

Abstract Submitted
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Growth and Collapse of Nanovoids in Tantalum Monocrystals Loaded at High Strain Rate¹ YIZHE TANG, University of California, San Diego, EDUARD BRINGA, CONICET & Instituto de Ciencias Básicas, Univ. Nac.Cuyo, BRUCE REMINGTON, Lawrence Livermore National Laboratory, MARC MEYERS, University of California, San Diego — Shock-induced spall in ductile metals is known to occur by the sequence of nucleation, growth and coalescence of voids, even in high purity monocrystals, but the atomistic mechanisms involved are still not completely understood. The growth and collapse of nanoscale voids in tantalum are investigated under different stress states and strain rates by molecular dynamics simulations. Three principal mechanisms of deformation are identified and quantitatively evaluated: shear loop emission, prismatic loop formation, and twinning. Dislocation shear loops expand as expected from a crystallographic analysis, and their extremities remain attached to the void surface in tension (a requisite for void growth), but can detach in compression. Prismatic loops that detach from the void are generated only during hydrostatic loading, due to the equal resolved shear stress components. Nanotwins form preferably due to tensile stress both uniaxial and hydrostatic. There is a slip-to-twinning transition as the strain rate exceeds 10⁸/s, and a simplified constitutive description is presented to explain this transition. Comparison with recent laser-shock experiments will be discussed.

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