**Micro-feature Characterization Methods for Additive Manufactured Titanium Samples**

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ABSTRACT

This paper introduces an exemplar (ND-1), a Ti-5553 additively manufactured (AM) part with approximately 2.5% process-induced porosity and subtractively manufactured features from 25-1600 micrometers (µm) in size. The exemplar is imaged with X-ray Computed Tomography (XCT) and Mechanical Polishing Serial Sectioning (MPSS) at resolutions of 6.5 µm/pixel and 0.689 µm/pixel, respectively. The high-resolution MSS imaging of the interior features (pores and machined features) expands the scope of questions that can be answered by XCT systems, reconstruction and segmentation algorithms, and long-term quality control.

Via two-dimensional analysis, we compare image signatures of cylindrical holes of the XCT and MSS data.

Each hole size (25, 50, 100, 200, 400, 800, 1600 µm) is evaluated by contrast-to-noise ratio (CNR) and maximum gradient along the radial direction. The results demonstrate how the CNR of XCT data degrades in holes with a radius under 200 µm, but MSS CNR is consistent down to 25 µm. Additionally, the CNR of circular features are plotted as a function of diameter and distance from the edge to quantify the cupping effects. It is also demonstrated that the XCT Maximum Gradient underestimates small pore sizes compared to the MSS signature. All analyses are plotted against the pixel density of holes.

The challenges of the XCT-MSS comparison are listed, including filling material, edge-rounding, image stitching, registration, and MSS non-planar polishing. Ultimately, this technique strengthens the verifiability criterion in claims about XCT systems.

**Keywords:** X-ray CT, Serial Sectioning, Optical Surface Profiler, Porosity, Registration, Titanium Alloy, Additive Manufacturing.

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