APPLICATION OF 3D X-RAY TOMOGRAPHIC AND FLUORESCENCE IMAGING TO BETTER UNDERSTAND THE RELATIONSHIP BETWEEN MATERIAL FORMULATION AND PERFORMANCE

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Understanding the effects of a material's morphology upon the overall material performance requires a detailed understanding of its initial morphology and how it changes under external stimuli. No technique can measure the 3D structure of materials on many size and time scales like X-ray computed tomography (CT). This technique is an indispensable tool for materials development and characterization. With this technique, 3D images of a material are collected, non-destructively, providing a probe into its internal 3D structure on features as small as 150 nm to multi-mm in scale or on time frames as short as 0.25 seconds per 3D image and on materials as diverse as aerogels to plutonium. This provides a better understanding of its manufactured morphology, after-experiment morphology, and even the morphological changes during the experiment.

This presentation will focus on three recent topics on the use of X-ray CT and confocal micro X-ray fluorescence within the Materials Science and Technology Division at Los Alamos National Laboratory to answer a variety of materials challenges of National Security importance. These challenges include understanding the in situ mechanical response within 3D printed polymer composite materials & hyper-elastic polymer foams, and the quantification of precious minerals within packed mining tailings. On top of these challenges, much of our research has focused on improving the robustness of CT measurements and making them more quantitative. Probing questions such as, "How many radiographs do I really need to acquire?", and "What resolution do I need so that the statistics are related to the object and are not skewed by the number of voxels within the object?" provides a foundation to answer these materials science questions with more confidence. On top of these simple analytical metrics, CT provides a robust starting point for modeling as well as digital volume correlation studies to better relate processing with structure, and ultimately, mechanical performance.

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