Microstructure and fatigue performace of additively manufactured AlSi10Mg

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ABSTRACT

Laser powder bed fusion technology (L-PBF) can readily fabricate near-net shape metal parts. Therefore, the automotive and aerospace industries have been investigating the L-PBF production of AlSi10Mg parts because of low specific density, good hardenability, and low powder costs. Further, local melting of the atomized powder and subsequent rapid solidification generates fine structures having mechanical properties that are competitive with conventionally produced Al alloys.
If the products remain in the as-built state (i.e., no post fabrication heat treatment), residual stresses are expected in the part and are superimposed on the operating stress with often unpredictable effects on its fatigue life. As-built part surfaces are rough compared to machined surfaces with a negative influence on the fatigue strength of L-PBF AlSi10Mg parts. On the other hand, surface machining is not only expensive but often impossible for L-PBF parts due to their geometric complexity.
This study investigates the fatigue behavior of L-PBF AlSi10Mg under the combined effect of untreated condition and as-built (i.e., rough) surface quality. Three sets of miniature specimens, each with a different orientation (A, B, C) with respect to the build direction were printed in an SLM 280 HL system operating with a layer thickness of 50 μm. Each set consisted of approx. 15 samples. The as-built samples were tested in cyclic plane bending at a load ratio R = 0 at a frequency of 25 Hz and a significant directional influence on the fatigue behavior quantified. To investigate the origin of this behavior, samples for each orientation were examined using metallographic techniques to determine the structure and quality of surfaces. Surface features depending on printing strategy and printing parameters of the different specimens qualitatively explain the observed directional fatigue behavior.

BIOGRAPHY

My name is Tibor Varmus I am a Ph.D. student at the Department of Materials Engineering at the Faculty of Mechanical Engineering in Žilina. In my study, I research the influence of surface roughness on the fatigue life of materials prepared by additive manufacturing. My interests are in science and technology, the space program, the automotive and aerospace industries. In my free time I read books on the history and repair of old cars.

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