HÖGSKOLAN VÄST

# Processability of Laser Powder Bed Fusion of Alloy 247 LC - Influence of process parameters on microstructure and defects

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AKADEMISK AVHANDLING

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framläggs för offentlig granskning.

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**Abstract**

Title: Processability of Laser Powder Bed Fusion of Alloy 247 LC - Influence of process parameters on microstructure and defects

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This thesis is about laser powder bed fusion (L-PBF) of the nickel-based superalloy Alloy 247LC. Alloy 247LC is mainly used in gas turbine blades and processing the blades with L-PBF may confer performance advantage over the blades manufactured with conventional methods. This is mainly because L-PBF is more suitable, than conventional methods, for manufacturing the complex cooling holes in the blades. The research was motivated by the need for academia and industry to gain knowledge about the processability of the alloy using L-PBF. The knowledge is essential to eventually solve the problem of cracking encountered when processing the alloy. In addition, dense parts with low void content should be processed and the microstructure and properties should meet the required performance. Heat-treatment is usually performed to acquire final properties, so it is also of interest to study this aspect. Thus, the thesis answered some of the important questions related to process parameter-microstructure-property relationships.

The present PhD thesis is a continuation of the author's Licentiate thesis, of the same title, which was defended on October 13, 2020. A new introduction was written and new research questions were added. The thesis presented an introduction in Chapter 1. A literature review was made in Chapter 2 to 4. In Chapter 2, the topic of additive manufacturing was introduced followed by an overview of laser powder bed fusion. Chapter 3 focused on superalloys. Here, a literature review was made from the broader perspective of superalloys but was eventually narrowed down to the characteristics of nickel-based superalloys and finally Alloy 247LC. Chapter 4 reviewed the main research on L-PBF of Alloy 247LC. The methodology applied in the thesis was discussed in Chapter 5. The thesis applied statistical design of experiments to show the influence of process parameters on the defects and microhardness. This was given at the beginning of Chapter 5 and followed by the description of the L-PBF manufacturing and the characterization methods. Other methods utilized in this thesis include heat-treatments, differential scanning calorimetry (DSC), thermodynamic modelling and time of flight secondary ion mass spectrometry (TOF SIMS). The main investigations, results and discussions, in this thesis can be found in papers A-E. The summary of these papers was written in Chapter 6. In paper A, a review of the literature was performed and it served as the basis for identifying the research questions. A preliminary study was performed in paper B to learn about the as-built and heat-treated microstructure of Alloy 247LC. Both papers A and B contributed to gaining an initial understanding of the processability and the obtainable microstructure in this alloy. To properly answer the research questions, 36 cubes were manufactured with different process parameters and the influence of these process parameters on the microstructure was investigated in papers C, D and E. Paper C was concerned with using design of experiments to correlate the process parameters to the quantity of defects and values of microhardness. Paper D utilized microscopy to study how the process parameters influence the microstructure and elucidated on the cracking mechanism. Subsequently, the influence of the process parameters on the heat-treated microstructure was studied in paper E. Finally, the conclusion of the thesis is presented in Chapter 7.