



Master Thesis Announcement

Correlation between Microstructure and Crack Path during Fatigue in Electron Beam Melting (EBM) fabricated Ti-6Al-4V

Background

Electron Beam Melting (EBM) is an additive manufacturing technology in which the raw material (usually metal powder) is fused together by heating using an electron beam. This technology allows to manufacture the near-net-shape components. 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 EBM produced parts are surface quality, defects and microstructure. Removing surface defects by machining leads to better fatigue properties. Defects such as pores and lack of fusion are inevitably presented, which lowers the fatigue performance. Hot isostatic pressing (HIP) can be performed to eliminate such defects and improve the fatigue properties. In general, the average fatigue life of EBM-produced Ti-6Al-4V with post HIP treatment is comparable or better than that of cast and forged material, but the scatter is much larger. To dare to use AM product in aerospace industry, it is necessary to reduce the scatter. The correlation between the microstructure, defects and fatigue fracture is thus of great importance.

Objectives

The objective is to establish the correlation between microstructure and crack initiation & propagation during fatigue in EBM fabricated Ti-6Al-4V. It is intended to clarify whether the crack initiation and propagation are affected by metallurgical features. The knowledge obtained may help robust EBM manufacturing to obtain high performance components.

Work Description

This project is in collaboration with GKN aerospace. Fatigue test have been performed at room temperature with 4-point bending test ($R=0.1$, max stress 675 MPa) on a few samples of EBM produced Ti-6Al-4V in the condition of as-built and post treatment (HIP+heat treatment).

The work in this thesis includes: 1) Literature study; 2) Examination of the typical microstructure of as-built and post treated (HIP, heat treatment) component; 3) Examination of the fracture surface after fatigue test to find the location of crack initiation by optical microscopy (OM) and scanning electron microscopy (SEM); 4) Examination of the microstructure at the location of crack initiation and crack propagation by a variety of technology including SEM, energy dispersive spectroscopy (EDX), OM etc. Comparison with the typical microstructure obtained in 2) will be performed. The inhomogeneity of the microstructure and the crack path will be focused. This is the core part of the thesis. 5) 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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