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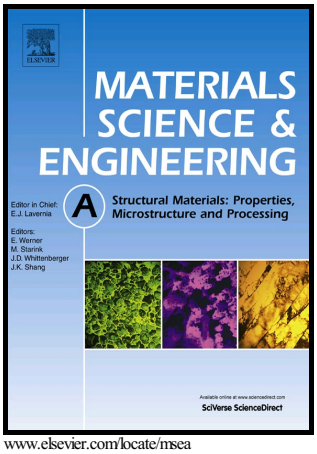

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Effect of building direction on porosity and fatigue life of selective laser melted AlSi12Mg alloy

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Abstract

Gas porosity is one of the most common defects in aluminum alloy parts manufactured by solidification processing, and can have a strong influence on fatigue properties. This study shows that gas pores with a fraction of 0.2-1.6% and an average size of 20-55μm are present in the Al-Si alloy parts manufactured by Selective Laser Melting (SLM). Failure after fatigue testing was found to initiate from surface or subsurface gas pores and fatigue life prediction equations were developed considering the influence of pores. The building direction did not have a statistically verifiable effect on the average gas porosity fraction, size and distribution, although the scatter in porosity fraction was greater in the vertically built specimens. At the same applied stress, the fatigue life of SLM manufactured specimens decreased with an increase in pore size, and specimens built horizontally exhibited a greater fatigue life than those built vertically. The cause is attributed to greater propensity of cracks to propagate along lower strength melt pool boundary layers in vertically built specimens.

Keywords: Additive manufacturing; selective laser melting (SLM); gas porosity; Aluminum alloy; Fatigue life prediction

1. Introduction

Hypoeutectic Al-Si alloys close to the eutectic composition (12.6 wt.%Si) are important cast Al alloys due to their excellent castability and low propensity to solidification defects. Consequently, AlSi10Mg and AlSi12 alloys have been commonly used for selective laser melting (SLM) [1]. In fact, among current commercial Al alloys, Al-Si based alloys are the most extensively studied Al alloys in the context of SLM due to their robust welding characteristics [2].