multiple tracks along S/Z-shaped scan paths with various hatching distance are simulated to understand the defects in complex structures, which is the first report in this area.

Citation

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