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Strain rate influence on the Hall-Petch effect in Cu
VIRGINIE DUPONT, TIMOTHY C. GERMANN, Los Alamos National Laboratory — The increased strength of materials with a decreasing grain size has been known for several decades as the Hall-Petch effect. This trend is true down to a specific grain size below which the strength starts decreasing again, due to a change in the underlying plasticity mechanisms caused by the increased grain boundary network density. We are interested in the strain rate influence on the Hall-Petch and “reverse Hall-Petch” effects. We use molecular dynamics simulations to study polycrystalline samples of copper of different grain sizes between 5 nm and 30 nm, and under uniaxial compression at a wide range of strain rates (10^8 to 10^{11} s $^{-1}$). We verify that the yield stress of the material increases with the strain rate, due to the time scale required to generate plasticity. Moreover, we observe that the grain size for which the yield stress is highest depends on the strain rate studied. These results are of particular importance for high strain rate loading conditions, such as shock compression.

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