# LATTICE STRAIN/STRESS MAPPING AROUND A FATIGUE CRACK DURING THE RETARDATION PERIOD AFTER AN OVERLOAD

Y. Sun[1], K. An[2], Y.F. Gao[1], C.R. Hubbard[2], H. Choo[1,2], and P. K. Liaw[1]

[1]Materials Science and Engineering Department, The University of Tennessee, Knoxville, TN 37996.

[2]Materials Science and Technology Division, Oak Ridge National Laboratory, Oak Ridge, TN 37831.

An overload that is applied during a fatigue crack-growth experiment will reduce the crack-growth rate. This well-known phenomenon is called retardation, but the relationship between the overload and the crack-growth rate retardation has not been quantitatively characterized. This lack of quantitative understanding is partially due to prior absence of experimental capabilities to measure the full strain/stress fields. Neutron diffraction was used to investigate the retardation phenomenon using both one-dimensional (1-D) and two-dimensional (2-D) mapping of the changes in the lattice strain around the fatigue crack tip in a series of compact-tension (CT) specimens. Seven specimens were fatigued to various stages of crack growth corresponding to before, at and after the overload event. The specimens were then studied ex-situ (at zero load) via neutron strain mapping methods. The strain mapping shows a compressive, residual-stress field ahead of the crack tip immediately after the overload. For the next several samples the fatigue crack advances though this compressive strain field and this qualitatively explains the retardation. Finite-element simulations based on a hysteretic-cohesive-interface model were carried out to examine the plastic-zone shapes during the retardation period. From the comparisons between the strain maps and the numerical simulations, we concluded that the instantaneous large plastic zone caused by the overload and the subsequent residual-stress fields are the key for slowing down the crack growth after the overload.