Numerical Predictions of Bottom Layer Stability in Material Extrusion Additive Manufacturing

Md Tusher Mollah[1], Raphaël Comminal[1], Marcin P. Serdeczny[1], David B. Pedersen[1], and Jon Spangenberg[1]

[1]Department of Mechanical Engineering, Technical University of Denmark, 2800 Kgs. Lyngby, Denmark

Abstract

Robocasting and 3D concrete printing are technologies that belong under the umbrella term material extrusion additive manufacturing. These two free form fabrication methods are used to produce 3D structures/components in materials such as ceramic pastes, thermosets, and concrete. Common for the materials is their viscoplastic behavior during deposition and structural buildup (i.e., increase in yield stress) after deposition. The material's complex nature makes it a non-trivial task to ensure that printed layers do not deform when depositing additional layers on top. In this paper, we numerically investigate the influence of the yield stress buildup of viscoplastic materials on the stability of the bottom layer during multilayer printing. Specifically, we have developed a computational fluid dynamics model that applies a scalar approach to alter the yield stress. The novel model provides fundamental knowledge on how to design the material's rheology, so the bottom layer can withstand both the hydrostatic- and extrusion-pressure.

The full paper may be found in a special issue of the TMS publication *JOM*, March 2022.