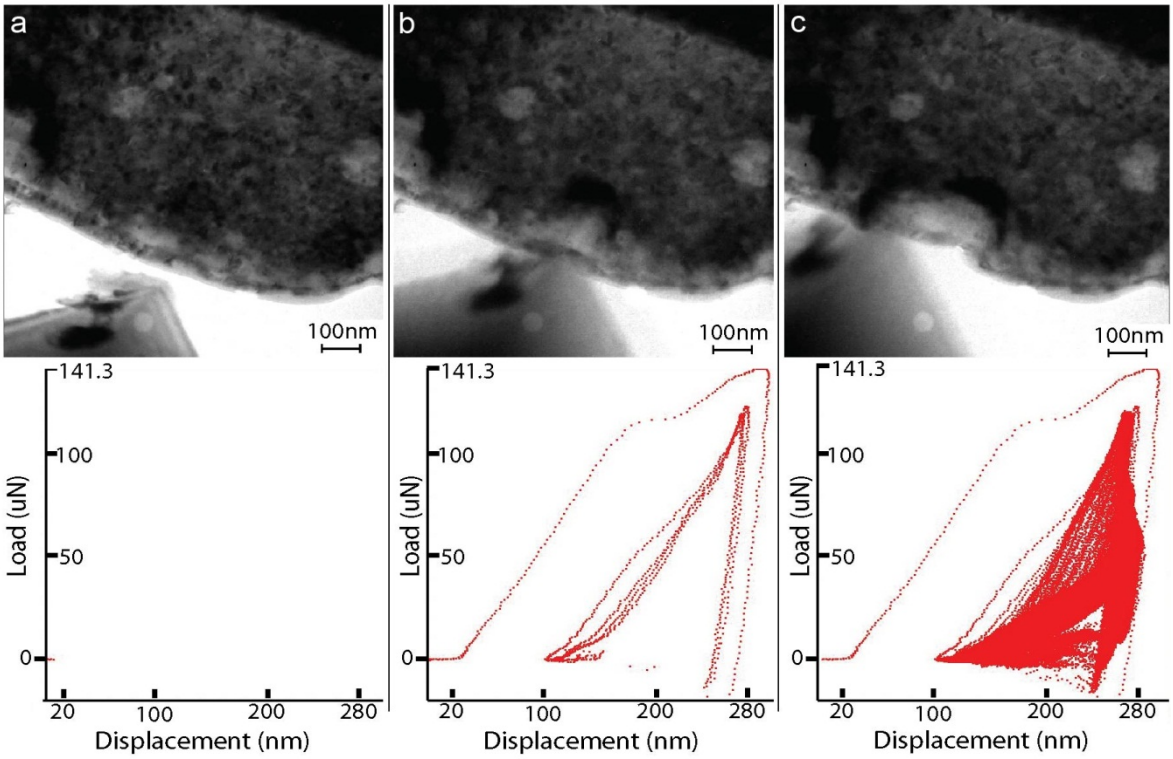
Sandia commissions in-situ instrumented nanoindenter for Transmission Electron Microscope. Metal deformation occurs by atomic-scale reshuffling of the crystalline lattice, typically by dislocation glide or twinning. One of the primary tools used to observe these individual deformation processes at the atomistic scale is the transmission electron microscope. Sandia has recently combined a high-resolution nanoindentor, capable of applying nanometer-scale deformation measurements on metal, with a transmission electron microscope for the purpose of studying deformation mechanisms in materials. This instrument also has the ability to simultaneously heat the test sample to temperatures up to 400 ^{o} C. Finally, the transmission electron microscope has been outfitted with two ion sources to simultaneously irradiate with a high dose of ions: the tandem heavy ion accelerator and colutron light ion (H and He) accelerator. This new one-of-a-kind instrument is being used to study material deformation and reliability at the nanoscale under thermal, irradiation, and combined environments, with applications ranging from reliability of weldments to aging of reactor structural alloys.



An example of nano-fatigue loading of nanocrystalline nickel-iron in a transmission electron microscope. In this example, 100 fatigue cycles with cyclic forces of 0-125 μN caused a change in the grain structure. This is the first known observation of instrumented in-situ fatigue-driven evolution within a TEM. For perspective, the peak force in this test was 1/100th of a gram.

U.S. DEPARTMENT OF ENERGY NNSA National Nuclear Security Administration

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