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Investigation for Fast Prediction of Residual Stresses and Deformations of Metal Additive Manufacturing

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ABSTRACT

Residual stresses and deformations are one of the challenges needs to solve for metal additive manufacturing part. Finite element method plays an important role in predicting the residual stresses and deformations to reduce the experimental costs, and provides a powerful tool for the optimization of process parameters and scanning strategies of heat source. However, the key problem in simulation is the mismatch between the melt pool and the built part in both spatial and temporal scale. This would result in large discretization in both spatial and temporal domains in the simulation, which gives rise to huge computational cost. Therefore, it is necessary to develop a computationally efficient and accurate model in predicting the residual stresses and deformations of the metal additive manufacturing part. A thermos-mechanical model based on a superposition law in the thermal calculation is proposed in the present study. The proposed model enables to solve the mismatch of spatial scale in metal additive manufacturing. The proposed model is employed to predict the residual stresses and deformations in many metal additive manufacturing process, such as the selective laser melting and wire and arc additive manufacturing. The proposed model shows attractively high computational efficiency, and the accuracy of the proposed model is also validated by the experiment.

KEYWORDS

Additive manufacturing; residual stresses and deformations; finite element

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