MICROSCALE CHARACTERIZATION OF CMCS USING 3D TOMOGRAPHY TECHNIQUES AND MACHINE LEARNING ALGORITHMS TO QUANTIFY AND CORRELATE INITIAL MICROSTRUCTURE TO DAMAGE EVOLUTION

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Ceramic matrix composites are leading ceramic technology with their improved toughness due to the continuous fibers embedded within a ceramic matrix and are often utilized in high temperature structural applications. Advanced 3-D imaging technology such as serial sectioning and x-ray computed tomography (CT) techniques allow for a wealth of information to be captured in regards to the microstructure and damage evolution of these materials. With this wealth of information comes the need to efficiently quantify these images in a way that informs and describes the relationship between the local microstructure and the material's resulting mechanical performance. This work focuses on the ability to segment, or quantify, CMC minicomposite microstructures obtained from synchrotron tomography using machine learning algorithms. The SiC/SiC minicomposites, were fabricated and tested under tensile load using synchrotron tomography at the advanced light source (ALS) at Lawrence Berkeley National Lab. Using synchrotron tomography, the microstructure of these mini composites was quantitatively measured using machine learning segmentation techniques. The microstructure constituents that were quantified include the volume fraction of matrix, fibers, and porosity, and fiber coating. After initial imaging, the mini composite specimens were imaged under increasing load to observe damage evolution as a function of tensile load. Machine learning in combination with in-house techniques were used to quantify matrix cracking and fiber fragmentations at increasing stress loads. This work shows an initial framework that correlates the relationship between the local microstructure and the material's resulting mechanical performance.