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High pressure, high strain rate material strength studies[1] B.A. REMINGTON, A. ARSENLIS, N. BARTON, J. BELOF, R. CAVALLO, B. MADDOX, H.-S. PARK, S. PRISBREY, R. RUDD, LLNL, A. COMLEY[2], M. MEYERS, UCSD, J. WARK, University of Oxford — Constitutive models for material strength are currently being tested at high pressures by comparing 2D simulations with experiments measuring the Rayleigh-Taylor (RT) instability evolution in solid-state samples of vanadium (V), tantalum (Ta), and iron (Fe). The multiscale strength models being tested combine molecular dynamics, dislocation dynamics, and continuum simulations. Our analysis for the V experiments suggests that the material deformation at these conditions falls into the phonon drag regime, whereas for Ta, the deformation resides mainly in the thermal activation regime. Recent Fe-RT experiments suggest perturbation growth about the alpha-epsilon (bcc-hcp) phase transition threshold has been observed. Using the LLNL multiscale models, we decompose the strength as a function of strain rate into its dominant components of thermal activation, phonon drag, and work hardening. We have also developed a dynamic diffraction diagnostic technique to measure strength directly from shock compressed single crystal samples. Finally, recovery experiments allow a comparison of residual dislocation density with predictions from the multiscale model.

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