Additive Manufacturing of Aluminum Alloy by Metal Fused Filament Fabrication (MF^3)

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Abstract

This research studies metal-fused filament fabrication (MF^3) for manufacturing aluminum alloy parts. An aluminum alloy powder-based feedstock with a polymer-binder system was extruded via capillary rheometer to form a filament. The filament was used to print green parts that were involved in a two-step debinding process combining solvent extraction and thermal breakdown of the polymer binder, then sintered in nitrogen atmosphere. Resulting grain structure, sintered density, and mechanical properties will be characterized and compared to metal injection molded (MIM) specimens. The main objective is to gain an understanding of the MF^3 process characteristics and the ensuing material properties and microstructure through carefully designed experiments and computer simulations, therefore creating additive manufactured components from a common lightweight metal. The overarching goal is to enable rapid, predictable, reproducible, low cost, and accurate production of metal parts with 3D features, thereby significantly expanding the current additive manufacturing capability.

1 Introduction

Metal Fused Filament Fabrication (MF^3) is an Additive Manufacturing (AM) process that combines the concepts of Fused Filament Fabrication (FFF), also referred to as Fused Deposition Modeling (FDM), and Metal Injection Molding (MIM). Falling under Material Extrusion Additive Manufacturing (MEAM), MF^3 is a growing topic of research and development that is beginning to become more accessible to hobbyists and users in industry, with applications in fields such as aerospace, medicine, and automobiles. MF^3 offers many benefits comparable to other AM processes such as electron beam melting (EBM), laser powder bed fusion (LPBF), and Binder Jetting, all of which can reliably produce metal parts. Such