Joint Special Interest Group meeting between euspen and ASPE
Advancing Precision in Additive Manufacturing
KU Leuven, Belgium, September 2023
www.euspen.eu

Investigation of focal spot blurring and its deblurring to improve the metrological structural resolution of XCT in the surface metrology of additively manufactured parts

X. Chen[1,2], S. Lou[1], W. Zeng[1], X. Jiang[1], P.J. Scott[1] and W. Sun[2]

[1]*Future Metrology Hub, University of Huddersfield, Huddersfield, HD13DH, UK*
[2]*Materials and Mechanical Metrology, National Physical Laboratory, Teddington, TW11 0LW, UK*

xiao.chen@hud.ac.uk

Abstract

X-ray computed tomography (XCT) is a promising dimensional metrology tool for additively manufactured (AM) parts due to its capability to measure both internal and external surface structures and the potential to simultaneously conduct different metrology tasks such as dimensional, surface texture and porosity measurement. But the capability of XCT to be such a powerful metrology tool is limited by its low resolution, which poses a significant filtering effect on the small-scale surface structures. Especially the compromise between the small focal spot size and sufficient X-ray power to penetrate the dense metal AM parts makes it difficult to achieve high resolution. The finite focal spot size results in a blurring on the XCT projection images, leading to a filtering on the surface texture. This work focuses on the investigation of the focal spot blurring and its deblurring to reduce the surface filtering effect of XCT in the surface measurement of metal AM parts. The focal spot blur was investigated by reconstructing the 2D effective focal spot using the projection image of a star pattern. The impact of XCT measurement settings, including current, voltage, beam focusing and the use of physical pre-filters, on the focal spot was investigated, and the guidance on reducing the focal spot blur by optimising the measurement setups was provided. In addition, for low-cone angle XCT measurements, the focal spot blurring effect on the projection images can be modelled as the convolution of the true image and the intensity distribution of the effective focal spot, therefore the deconvolution techniques were performed on projection images to deblur the focal spot blur. The improvement of the XCT measurement performance on AM parts by deconvolution was examined and the factors affecting the deconvolution performance were investigated, including the accuracy of the reconstructed focal spot, the noise level of the measurement and the deconvolution algorithm. The results show that the deconvolution can improve the XCT measurement resolution and restore surface structures that have even been lost in the original measurement. However, it is also noticed that the performance of deconvolution is limited by the measurement noise.