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Thermal Simulation of Big Area Additive Manufacturing

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Abstract **-** A common failure mode of Big Area Additive Manufacturing (BAAM) is the phenomena of slumping. Slumping occurs when the structure retains excessive heat, often seen when there is insufficient cooling between layers. This study developed a transient thermal simulation model to aid in predicting the slumping phenomena, specifically in overhanging features. The simulation was modeled in ANSYS where the walls were created to match the dimensions in the experimental pyramid at 12.5 mm wide with a thickness of 5 mm. The structures overall size was 1.06 m by 0.77 m and 25 layers tall. Each layer was created independently to allow for element birth/death commands and for individual layer mesh parameters. Using the built-in element birth/death commands each layer would be inserted on top of the previous layer. As each new layer is activated a temperature input of 202°C is applied then subsequently turned off as the next layer is activated. The printing material, ABS (Acrylonitrile Butadiene Styrene), properties and heat transfer coefficient of the structures are functions of temperature. The simulation model is compared to an experimentally measured part. A FLIR E60 thermal imaging camera is utilized to capture the vertical thermographic profile of the build. The camera was paired with a computer running the FLIR Tools software package in order to record, save, and later analyze the thermographic history. The thermal images also captured three different vertical lines traversing all layers. Each pixel in the lines would record the corresponding temperatures of the structure. The data taken from the three lines show that the cooling present in the structure is of an exponential form. This result matches what was produced from the simulation, within 5 % error. The simulation allows for dwell times to be adjusted in the model until failure is no longer predicted. Utilizing these transient thermal modeling techniques will aid BAAM designers to identify potential slumping during the print process.

Keywords**:** Thermal modeling; Process monitoring; Simulation