Abstract Submitted
for the SHOCK19 Meeting of
The American Physical Society

Scaling laws for the pressure and rate dependence of spall strength JUSTIN WILKERSON, Texas AM University — Experimental studies have found that the spall strength of many face-centered cubic metals increases linearly with shock pressure. Additionally, an anomalous grain size dependence of spall strength has been measured in a few face-centered cubic metals. Here we derive the first quantitative theory capable of explaining these phenomena. The scaling laws agree well with experimental measurements and atomistic calculations of both single crystal and polycrystalline materials subject to a very wide range of conditions. Utilizing these scaling laws, we are able to map out three distinct regimes in which spall strength (i) increases with decreasing grain size in accordance with conventional wisdom, (ii) non-intuitively decreases with decreasing grain size, and (iii) is independent of grain size. With respect to shock pressure dependence, the scaling laws address both shock hardening and shock softening. Shock hardening is induced by a shock-induced increase in the total dislocation density. Shock softening can be induced by either thermal softening or shock-induced reductions in material viscosity. These phenomena are captured quite well by rather simple scaling relations.

Justin Wilkerson
Texas A
M University

Date submitted: 28 Feb 2019 Electronic form version 1.4