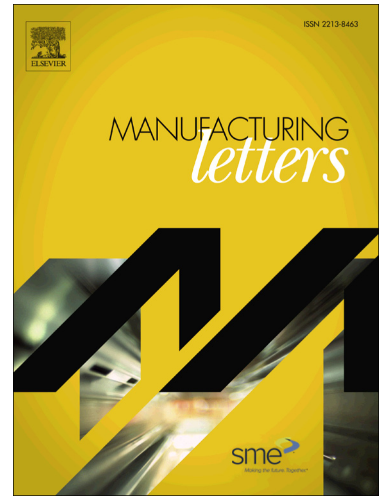
Accepted Manuscript



Evaluation of fatigue performance of additively manufactured SS316 via internal damping

Ali Haghshenas, M.M. Khonsari

PII: S2213-8463(18)30031-2
DOI: https://doi.org/10.1016/j.mfglet.2018.09.001
Reference: MFGLET 160

To appear in: *Manufacturing Letters*

Received Date: 17 February 2018
Revised Date: 31 August 2018
Accepted Date: 9 September 2018

Please cite this article as: A. Haghshenas, M.M. Khonsari, Evaluation of fatigue performance of additively manufactured SS316 via internal damping, *Manufacturing Letters* (2018), doi: https://doi.org/10.1016/j.mfglet.2018.09.001

Evaluation of fatigue performance of additively manufactured SS316 via internal damping

Ali Haghshenas, M. M. Khonsari[1]
Department of Mechanical and Industrial Engineering, 3283 Patrick Taylor Hall, Louisiana State University, Baton Rouge, LA 70803, USA

Abstract

Additively manufactured (AM) specimens made of stainless steel 316 are tested using the impulse excitation technique (IET) and their damping characteristics are correlated to fatigue life. Results reveal that the damping value is inversely proportional to the fatigue life of the specimens. It is also shown that the procedure enables one to determine the onset of crack initiation and thus provides a viable approach for monitoring the integrity of AM parts.

Keywords: Fatigue life; damping analysis; impulse excitation technique; onset of fatigue crack

1. Introduction

AM applications in aerospace, automotive, biomedical industries are growing exponentially due to the ability to produce geometrically complex parts rapidly and on demand. Of particular interest is the laser deposition technique for powder metal to produce durable parts [1,2]. Research shows that evaluation of the integrity of AM parts remains to be a major challenge, particularly when they are subjected to cyclic loading [3,4].

AM and conventionally manufactured (CM) parts have comparable static behavior [5]. However, evaluation of AM parts shows different behavior when subjected to cyclic fatigue loading [6]. This is due to the fact that defects in the form of microstructural heterogeneity act as local stress raisers. Such impurities are much more likely to exist in an AM part due to the nature of their manufacturing process [6]. To this end, there are studies that report shorter fatigue life for AM parts compared to their wrought counterparts regardless of the AM technique [7-9].

The assessment of the structural integrity of AM parts is significantly more challenging compared to those of the conventionally fabricated ones since apart from the properties of the powder feedstock, the performance of 3D printed metal components largely depends on the laser power, speed, thickness of the layers. These parameters can affect the thermal history of the printed part and hence its size, porosity, and existing phases [6]. Further, irregular variations in these heterogeneities can cause large changes in fatigue performance.

In conventionally fabricated materials extrusions and intrusions on the surface (slip bands) and/or “microstructural weak points” —point defects, dislocations, grain boundaries, etc.— are the main source of fatigue crack initiation. Intrusions and extrusions grow as the number of cycles increase and result in accumulation of plastic strain energy [10]. When the plastic strain energy

[1] Corresponding author, khonsari@ lsu.edu, V: 225.578.9192, F:225.578.5924