Newton, Lewis and Senin, Nicola and Leach, Richard (2017) Focus variation measurement of electron beam melted surfaces. In: 16th Conference on Metrology and properties of Engineering Surfaces, 27-29 June 2017, Göteborg, Sweden.

Focus variation measurement of electron beam melted surfaces

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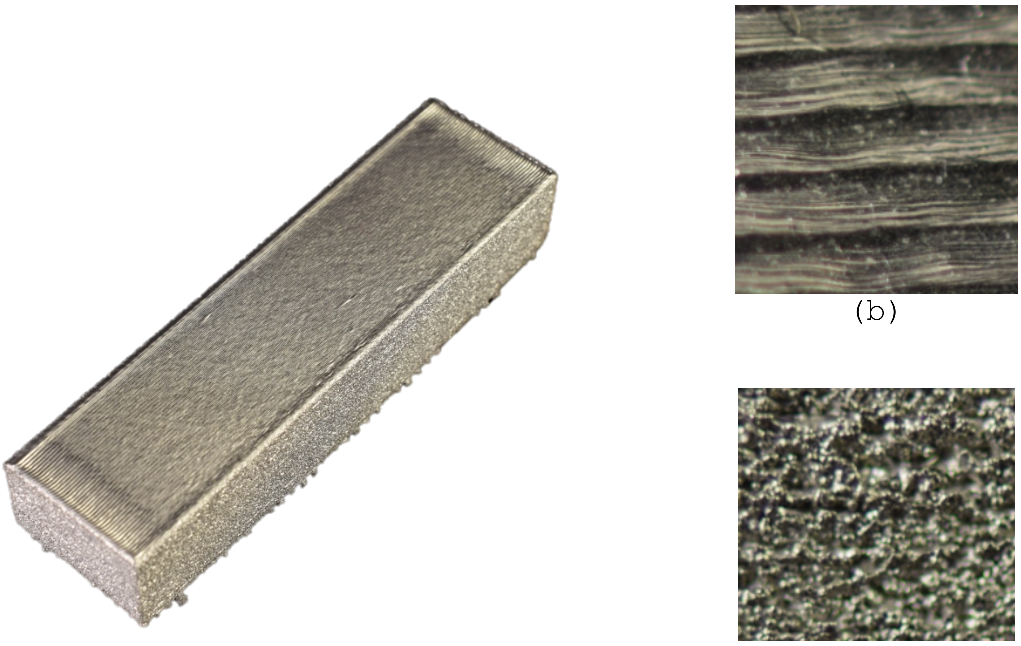
Keywords: electron beam melting, surface metrology, focus variation

Abstract Electron beam melting (EBM) is a promising additive manufacturing process which is seeing increasing use in high value manufacturing sectors such as aerospace [1]. With its layer-by-layer approach, EBM can allow the creation of parts of complex shapes, thus reducing the need for assembly [2]. Surface topography measurement of EBM parts is gaining an increasingly important role, both for assessing the surface finishes that can be obtained with the process before and after post-processing, and as a useful tool to investigate how the manufacturing process behaves through the observation of surface features produced (observation of the manufacturing process signature or fingerprint) [3]. EBM surfaces are very complex and irregular, with a large number of high slopes and undercuts [4]. It is, therefore, very difficult to measure the surface topography of an EBM part. Optical technologies for areal topography measurement are now popular, thanks to their capability for fast acquisition of dense data sets [5]. Focus variation (FV) is one of the most promising measurement technologies for EBM parts, as it combines reasonably fast measurement times with good capability to capture complex topographies [6]. However, many possible FV set-ups could be adopted for measuring an EBM surface. Objective lens magnification, illumination conditions and detector parameters are some of the most relevant control variables that can be varied, in the attempt to achieve optimal measurement results.

In this work we investigate how variations in magnification, illumination and detector parameters influence the assessment of topographic properties via FV measurement. The sample is a rectangular block, 20 mm × 20 mm × 70 mm, made from titanium alloy Ti6Al4V by EBM (Figure 1). The sample's surfaces are measured with an Alicona Infinite Focus G5 focus variation instrument while varying the following control parameters: objective lens magnification: 10×, 20×, 50×; type of illumination: coaxial, ring; intensity of emitted light; detector parameters: exposure, gain and contrast. The influence of the selected control parameters on the results of FV topographic measurements are assessed by computing ISO 25178-2 [7] areal field texture parameters on the reconstructed topographies. Texture parameters are computed on repeated measurements, with and without bandwidth matching [8], and statistically assessed for agreement or

discrepancy, to determine the significance of the control parameters on the texture assessment results.



(b)

(c)

(a)

Figure 1. Photograph of the 20 mm × 20 mm × 70 mm sample artefact used in the comparison (a) and two images of its top surface (b) and side surface (c). Field of view for details 2000 μm ×2000 μm.

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