# X-ray computed tomography of additively manufactured metal parts: the effect of magnification and reconstruction sampling on surface topography measurement

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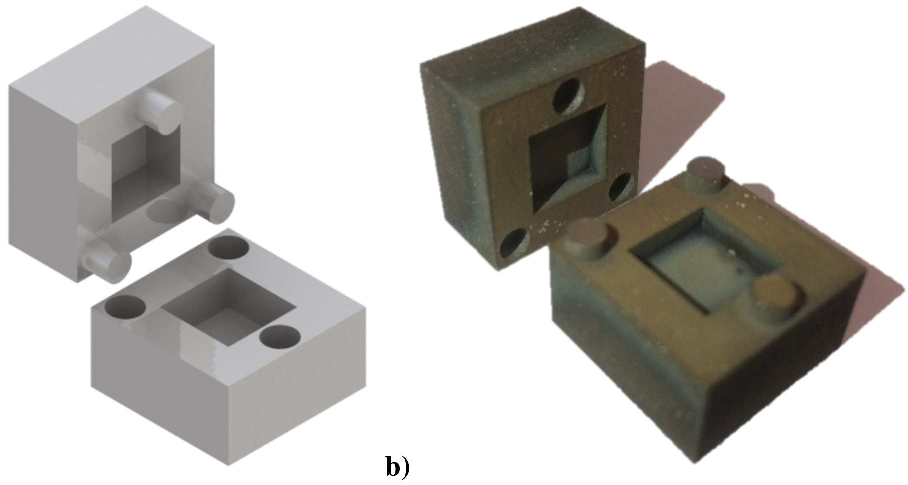
**Keywords:** surface texture, metrology, additive manufacturing, X-ray computed tomography

**Abstract** X-ray computed tomography (XCT) has recently become recognised as a viable method of surface topography measurement for additively manufactured (AM) metal parts [1–5]. AM is capable of producing internal features that are inaccessible to other surface topography measurement instruments [6,7], which makes XCT topography measurement particularly interesting to the AM community. A rigorous assessment of the ability of XCT systems to measure surface topography is, however, yet to be performed, and represents a complex challenge that must account for the large number of control variables involved in XCT measurement (e.g. voltage, current, magnification, computational corrections, filtering and surface determination). The aim of this study is to investigate the sensitivity of XCT topography measurement to some such control variables. More specifically, the effects of varying magnification (i.e. the ratio between source-to-detector distance and source-to-object distance [8]) and reconstruction sampling (i.e. the resolution of the volumetric grid filled during reconstruction [9]) are investigated. These variables have been chosen for their influence on the voxel size of the volumetric dataset, which in turn affects the extracted topography, and any subsequent texture assessment. In this work, the internal top surface of a hollow Ti6Al4V cubic artefact with an external size of (10 × 10 × 10) mm, fabricated via laser powder bed fusion (LPBF) is considered (see figure 1). Measurements are performed with geometric magnification (the first control variable) set at 5×, 10×, 20× and 50×, aligned with typical magnifications used during optical surface topography measurement. The effects of super- and sub-sampling in the volume reconstruction phase (the second control variable) are investigated using Nikon software (CT Pro). Texture parameters and reconstructed topography profiles obtained as a result of XCT measurements are investigated and compared to measurements by coherence scanning interferometry (CSI) and focus variation (FV). Datasets are bandwidth-matched [10] between instruments for the quantitative comparison of texture parameters. For profile comparison, CSI, FV and XCT areal topographies are relocated with geometric registration methods. Initial results indicate that, for selected combinations of magnification and

sampling reconstruction, XCT surface topography is in agreement with topography obtained by CSI, FV and stylus measurements. The authors expect this study to provide information about how these control variables can be optimised, (with the purpose of decreasing measurement complexity and time) without significantly altering the quality of the topographic result.



**a)** **b)**

**Figure 1**. Proposed (10 × 10 × 10) mm artefact for the measurement of internal surface texture: a) CAD model; b) heat-treated, current Ti6Al4V prototype fabricated by LPBF. The two components of the artefact can be assembled to simulate internal surfaces, and separated for measurement by traditional methods. The final version of the artefact will have no post-processing in order to preserve the as-built surface.

**Main References**

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