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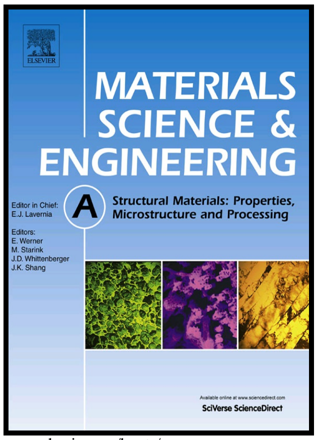

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High-temperature internal friction and dynamic moduli in copper

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Abstract

New measurements of dynamic shear and Young's moduli and their associated internal frictions were made with torsional and flexural forced-oscillation methods, respectively, on three polycrystalline specimens of pure copper. The tests spanned the 1–1000s range of oscillation periods, at temperatures ranging from those of annealing close to the melting point (1050 °C) down to room temperature. A broad internal friction peak, found at temperatures around 700 °C (at 1 Hz) for samples annealed at 1050 °C, is superimposed on a monotonic relaxation background. Non-linear viscoelastic behaviour is observed above strains around $5{\times}10^{-6}$. The period- and temperature-dependence of both shear modulus and internal friction is adequately captured by an extended "background plus peak" Burgers model for viscoelastic rheology. Activation energies are found to be around $200\,\mathrm{kJ\,mol^{-1}}$ for both the high-temperature peak and monotonic damping background, consistent with common diffusional control of both the dissipation background and superimposed peak, plausibly involving stress-induced migration of dislocations. Complementary torsional microcreep tests at selected temperatures reveal that most of the inelastic strain is anelastic (viscous) for loading durations less (greater) than 1000 s. Such linear viscous deformation, observed at low stress in coarse-grained polycrystalline copper, involves much higher strain rates than expected from published rheology, plausibly

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