Abstract Submitted
for the MAR11 Meeting of
The American Physical Society

Comparative Studies of Constitutive properties of Nanocrystalline and Bulk Iron During Compressive Deformation XIAOHUI YU, JIANZHONG ZHANG, LIPING WANG, YUSHENG ZHAO — We present a comparative study of mechanical properties of bcc nano-crystalline iron and micron-crystalline iron by in-situ high-pressure synchrotron x-ray diffraction under tri-axial compression. For nano-Fe with a starting high dislocation density of 10^{16} m^{-2}, the peak broadening is almost reversible upon unloading from 8.6 GPa to ambient pressure, indicating that no additional dislocations are built up during compressive deformation inside grains, at grain boundaries or twin boundaries. Furthermore, an orientation dependent surface strain is found to be stored in the surface layer of the bcc nano Fe, which is in agreement with the core-shell model of the nano crystals. For micron-Fe, a significant and continuous peak sharpening and the associated work softening were observed after the sample is yielded at pressures above 2.0 GPa, which can be presumably attributed to a pressure-induced dislocation annihilation. This finding/interpretation supports the hypothesis that the annihilation of dislocations is one of the dominant mechanisms underlying the plastic energy dissipation. The determined yield strength of 2.0 GPa for nano-Fe is more than 15 times higher than that for micron-Fe (0.13 GPa), indicating that the nano scale grain-size reduction is a substantially more effective strengthening mechanism than the conventional carbon infusion in iron.

Xiaohui Yu

Date submitted: 09 Nov 2010 Electronic form version 1.4