Abstract Submitted
for the MAR17 Meeting of
The American Physical Society

Tensile strength and failure mechanisms of tantalum at extreme strain rates[1] ERIC HAHN, Univ of California - San Diego, SARYU FENSIN, TIMOTHY GERMANN, Los Alamos National Laboratory, MARC MEYERS, Univ of California - San Diego — Non-equilibrium molecular dynamics simulations are used to probe the tensile response of monocrystalline, bicrystalline, and nanocrystalline tantalum over six orders of magnitude of strain rate. Our analysis of the strain rate dependence of strength is extended to over nine orders of magnitude by bridging the present simulations to recent laser-driven shock experiments. Tensile strength shows a power-law dependence with strain rate over this wide range, with different relationships depending on the initial microstructure and active deformation mechanism. At high strain rates, multiple spall events occur independently and continue to occur until communication occurs by means of relaxation waves. Temperature plays a significant role in the reduction of spall strength as the initial shock required to achieve such large strain rates also contributes to temperature rise, through pressure-volume work as well as visco-plastic heating, which leads to softening and sometimes melting upon release. At ultra-high strain rates, those approaching or exceeding the atomic vibrational frequency, spall strength saturates at the ultimate cohesive strength of the material.

[1]UC Research Laboratories Grant (09-LR-06-118456-MEYM); Department of Energy NNSA/SSAP (DE-NA0002080); DOE ASCR Exascale Co-design Center for Materials in Extreme Environments

Eric Hahn
Univ of California - San Diego

Date submitted: 11 Nov 2016 Electronic form version 1.4