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Properties of Wear Tested Single Crystal Nickel at the Nanoscale-Experiment and Simulation

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Strength, friction, and wear are dominant factors in the performance and reliability of nickel based nanoscale devices. However, the effects of frictional contacts and wear on device performance are undefined. To address these effects on a fundamental level, we have begun a program using nanoscratch and nanoindentation to study wear on <001> oriented single crystal nickel. Nanoscratch techniques were used to generate wear patterns as a function of load and number of cycles. Nanoindentation was then used to measure properties in each wear pattern. The results showed there was a strong increase in hardness with increasing applied load that was accompanied by a change in surface deformation. EBSD and TEM revealed a parallel change in microstructure with increasing applied load and number of wear cycles, from a dislocation cell structure to subsurface structure of randomly oriented nanocrystalline grains. Finite element simulations of the wear process show the same progression in structures. In this presentation, we will combine experimental results with finite element simulations to show how structure and properties evolve under sliding contacts in single crystal nickel and their impact on device performance. This work was supported by Sandia National Laboratories. Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company for the United States Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000.

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