Materials and Process Design for Metal Fused Filament Fabrication (MF^3)

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Abstract

Manufacturing metals products with extrusion-based 3D printing process such as fused filament fabrication (FFF) has emerged as an alternative to conventional laser powder bed fusion 3D printing process as it offers the unique advantage of being overall cost-effective and providing the user the flexibility to manipulate various material properties and process parameters. In the metal FFF process, high powder-filled polymer systems are used to 3D print a part and subsequent process that involve removal of the polymer through debinding followed by sintering to obtain a fully dense metal product. One challenge working with the metal FFF 3D printing process is that with an increase in metal powder loading in the polymer matrix there is an increase in viscosity of the metal filled polymer feedstock that obstructs the flow of material through the nozzle while extrusion 3D printing. The current work focuses on understanding the science behind the rheological properties of unfilled and metal powder filled polymers by correlating it with the extrusion process in FFF 3D printing to gain a better control on feedstock flow behavior. Additionally, this work focuses on demonstrating the shear-rate and temperature dependence of viscosities for 70, 80, & 90 wt.% bronze powder-filled polymer binder when compared with unfilled polylactic acid (PLA) for extrusion FFF 3D printing. It is anticipated that this work will provide new insights in material design for high-powder filled polymers in metal FFF and reduce the trial and error experiments.

Biography

Paramjot Singh is a Ph.D candidate at the University of Louisville with the Material Innovation Guild where he is working towards the advanced materials development and processing for Additive Manufacturing. He received his Master's from San Diego State University where he worked at the Powder Technology Lab. His current research focuses in the development of feedstock systems involving polymer binders and metal powders for cost efficient Additive Manufacturing.