Nanocrystalline metals exhibit strongly time-dependent plastic deformation. This results in a high degree of strain-rate sensitivity and susceptibility to creep and relaxation, even at room temperature. With the advent of thin film processing techniques like sputtering and electrodeposition for fabrication of controlled microstructures of nanocrystalline materials, nanoindentation and microcompression techniques are increasingly used to extract time dependent plasticity parameters from stress relaxation, creep and strain rate sensitivity measurements [1, 2]. However, no systematic comparison of the micromechanical experimental techniques (nanoindentation and microcompression) has been performed on the same material to establish the relative merits and consistency of these results with their counterpart “bulk” tests.

This poster will present experimental data from micro-tensile, micropillar compression and nanoindentation tests on nanocrystalline nickel at room temperature to directly compare and validate the test results for stress relaxation and strain rate sensitivity measurements. Microcompression and nanoindentation tests were performed on the non-deformed gripper section of the tensile bar to ensure that the same material is interrogated so as to rule out sample-to-sample variations. The extracted time dependent plasticity exponents and apparent activation volumes will be compared for all three test types and the possible rate controlling deformation mechanism(s) will be discussed. It is hoped that this study will conclusively bridge the gap between uniaxial bulk, uniaxial microcompression and triaxial nanoindentation tests.

Figure 1. Micropillar compression, nanoindentation and micro-tensile strain rate jump tests on nanocrystalline Ni at room temperature to compare the three test types

References: