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THE AMBIENT-TEMPERATURE MECHANICAL PROPERTIES OF UFG Ag WITH NANOTWINS USING MICROSHEAR TESTS

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Abstract

The ambient-temperature mechanical properties of ultrafine grain (UFG) high-purity silver were studied using microshear specimens. 150μm silver interlayers prepared by planar magnetron sputtering and diffusion bonding were tested in torsion (pure shear). There is a duplex structure with "as deposited" regions of small (0.25 – 1.25μm diameter) columnar grains with microtwins that are parallel to the shear plane and recrystallized regions with a lower density of randomly oriental microtwins. The average grain size, defined by boundaries greater than 15° misorientation, was approximately 1.25μm, not including a high density of oriented nano-twins parallel to the maximum resolved shear stress in the columnar grain regions. The interlayers have very high ductility (equivalent uniaxial strain, ε, > 3) in pure shear, comparable to conventional grain sizes, and show what appears to be an eventual mechanical steady-state. The Hall-Petch 0.2% offset yield-stress behavior at 1.25μm is consistent with other earlier work at similar grain sizes. The hardening rates ($\theta = d\sigma/d\varepsilon$) are substantially higher in the UFG Ag, possibly due to the high density of nano-twins or possibly the duplex structure. The saturation stresses are essentially identical to that of conventional grain sizes in the UFG material, which contrasts earlier tensile fracture-testing. The strain-rate sensitivity is identical to coarse-grain silver.

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