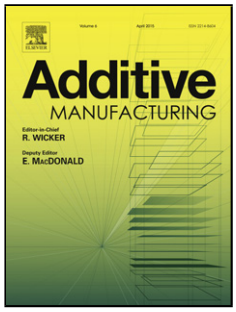

Title: Fused Filament Fabrication of Fiber-Reinforced Polymers: A Review

Authors: Bastian Brenken, Eduardo Barocio, Anthony Favaloro, Vlastimil Kunc, R. Byron Pipes

PII: S2214-8604(17)30447-5
DOI: https://doi.org/10.1016/j.addma.2018.01.002
Reference: ADDMA 267

To appear in:

Received date: 3-10-2017
Accepted date: 22-1-2018

Please cite this article as: Bastian Brenken, Eduardo Barocio, Anthony Favaloro, Vlastimil Kunc, R.Byron Pipes, Fused Filament Fabrication of Fiber-Reinforced Polymers: A Review (2010), https://doi.org/10.1016/j.addma.2018.01.002

Fused Filament Fabrication of Fiber-Reinforced Polymers: A Review

Bastian Brenken[a,b,*], Eduardo Barocio[a,c], Anthony Favaloro[a,b], Vlastimil Kunc[b,d] and R. Byron Pipes[a,b,c]

[a]: Composites Manufacturing and Simulation Center (CMSC)
Indiana Manufacturing Institute
1105 Challenger Avenue, Suite 100
West Lafayette, IN, 47906-1168
www.purdue.edu/cmsc
[b]: School of Aeronautics and Astronautics, Purdue University
701 West Stadium Avenue
West Lafayette, IN, 47907-2045
[c]: School of Materials Engineering, Purdue University
701 West Stadium Avenue
West Lafayette, IN, 47907-2045
[d]: Manufacturing Demonstration Facility
Oak Ridge National Laboratory
2370 Cherahala Blvd
Knoxville, TN, 37932
[*] : Corresponding author, email address: bbrenken@purdue.edu

Abstract

Recent advancements in the Additive Manufacturing (AM) Fused Filament Fabrication (FFF) approach are described with focus on the application to tooling and molds for composite materials and structures. A detailed summary of mechanical properties of printed parts for different composite material systems is presented and discussed. These material systems are comprised of discontinuous fiber-reinforced polymers characterized by fiber orientation dominantly parallel to the direction of the extrudate. An overview of the FFF process and its physical phenomena is given including the flow and resulting fiber orientation, the bond formation between adjacent beads and the thermomechanical solidification behavior of the deposited material. Based on reviewed research in these different phenomena, future research needs are discussed and desirable objectives are formulated.

Key words: Additive Manufacturing, Fused Filament Fabrication, Fused Deposition Modeling, Extrusion Deposition, Polymer Composite Materials

1. Introduction

Additive Manufacturing (AM) technologies offer the potential for significant cost savings due to reduced material waste and the capability for a tool-less production of intricate geometries. Therefore, they have gained considerable attention during the last decade. The Fused Filament Fabrication (FFF) process, which is also termed Fused Filament Fabrication (FDM), is one of the most popular AM methods. The recent development of large scale printers, which melt pelletized material deposited by a screw extruder, has yielded yet another name, Extrusion Deposition. In the extrusion based process, printing is achieved by controlled deposition of molten feed stock material. By following a predefined machine path, the 3D