Strain & Phase Mapping of Industrial Materials & Processing by Synchrotron

North Mammoth, Tuesday Afternoon Workshops 1:30 pm – 4:30 pm

Organizer & Instructors:
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This workshop will focus on the general principles of strain and phase mapping using synchrotron radiation to interrogate a wide range of advanced engineering materials. X-ray diffraction can be utilized to systematically and comprehensively understand the effects of processing and the resultant evolution of structure on the overall mechanical properties, performance, and thermal stability for materials. Standardized procedures for the testing and analyses of size-dependent mechanical and functional properties at the nanoscale, which are essential for the design, modeling, and life assessment of advanced engineering materials for structural and functional applications, will also be addressed.

Unique experimental techniques, in particular energy dispersive X-ray diffraction (EDXRD), will be reviewed in this workshop for the in situ and ex situ characterization of the structure, residual stresses, and fracture and fatigue response. Systematic and well-executed experiments to investigate monotonic and cyclic deformation and failure across nanometer to macroscopic length scales are discussed in carefully chosen and synthesized model systems. We will discuss techniques to directly measure the residual stress tensor in materials as a function of depth, to correlate the residual stress profiling to deformation and fracture processes of advanced engineering materials and to relate deformation modes to structural parameters.

Herein we will report on the application of these techniques on Fatigue, Stress Corrosion Cracking (SCC) and Corrosion Fatigue (CF) crack phenomena in Steel and Aluminum alloys. Prof. Tsakalakos will also discuss advanced techniques to measure the residual stress tensor in nanostructured materials as a function of depth, using synchrotron methods. The residual stress profile will be correlated to deformation and fracture processes of engineering materials and nanomaterials and coatings including Alumina-Titania Nanostructured coatings. Systematic and well-controlled experiments aimed at investigating monotonic-cyclic deformation and failure across nanometer to macroscopic length scales are discussed in carefully chosen model systems. Applications of the EDXRD on ceramics densification, by flash sintering are given.

Many material issues relevant to scientific and industrially inquiry require determination of the spatial distribution of strain and phases in order to gain insight into microstructures that govern material properties. High-energy x-rays are often necessary to penetrate into bulk sample sizes and geometries while the material undergoes pertinent processing or operating conditions. We will discuss several synchrotron-based x-ray scattering techniques that enable scientists and engineers to probe materials and spatially resolve the sample microstructure from the sub-micron to millimeter length scales. John Okasinski will provide a comprehensive review of these synchrotron methods for engineering materials.

Synchrotron energy-dispersive X-ray diffraction (EDXRD) is one of the few techniques capable of probing the active materials inside a production or prototype electrochemical cell. This powerful technique has provided useful insights in to the otherwise-hidden behaviors. Still, while placing a battery in the beamline will yield a researcher with data, to make the best of this resource, one should know best practices and common pitfalls. With five years of experience working with EDXRD, William A. Paxton will share the practical knowledge required to succeed at the beamline.