Optimization of post-processing parameters for enhanced characterization in metal extrusion 3D printing of copper-polymer composites

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Abstract

The high costs associated with metal additive manufacturing methods including expensive feedstock, energy-intensive lasers, and controlled environments have limited their widespread adoption in industries like aerospace and automotive, despite powder bed fusion success in producing intricate and high-precision components. As a cost-effective alternative, material extrusion 3D printing enables the fabrication of metal-polymer composites using simpler equipment. However, challenges remain in optimizing post-processing parameters to enhance mechanical performance and microstructural integrity. This study focuses on improving the post-processing of copper-filled PLA parts fabricated with an Artillery Sidewinder X1 material extrusion printer. A Taguchi design of experiments approach using an L_8 orthogonal array was employed to investigate the effects of debinding time, sintering time, and layer thickness. Results showed that shorter debinding compromised structural integrity in 25% of samples, while optimized settings

achieved a 30.59% shrinkage and a 12.5% hardness increase. These findings highlight the significance of proper thermal post-processing in controlling dimensional changes and improving part quality. © The Author(s) 2025.

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3D Printing; Additive manufacturing; Debinding; Material extrusion; Metal; Polymer; Sintering

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Abstract

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