Institute Interest Seminar Series

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On understanding the microstructure from transmission electron micrographs erected from site specific Focused Ion Beam lift-outs

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Advances in the fabrication of transmission electron microscopy (TEM) thin films using Focused-Ion beam machining allows for direct observation of microstructures under specific macroscopic features such as fracture surfaces and arrested crack tips. As evident from fracture studies by May Martin, the underlying microstructure cannot be assumed based on the fractography alone, and so a multifaceted, multiscale approach must be taken. Care must be taken not only in designing the experiment for proper microstructure analysis, but also in understanding how to interpret micrographs. Tests are being designed to look into the effects of closure and rubbing on the microstructure beneath a fatigue crack and correctly interpreting the layer of refinement observed at the fracture surface. In an arrested fatigue crack experiment on Haynes 230 and Copper, the microstructure ahead of a crack tip has shown more extensive plasticity and refinement than previously anticipated, suggesting that this refinement layer existed before the crack passed through. These studies have challenged our current understanding of the classical fatigue model and shown the importance of microscopic understanding and multiscale modeling. Similar arrested fatigue crack tests will be performed in 316 stainless steel with and without the presence of hydrogen in an effort to understand the role that hydrogen plays on plasticity specifically at the crack tip. Current studies on the fracture surfaces on 304 and 316 stainless steel are studying the role hydrogen plays in the microstructure immediately beneath fatigue striations.