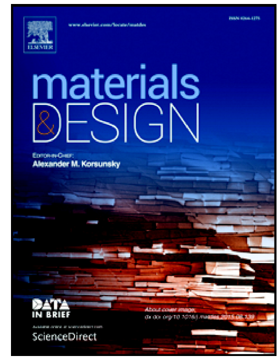
Accepted Manuscript



Interlayer adhesion and fracture resistance of polymers printed through melt extrusion additive manufacturing process

Nahal Aliheidari, Josef Christ, Rajasekhar Tripuraneni, Siva Nadimpalli, Amir Ameli

PII: S0264-1275(18)30531-8
DOI: doi:10.1016/j.matdes.2018.07.001
Reference: JMADE 4034

To appear in: *Materials & Design*

Received date: 24 April 2018
Revised date: 30 June 2018
Accepted date: 2 July 2018

Please cite this article as: Nahal Aliheidari, Josef Christ, Rajasekhar Tripuraneni, Siva Nadimpalli, Amir Ameli , Interlayer adhesion and fracture resistance of polymers printed through melt extrusion additive manufacturing process. Jmade (2018), doi:10.1016/j.matdes.2018.07.001

Interlayer Adhesion and Fracture Resistance of Polymers Printed through Melt Extrusion Additive Manufacturing Process

Nahal Aliheidari [a], Josef Christ [a], Rajasekhar Tripuraneni [b], Siva Nadimpalli [b], Amir Ameli [a,*]

[a] Advanced Composites Laboratory, School of Mechanical and Materials Engineering, Washington State University Tri-Cities, 2710 Crimson Way, Richland, WA 99354, USA

[b] Department of Mechanical and Industrial Engineering, New Jersey Institute of Technology, University Heights Newark, New Jersey 07102, USA.

[*] Corresponding author: a.ameli@wsu.edu; 2710 Crimson Way, Richland, WA 99354, USA

Abstract

This study aims to establish the relationships between the process parameters, mesostructural features (interlayer neck and void sizes), and the fracture resistance of 3D printed parts. The proposed method enables the decoupling of bond quality and mesostructure effects on the overall fracture behavior. Double cantilever beam specimens of acrylonitrile butadiene styrene (ABS) were designed, printed, and fracture tested. The apparent fracture resistance ($J_{c,a}$), the interlayer fracture resistance ($J_{c,i}$), and the microstructure were characterized. The fracture results and the microscopic examinations indicate that $J_{c,a}$ is strongly correlated with the process parameters through both the interlayer adhesion as well as the mesostructure. Nozzle and bed temperatures and layer height were found to have significant effects on the fracture behavior. For instance, the $J_{c,a}$ increased by 38% with a 20 °C increase in the nozzle temperature. This originated from 15% increase in the interlayer fracture resistance and 23% increase in the actual fracture surface area (interlayer neck size). The quality of interlayer bond was explained in terms of temperature, pressure, and time of the process. This work quantifies the relationships between the printing