Master Thesis Announcement

Microstructural Factors Affecting Threshold ΔK_{th} during Fatigue in Ti-6Al-4V Produced by Additive Manufacturing

Background

In Additive manufacturing (AM), the component is built by adding material layer by layer from a CAD (computer aided design) model. AM allows manufacturing of complex products with near-net shape and the design freedom is very high. This enables faster product development, short development cycles, lighter products and a more efficient use of the material. The most commonly used heat sources for AM are laser beam and electron beam. Laser additive manufacturing, consisting of laser metal deposition, selective laser sintering and selective laser melting (also refer to as Laser beam Powder-Bed-Fusion (LB-PBF)), is one of the most important process for metallic materials. In LB-PBF, the parts are built by spreading powder layers and melting selective regions, layer by layer within a chamber filled by inert gas. Electron Beam Melting (EBM) is another additive manufacturing technology in which the raw material (usually metal powder) is fused together by heating using an electron beam. The process takes place under vacuum, which makes it suit to manufacture parts in reactive materials with a high affinity for oxygen, e.g. titanium.

Fatigue property is the most important criterion for the performance of load-bearing Ti alloys in aerospace application. The major factors causing failure of AM produced parts are surface quality, defects and microstructure. AM fabricated Ti-6Al-4V has been found to be sensitive to the presence of small defects contributing to a large scatter in fatigue testing, especially at loading close to the threshold stress value. Due to the difficulties of detecting small defects at inspection and eliminating completely small defects from the process, it is of great importance to raise the threshold value of the material (ΔK_{th}).

Objectives

The objective of this Master thesis is to identify how different factors including microstructure, heat treatment and local chemistry affect the threshold properties during fatigue in Ti-6Al-4V produced by AM. The knowledge obtained may help robust AM manufacturing to obtain high performance components.

Work Description

This project is in close collaboration with GKN aerospace. The material investigated is Ti-6Al-4V manufactured by AM using laser and electron beam in the as-built and heat-treated condition. The heat treatment is designed in a way to obtain a specific microstructure. Crack propagation threshold testing using Kb-specimen which has a notched surface flaw will be performed in GKN.

The work in this thesis includes: 1) Literature study; 2) Examination of the typical microstructure of as-built and heat-treated component; 3) Examination of the microstructure and chemistry at the location of crack initiation by a variety of technology including SEM, energy dispersive spectroscopy (EDX), OM etc. 4) Comparison between the as-built and heat-treated condition. 5) Comparison between laser AM and EBM. 6) Summary of results and thesis writing.

Qualification

We are looking for you who are studying towards a Master of Science degree in the field of material science, applied physics or mechanical engineering.

Time frame: The thesis covers 30 credits / 20 weeks or 60 credits/40 weeks

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