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(G*) Simulating Phase Changes in Metal Additive Manufacturing: A DEM Approach

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Metal additive manufacturing emerges as a pivotal innovation in modern manufacturing technologies, characterized by its exceptional capability to fabricate complex geometries. This process depends on the critical phase change phenomenon, where metals change between solid and liquid states under the intense heat from lasers. Accurate simulations of these phase changes are essential for enhancing the precision and reliability of metal additive manufacturing processes, thereby expanding the range of producible designs. However, the challenge lies in the detailed modeling of particle responses to thermal variations. This entails an understanding of melting dynamics—how particles transition from solid to liquid upon reaching their melting points, their interactions and fusion during this transformation, and the resultant changes in properties such as viscosity and flow. In response, this study introduces an innovative Discrete Element Method (DEM) for simulating particle dynamics and phase changes in metal additive manufacturing. By modeling metal powder as a cluster of interconnected smaller particles, this approach simplifies the simulation of melting and solidification. It combines particle dynamics and phase change simulations into a single framework, offering computational efficiency and adaptability to various materials and manufacturing conditions. As a result, this presents a practical alternative to more complex methods like Computational Fluid Dynamics (CFD) and facilitates rapid prototyping and optimization in metal additive manufacturing.

Keyword-1

metal additive manufacturing

Keyword-2

discrete element method

Keyword-3

phase change

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