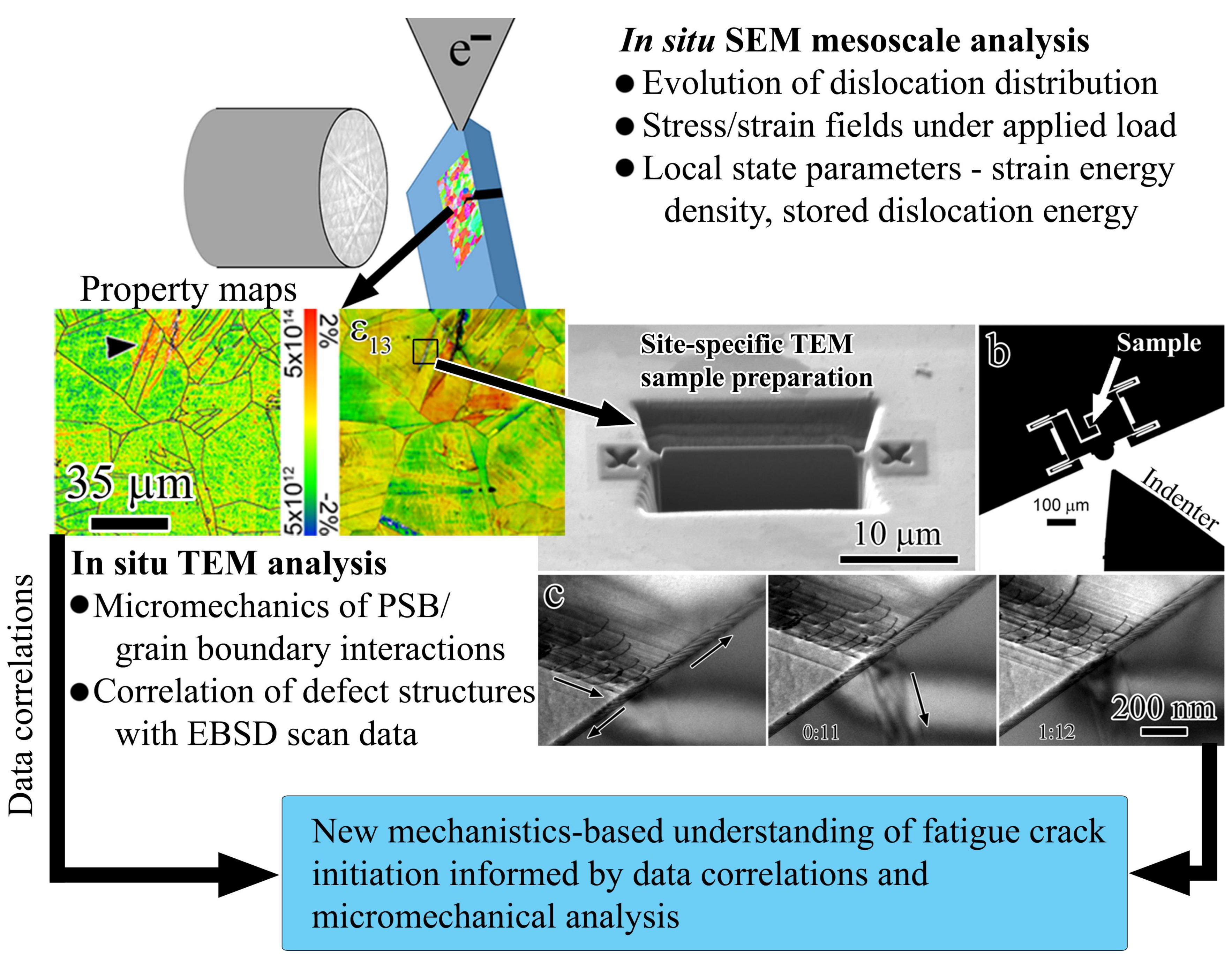
Kacher Lab

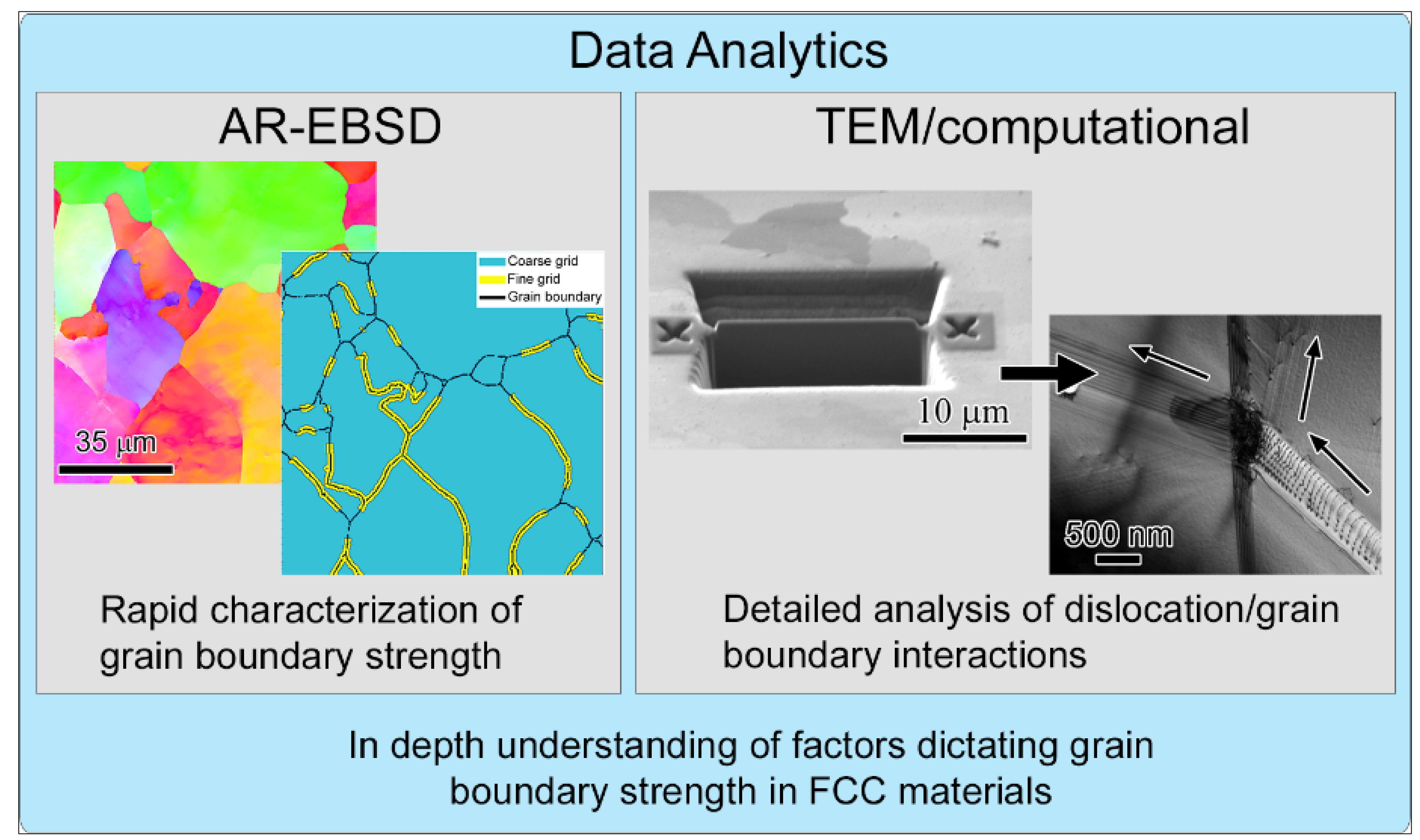
Motivation: As a lab, we are interested in understanding the relationship between processing, microstructure, and failure of metals and alloys in extreme environments. A common approach in our group is to characterize degradation modes at the mesoscale using high resolution EBSD-based techniques and then find novel ways to recreate extreme environments *in situ* in the transmission electron microscope where defects and chemical processes can be observed directly. A few of our current projects are summarized below.

Understanding fatigue crack initiation

This research employs a multiscale electron microscopy approach, combining high resolution EBSD (HREBSD) with *in situ* SEM deformation at the mesoscale with TEM-based dislocation characterization and *in situ* TEM deformation at the microscale.

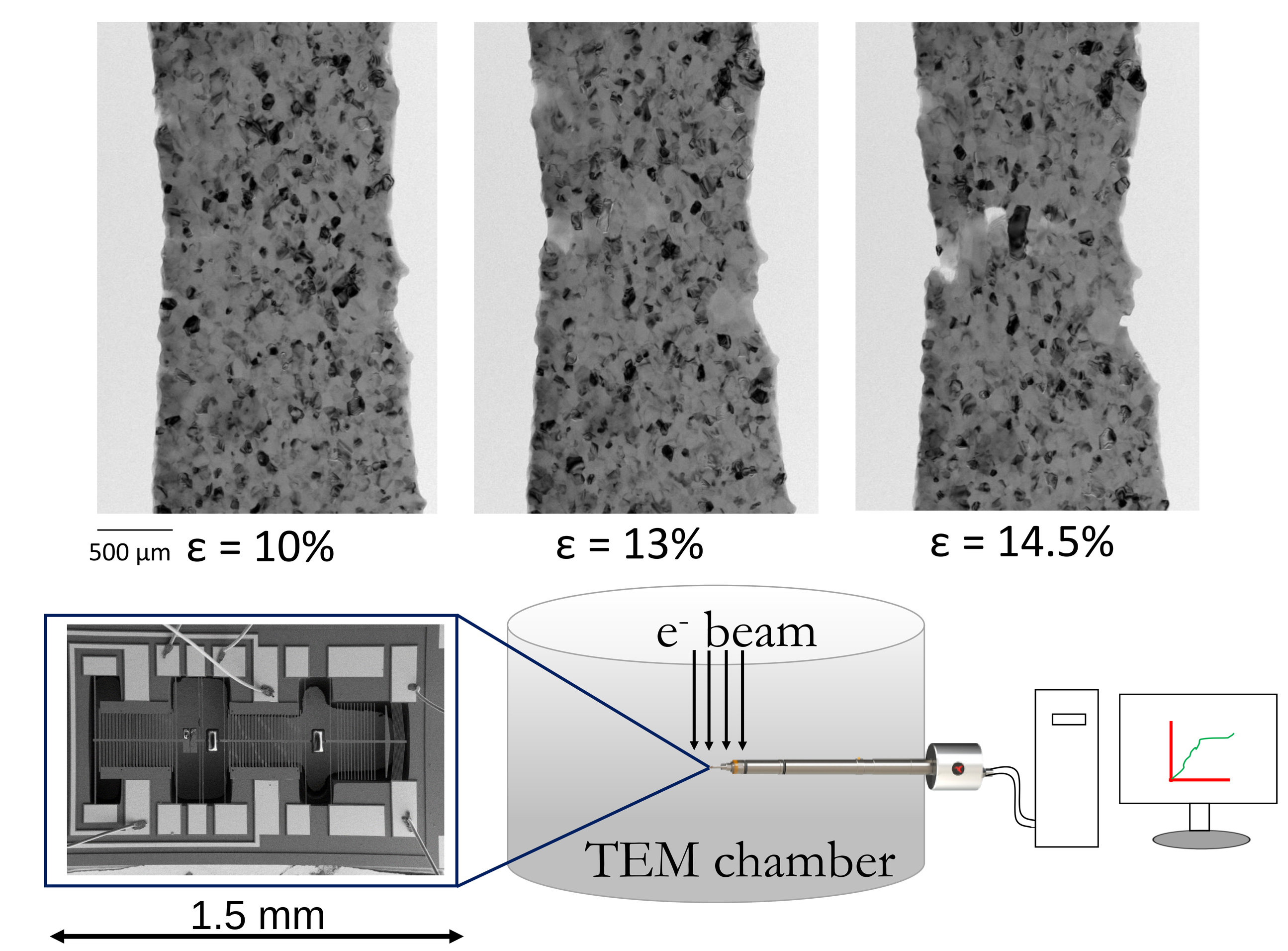


Combining AI with SEM to calculate grain boundary strength



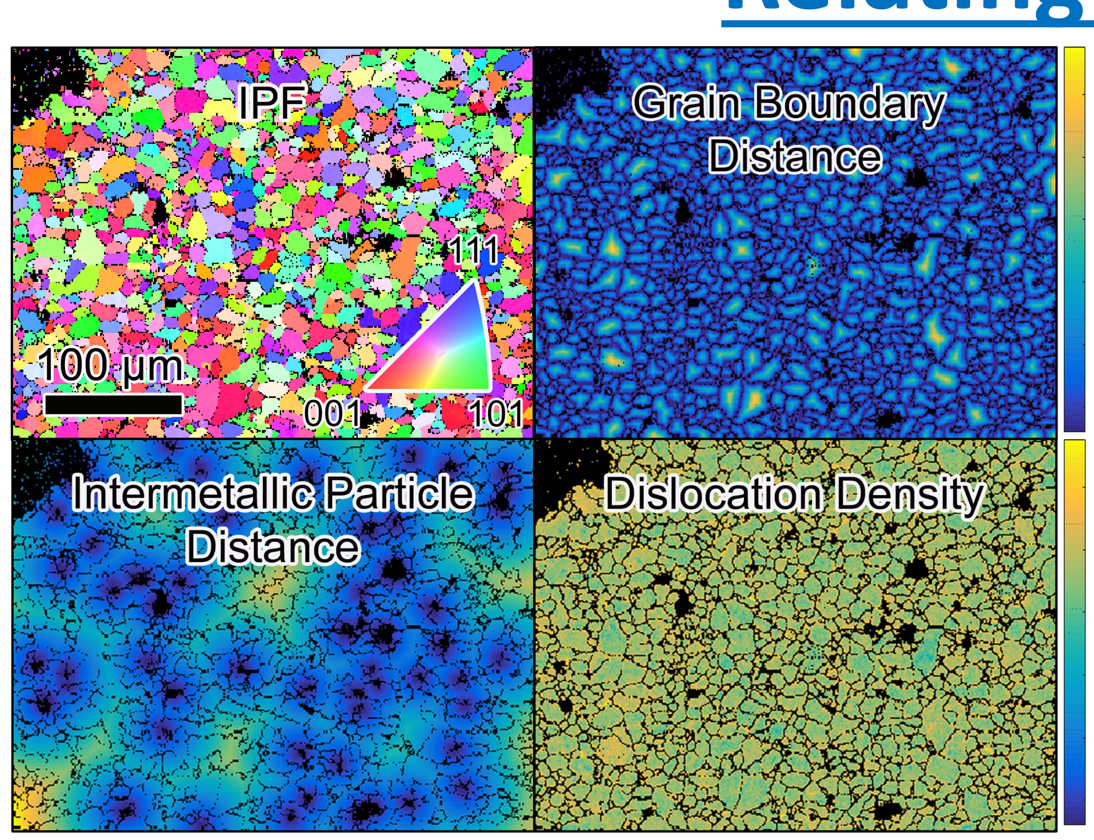
Grain boundaries are one of the most important variables in determining the mechanical properties of materials. This project develops EBSD-based techniques to quantify grain boundary strength during deformation. Artificial intelligence will be built into automated defect analysis to rapidly characterize thousands of grain boundaries.

In situ TEM deformation of ultrafine grained materials



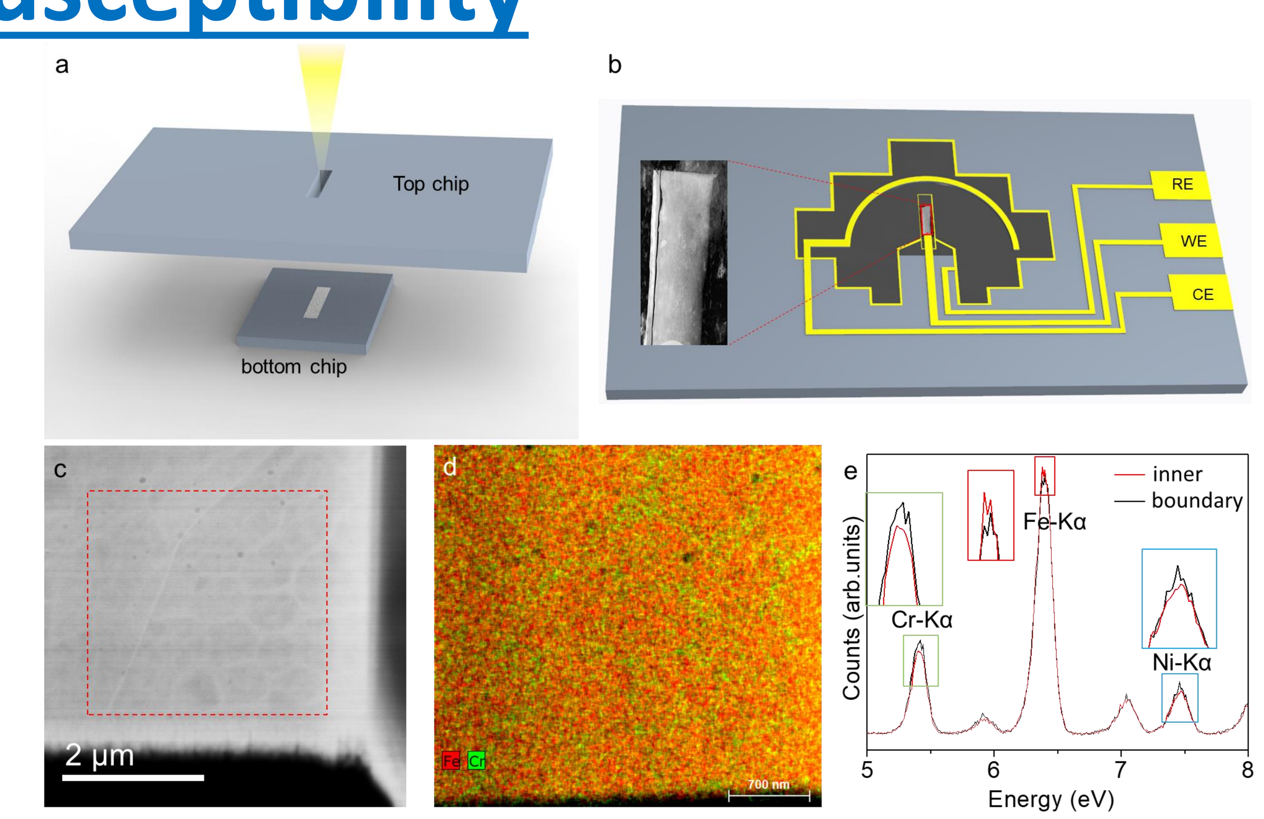
Ultrafine grained (UFG) and nanocrystalline (NC) metallic thin films exhibit different deformation mechanisms than their course grained equivalents, such as intergranular dislocation glide, grain boundary sliding and grain growth. This project uses *in situ* TEM experiments to explore deformation behavior of UFG and NC materials at the nanoscale.

Relating microstructure to corrosion susceptibility



Corrosion remains one of the greatest challenges in materials development. This project combines rapid microstructure characterization with automated image analysis to understand what factors dictate localized corrosive attack in materials.

In situ TEM corrosion experiments are also conducted to directly characterize corrosion attack at the nanoscale.



Current needs

We currently have openings in the following areas:

- Relating corrosion to microstructure (in collaboration with Sandia National Laboratories)
- Quantifying grain boundary strength using EBSD and TEM analysis (NSF funded)
- Fatigue crack initiation (DOE funded)
- Hydrogen embrittlement in Al alloys (Air Force funded)