Sample Preparation and Microstructure Characterization of Novel Ceramic Matrix Composites

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Introduction/Motivation

- Manufacturing of ceramic matrix composites (CMCs) induces defect like voids and cracks
- Limited knowledge of CMC damage behavior in operating environment
- Comprehensive microstructure characterization needed to generate representative volume elements for multiscale predictive model
- Models to be used for material property homogenization as well as damage initiation and propagation

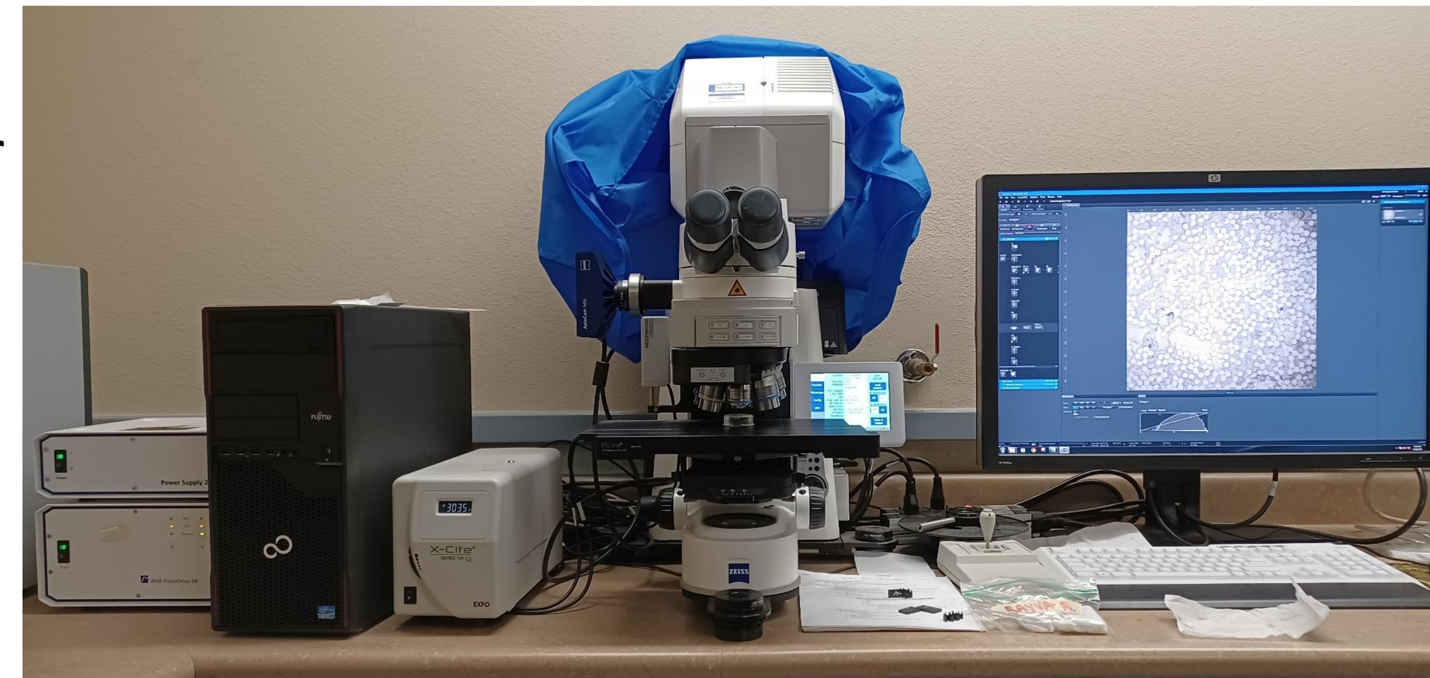
Methodology

- Cut carbon-fiber-reinforced silicon carbonitride (C/SiNC) matrix samples using a low-speed diamond wafering blade
- Cold mounted samples into epoxy resin
- Polished using series of Struers polishing discs with successively smaller grit size
  - 30 μm down to 0.04 μm
- Perform multiscale material characterization study using confocal microscopy
  - High resolution and variable magnifications

Figure 1: Cold mounted C/SiNC samples

Figure 2: Polishing machine with polishing discs located above and polishing pastes lined up to the right

Figure 3: Confocal microscope with power source and computer to run image acquisition software to the left and monitor to view micrographs on the right



Results

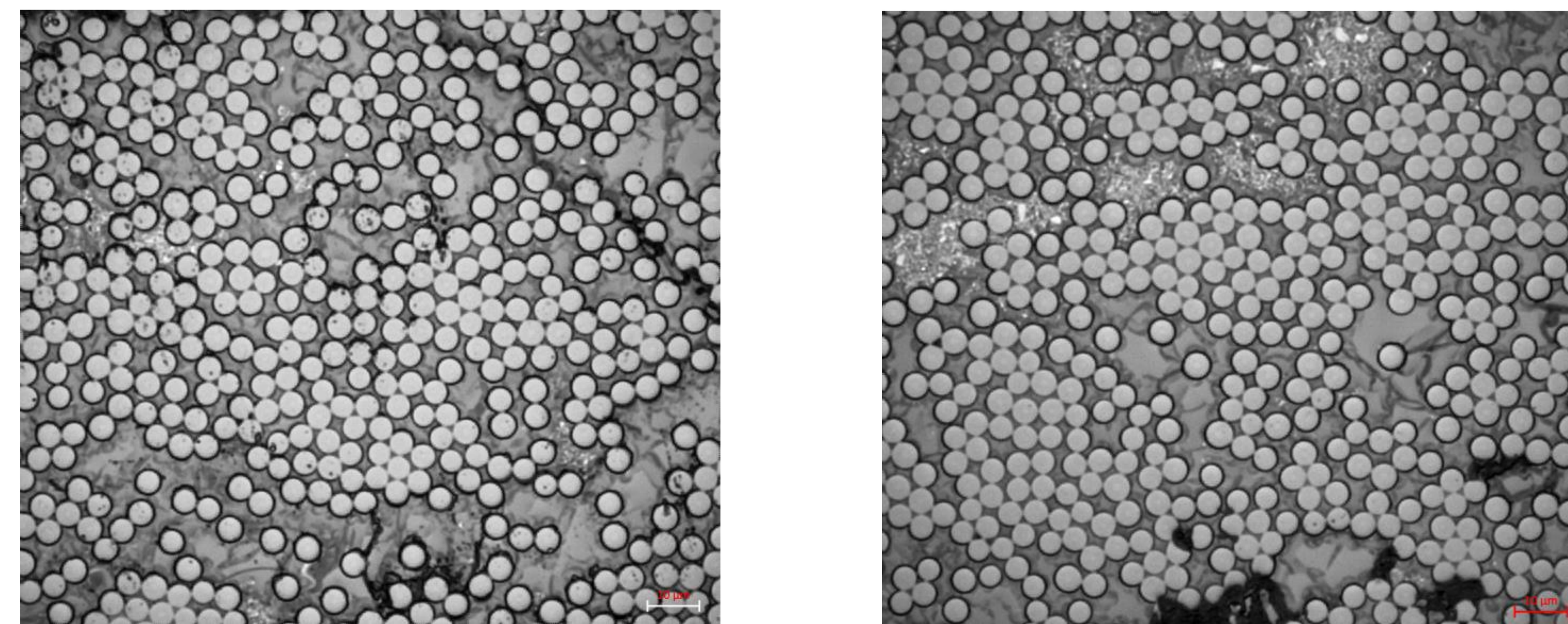


Figure 4: Micrographs of C/SiNC samples with different polishing procedures

Conclusion

- When using the microscope, there are many parameters that must be exactly fine-tuned
  - Light, exposure, magnification
  - Image acquisition and post-processing within software
    - Z- stacking, extended depth of focus, shading correction
- Many external factors influence quality of micrographs
  - Polishing procedure, quality of polishing paste and polishing discs

Future Work

- Acquire micrographs of higher quality using a scanning electron microscope (SEM)
- Utilize machine learning algorithm for feature extraction and feature quantification as well as for defect categorization
- Construct dictionary of high-resolution micrographs to train a deep learning framework capable of generating experimentally informed RVEs

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