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Effect of mean stresses on mode of failures and fatigue life of selective laser melted stainless steel

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Abstract

In today's era of modern manufacturing, selective laser melting is getting increasingly popular due to its capability of producing geometrically complex parts directly from CAD model in a single step. Few papers have reported the fatigue behaviour of selective laser sintered stainless steel specimens. In the present study, effect of tensile, zero and compressive mean stresses on mode of failures and fatigue strength of laser sintered 15-5 precipitation hardened stainless steel specimens have been investigated. Presence of compressive mean stress is found to improve the fatigue life while tensile mean stress is found to be detrimental. For tensile and compressive mean stresses, fracture surfaces show four distinct regions: crack initiation site, stable crack growth region, unstable crack growth region and fracture region. However, under zero mean stress fracture surfaces do not show any unstable crack growth region. Unstable crack growth region could be attributed to presence of mean stresses. Predominant mode of failure for compressive mean stress is brittle. Presence of tensile mean stress leads to fracture surface having brittle and mixed-rupture characteristics of quasi-cleavage and dimples respectively; whereas under zero mean stress fracture surface shows ductile-brittle mixed mode of failure.

Keywords: Selective Laser Melting; Mean stress; Fatigue life; Mode of failure; Stainless steel

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1. Introduction

In today's manufacturing sector, one of the most recent emerging areas is Additive Manufacturing (AM). Although the term "additive manufacturing" prevails in literatures decades ago, but it has been used only for prototyping purposes. There are different types of additive manufacturing techniques like Direct Laser Deposition (DLD), Selective Laser Sintering (SLS)/ Selective Laser Melting (SLM)/ Direct Metal Laser Sintering (DMLS), and Fused Deposition Method (FDM) etc. Although there is a minute difference between SLS/DMLS and SLM, these terms are used interchangeably in different literatures. Among various additive manufacturing

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