In-Situ Neutron Diffraction During Cyclic Deformation : Studying the Reversibility of Deformation Induced Twinning and Phase Transformation.

D.W. Brown[1], S. R. Agnew[2], B. Clausen[1], A. Jain[2], R. Vaidyanathan[3], S. Qiu[3]

[1]Los Alamos National Lab
[2]University of Virginia
[3]University of Central Florida

Over the last 2 years, we have developed a robust capability to study materials during tension-compression cyclic deformation *in-situ* on the SMARTS diffractometer. Of particular interest have been processes that are reversible within a single complete cycle, such as deformation twinning in magnesium and stress induce phase transformations in shape memory nickel-titanium alloys. For the purposes of this talk, twinning may be considered as a stress-induced transformation, but with only a shear component and no volume or symmetry change.

In-situ neutron diffraction experiments have been completed during cyclic deformation of extruded Mg AZ31B alloy and NiTi to several hundred cycles. The phase fraction of the daughter phase (either twin or martensite) and the internal (residual) strains are monitored as a function of cycle. The observed changes in the microstructure will be related to the observed macroscopic behavior, e.g. shrinking of the hysteresis loop and fracture. For instance, twins appear with compressive deformation along the extrusion axis and withdraw with subsequent tensile deformation. The recovery (de-twinning) of the twins at the maximum tensile strain is observed to decrease with increased cycles, that is the overall twin volume fraction increases. In particular, parent grains which initially have their $\left(11\bar{2}0\right)$ plane normals parallel to the straining direction cease to de-twin completely at higher cycles as failure is approached. Despite this, surprisingly little repartition of the internal stresses amongst the different grain orientations was observed.