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Entropy-dominated Dissipation in Sapphire Compressed Dynamically from 14 to 87 GPa W.J. NELLIS, Harvard University, G.I. KANEL, S.V. RAZORENOV, A.S. SAVINYKH, Institute for High Temperatures, A.M. RAJENDRAN, Army Research Office — States reached by dynamic compression are governed by free energy in which dissipative energy is –TS, where T is temperature and S is entropy. In a liquid like Ar effective pair interaction enegy is ∼0.01 ev. As a result Ar is relatively compressible with a shock rise time of ∼0.5 ps and 2.2 fold compression at a T of 14,000 K at 50 GPa. Thermal energy is ∼90% of shock energy. Entropy changes are small in a shocked fluid and dissipative energy appears primarily as T. We have measured wave profiles of sapphire with elastic strength of ∼15 GPa in three different crystal orientations at shock stresses of 14, 24, and 87 GPa. At 24 GPa the rise time of the plastic wave is ∼300 ns, 5 orders of magnitude greater than in liquid Ar. At 50 GPa sapphire is compressed 1.1 fold to a T of ∼500 K. Thermal pressures are negligible and bond strengths are ∼1 ev, about 2 orders of magnitude greater than in Ar. Bonds in sapphire probably break over ∼10s of ns. This long rise time causes quasi-isentropic compression with negligible shock heating. Dissipative energy goes primarily into the entropy of disordering the strong 3-D lattice, rather than into T.

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