IMPROVED QUANTIFICATION OF OBJECTS IMAGED IN 3D USING X-RAY MICRO-TOMOGRAPHY

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Micro X-ray Computed Tomography (MXCT) is widely used in the materials science community to examine the internal structure of materials for voids, inclusions and cracks. Most materials research uses MXCT as a tool to collect qualitative data on the materials, simply answering; Are there voids or other features present within the sample? Often of more importance, researchers are questioning the sizes and distributions of these voids and features as a tool to compare lot-to-lot or experiment-to-experiment results. Accurate 3D measurements are non-trivial. Many experimental parameters must be set that can determine the quality of the measurement statistics and only a few references attempt to quantify objects in 3D. Because of the discrete nature of 3D scientific imaging, smaller objects with fewer voxels can also have a large impact on the final statistics.

In this presentation we examine some of the requirements for accurate three-dimensional measurements. First, we will present data investigating the instrumental conditions required for dimensional accuracy; specifically, the number of radiographs required to balance acquisition time and dimensional accuracy with noise. To do this, a standard has been created by embedding NIST standard microspheres within a low-density polymer. A series of data sets has been collected, varying the number of radiographs collected to determine the appropriate number required. Results show that approximately 721 radiographs (four radiographs per degree of sample rotation) balances signal-to-noise with acquisition time when the sample has high contrast. Secondly, an examination of the number of voxels within an object versus the noise of the measurements will be shown. Using cylinders drawn in Avizo Fire with a 3:1 aspect ratio and resampled down to very low resolution, the statistics of their volume, surface area and Feret diameter can all be examined. Results indicate that surface area and Feret Shape measurements require ~100 and ~1000 voxels respectively within the object for robust statistics. As case studies, voids present within dynamically damaged Cu samples and within polymer foams as imaged using an Xradia MXCT, will be presented.