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Experimental validation of a numerical thermal model of EBM process for Ti6Al4V

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The Electron Beam Melting process (EBM), or also known as Electron Beam Additive Manufacturing (EBAM), is an additive manufacturing (AM) process that use an electron beam to melt metallic powders. Although the use of an electron beam in the AM field is relatively recent, several applications have already been made in the aerospace and medical fields [1, 2]. To increase the applicability of the EBM process and to make it more reliable different modelling techniques will be helpful tools. Modelling may have the potential to reduce the optimisation time when compared with experimental trial and error approach. In fact, by means of numerical modelling, process stability could be reached by exploring virtually what-if scenarios. However, experimental validation is necessary to ensure the accuracy of the modelling. The aim of this paper is to validate the effectiveness and reliability of the Finite Element (FE) thermal model developed in a previous work [3] by comparing numerical results and experimental measurements.

Two different scanning strategies were studied: multi beam and continuous line melting. In multi beam melting, separate short melt lines (multi beam lines) are activated at different points along the predefined melt track. The electron beam jumps sequentially between the short lines until the complete melt track is finished. Continuous line melting means that the complete predefined melt track is melted from the start point to the stop point in one single sequence. The following parameters were investigated: beam speed, beam size and length of multi beam lines. A novel experimental setup was used in which several single line melt tracks were manufactured in an Arcam Q10 system. Standard Arcam Ti6Al4V powder was used and the layer thickness was set to 0.05 mm. Microscope images were used to acquire the width of the melt pool at different positions along the melt tracks. The experiments were replicated by numerical simulations using the model in [3] and the Abaqus software. A good agreement between simulations and experimental data was found. Further improvements of the existing model and the possibilities to investigate multiple lines melting (hatching) are discussed.

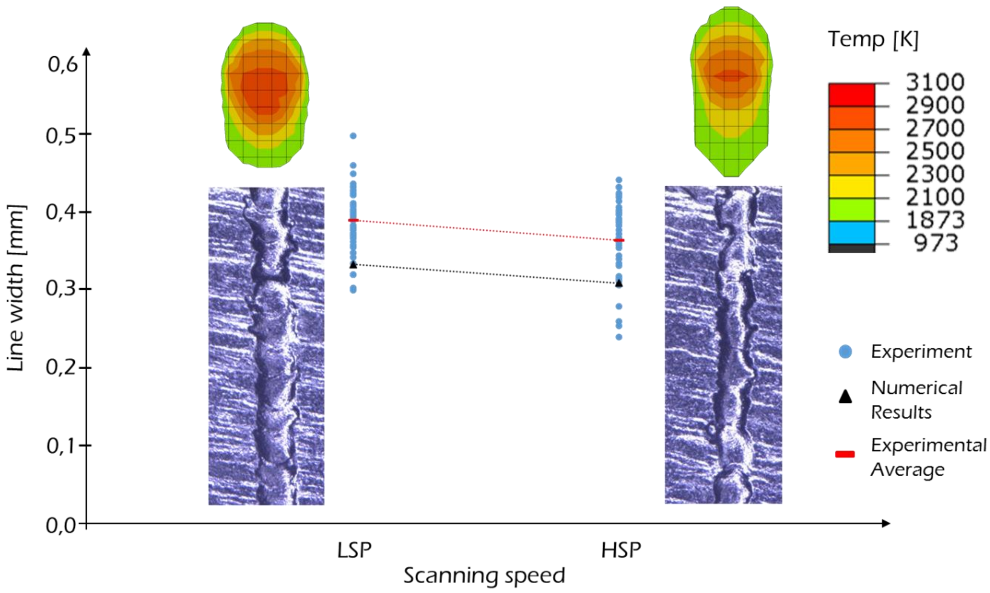

Figure 1-Single line multi beam melting. Comparison between numerical and experimental results for two different values of scanning speed.

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