Characterization of Defects and Designed Flaws in Metal Additive Manufacturing (AM) Parts with X-ray Computed Tomography (XCT)

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Metal Additive Manufacturing (AM) has great potential to revolutionize manufacturing industries, but a reliable method to detect defects in AM-produced parts with complex internal structures must be developed prior to its widespread adoption. In this research, defects occurring in additively manufactured metal parts are characterized with X-ray Computed Tomography (XCT). In addition, the concept of metrological XCT is introduced, with the goal of providing more accurate dimensional measurements of the internal features.

Preliminary experiments have been conducted toward the larger goal of evaluating XCT as a viable option for nondestructive evaluation of AM-produced components. Critical to this evaluation is the principle of the Probability of Detection (PoD), which has not been previously determined for typical AM defects using XCT. The first step in determining the PoD for XCT is to develop a suitable artifact with embedded features that are representative of the defects occurring in AM-produced parts. Two sets of samples were built by AM and their embedded defects measured by XCT. In the first set of samples, the chosen AM processing parameters were suboptimal, ensuring that defects would be present in the parts. These parameters were also varied to understand their effect on the resulting microstructure and defect formation. Measurements of porosity and the pore size distribution were determined from the XCT images. In the second set of samples, synthetic internal features were added, some approximating typical AM defects. Dimensional XCT was used to evaluate the quality of these features. Based on the results, a future experiment with the goal of estimating the PoD of critical AM defects with an XCT system is suggested.