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Using Omega and NIF to Advance Theories of High-Pressure, High-Strain-Rate Tantalum Plastic Flow[1] R.E. RUDD, A. ARSENLIS, N.R. BARTON, R.M. CAVALLO, C.M. HUNTINGTON, J.M. MCNANEY, D.A. ORLIKOWSKI, H.-S. PARK, S.T. PRISBREY, B.A. REMINGTON, C.E. WEHRENBERG, Lawrence Livermore National Lab — Precisely controlled plasmas are playing an important role as both pump and probe in experiments to understand the strength of solid metals at high energy density (HED) conditions. In concert with theory, these experiments have enabled a predictive capability to model material strength at Mbar pressures and high strain rates [1]. Here we describe multiscale strength models developed for tantalum and vanadium starting with atomic bonding and extending up through the mobility of individual dislocations, the evolution of dislocation networks and so on up to full scale [2]. High-energy laser platforms such as the NIF and the Omega laser probe ramp-compressed strength to 1-5 Mbar [3,4]. The predictions of the multiscale model agree well with the 1 Mbar experiments without tuning [4]. The combination of experiment and theory has shown that solid metals can behave significantly differently at HED conditions; for example, the familiar strengthening of metals as the grain size is reduced has been shown not to occur in the high pressure experiments [4]. [1] R.E. Rudd et al., MRS Bull. 35, 999 (2010). [2] N.R. Barton et al., J. Appl. Phys. 109, 073501 (2011). [3] H.-S. Park et al., Phys. Rev. Lett. 104, 135504 (2010). [4] H.-S. Park et al., Phys. Rev. Lett. 114, 065502 (2015).

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