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Digital Twin of the Manufacturing Route from Powder Production to Components by Metal Binder Jetting

Binder jetting is ideal for producing individual parts with highly complex geometries. To achieve direct production of net-shape components with minimal post-processing, multi-scale numerical models were developed in this study to integrate the simulation of the manufacturing steps. Computational Fluid Dynamics (CFD) analysed the gas atomization process to calculate particle size distribution. Discrete element (DE) and finite element (FE) methods simulated powder spreading and sintering processes. The interaction between powder particles and binder was modelled using the CFD-DEM methods. By accounting for the density distribution, gravity, and friction in these models, both the sintering shrinkage and the final geometries of the components were accurately predicted. Furthermore, the kinetic Monte Carlo Potts model was also applied to simulate the microstructural evolution during sintering. The simulation results were validated by the experimental data from various manufacturing steps.

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