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# Coherence scanning interferometry for additive manufacture

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**Abstract.** Additive manufacture (AM) of metal components is a rapidly maturing technology; but given the large number of interrelated process parameters, it remains difficult to control to high precision. It has been observed that processing conditions may be associated with specific features in the surface texture [1], creating a drive to achieve fast, and reliable topographic measurement of metal AM surfaces. One of the most developed metal AM processes, selective laser melting (SLM), still produces parts that exhibit rough surface textures with dense distributions of features at a wide range of lateral and vertical scales, aspect ratios, and reflective properties; with the additional complication of the presence of high slopes, undercuts and surface recesses. These features make metal AM surfaces challenging to measure by both tactile and optical means [2,3].

Recent innovations in coherence scanning interferometry (CSI) have increased baseline sensitivity of the measurement through high dynamic range (HDR), and dynamic noise reduction (DNR) techniques [3,4]. Improved sensitivity in CSI instruments increases the capacity to measure surface features with low reflectance, or surfaces sloped beyond the numerical aperture of the instrument, making CSI a valuable tool for process development and quality control of metal AM parts [5,6].

As with any optical measurement technique, CSI can be performed with a range of measurement conditions and data reduction methods. In 2010, the National Physical Laboratory (NPL) published a good practice guide for CSI measurement of rough surfaces [7], but the addition of HDR and DNR techniques further expands the range of measurement parameters beyond those outlined in this guide. To date, no study has evaluated the effect of these parameters on the measurement of AM surface topography.

This study will conduct a limited sensitivity analysis on a CSI system for a 20 mm Ti6Al4V cube produced by SLM (see figure 1) varying objective lens magnification (5.5×, 20×, 50×), measurement mode, Z resolution (normal, high), light source spectral bandwidth (80 nm or 40 nm), HDR and DNR. This study will not attempt to provide an exhaustive combination of these parameters, rather to explore the parameter space and provide insight into areas of interest for future

rigorous examination. The topographic measurements will be analysed for data coverage, the presence of measurement artefacts, and the variability of surface texture parameters. This work is intended to provide information and guidelines to improve topographic measurement quality without increasing measurement complexity.

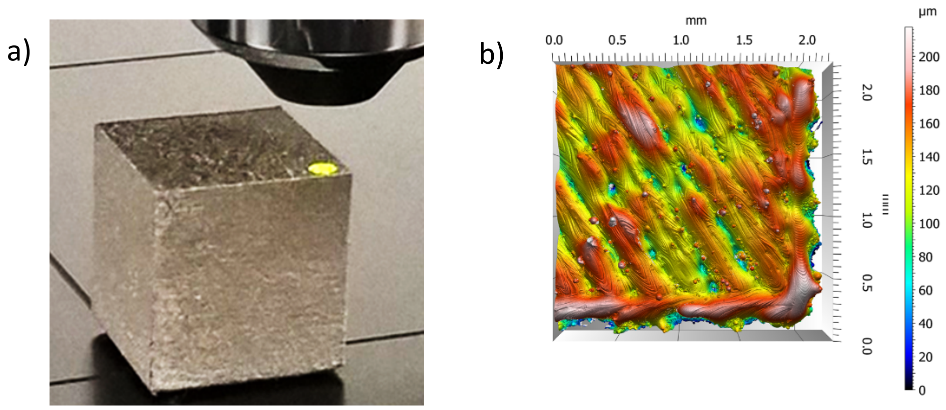


**Figure 1**. a) Micrograph of 20 mm Ti6Al4V SLM cube, b) CSI measurement of the cube surface; 20× objective lens (NA 0.40, stitched images of 0.42 mm × 0.42 mm field of view).

**Main References**


[1] National Institute of Standards and Technology, (2013) *Measurement science roadmap for metal-based additive manufacturing*, Energetics Incorporated, Columbia, Maryland, USA.

[2] Townsend, A., Senin, N., Blunt, L., Leach, R. K., Taylor, J. S. (2016) Surface texture metrology for metal additive manufacturing: a review, *Precision Engineering*, 46, 34-47.

[3] Fay, M., Colonna de Lega, X., de Groot, P. (2014). Measuring high-slope and super-smooth Optics with high-dynamic-range coherence scanning interferometry, *Classical Optics*, OW1B.3.

[4] de Groot, P. (2015). Principles of interference microscopy for the measurement of surface topography, *Adv. Opt. Photon.*, 7, 1-65.

[5] de Groot, P. (2011). *Coherence scanning interferometry*. In: Leach R K (Ed). *Optical measurement of surface topography* (pp. 187-208). Berlin: Springer Verlag.

[6] Fay, M. F., Badami, V. G., and Colonna de Lega, X (2014). *Characterizing additive manufacturing parts using coherence scanning interferometry*. Proc. ASPE Spring Topical Meeting on Additive Manufacturing.

[7] Petzing, J., Coupland, J., Leach, R. K. (2010). The measurement of rough surface topography using coherence scanning interferometry. *NPL Measurement Good Practice Guide No. 116*.