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Part-scale Thermo-mechanical Modelling for The Transfusion Module in The Selective Thermoplastic Electrophotographic Process

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Additive manufacturing (AM) is a breakthrough approach to industries, potentially relieving the limitation when producing complex geometries with traditional manufacturing processes. Selective thermoplastic electrophotographic process (STEP) is a brand-new AM process proposed by Evolve additive solutions Inc Solutions, Inc. The STEP process works based on layer-wise manufacturing by fusing 2D layers produced by electrophotography onto a 3D bulk structure. The principle of the 2D to 3D deposition process in STEP is through heating up both the incoming 2D layer and the bulk material and then applying pressure to fuse the 2D layer onto the already-built component. This deposition module in STEP is known as transfusion. With the two core modules, electrophotographic, and transfusion, STEP could create a fully dense and multi-material part [1], and the developers hope, it could be an alternative to injection molding.

In the present work we develop the first numerical model for the STEP process. It is a part-scale thermo-mechanical finite element model based on the flash heating (FH) [2] method in the commercial software package ABAQUS. FH is a part-scale method, originally developed to solve thermal problems in laser-based AM processes, without truly resolving the interaction between the heat source and the bulk material, but instead uniformly distributing the input energy on the recently-activated meta-layer. Both the part material, as well as the support material in the STEP machine are considered. The thermal and mechanical predictions are compared with relevant experimental measurements for validation purposes. A comprehensive manufacturing parametric study is also presented. This modelling approach will potentially pave the way for making a robust digital twin of the STEP process, that later could be integrated in the STEP process itself, serving as a feedback source for real-time correction of the input process parameters for achieving a close to defect-free end-product.

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