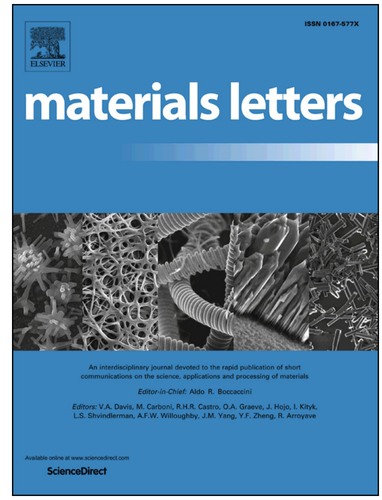
Accepted Manuscript



3D printing of thermoplastic PI and interlayer bonding evaluation

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PII: S0167-577X(18)31051-6
DOI: https://doi.org/10.1016/j.matlet.2018.07.020
Reference: MLBLUE 24586

To appear in: *Materials Letters*

Received Date: 31 January 2018
Revised Date: 23 May 2018
Accepted Date: 5 July 2018

Please cite this article as: W. Wu, W. Ye, P. Geng, Y. Wang, G. Li, X. Hu, J. Zhao, 3D printing of thermoplastic PI and interlayer bonding evaluation, *Materials Letters* (2018), doi: https://doi.org/10.1016/j.matlet.2018.07.020

3D printing of thermoplastic PI and interlayer bonding evaluation

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Abstract

Thermoplastic polyimide (TPI) has a narrow processing temperature range, high viscosity, and high viscous flow temperature (T_f). These properties lead to difficulties in 3D printing and traditional forming with TPI owing to deformation caused by thermal stress, stratification, and other problems. The thermal stability of TPI raw materials and 3D printing filaments were analyzed in this study. Relationships between the T_f of the 3D printing filament and the starting printing temperature were studied. The influence of the 3D printing temperature on the interlayer bonding force of a 3D printed part was studied. The appropriate printing temperature range of TPI 3D printing was found to be 320–340°C. When the printing temperature was 335°C, the interlayer bonding force was 344.5 N. When the printing temperature was 340°C, the interlayer bonding force decreased to 260.5 N. Within the appropriate 3D printing temperature range, complex TPI components with good interlayer bonding and high temperature resistance could be printed.

Key words: 3D Printing, Thermoplastic polyimide, Thermal crosslinking, FDM, Additive manufacturing, Interlayer bonding

Introduction

Thermoplastic polyimide (TPI) is a special engineering plastic with excellent features, such as good impact and abrasion resistance, high-temperature stability, and a long service lifetime. TPI can be used at -248°C to 250°C for long time periods [1,2]. TPI not only has excellent comprehensive properties, but is also easily processed and can be produced more efficiently than polyimide [3].

Fused deposition modeling (FDM) three-dimensional (3D) printing technology have the advantages of a simple forming process, with low costs, easy operation, and the ability to directly form three dimensional solid parts with complex structures [4]. Hegde et al. obtained a polyimide part using mask projection light curing technology and photoinduced molecular chain chemical crosslinking combined with a heat treatment, by configuring a photosensitive polyimide solution [5]. Gurrala et al. analyzed the relationship between the strength of FDM printed parts and the bonding of the raster by establishing a mathematical model for cylindrical raster bonding and performing FDM printing experiments [6]. Kishore et al. studied additive manufacture of high performance semi-crystalline thermoplastics and their composite materials. It has been