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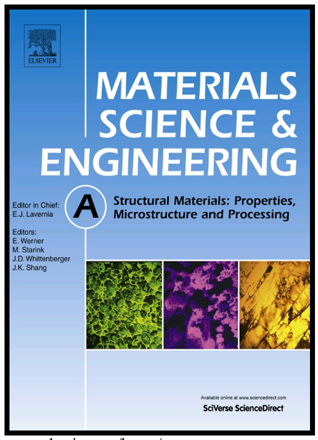

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Indentation-Based Rate-Dependent Plastic Deformation of Polycrystalline Pure Magnesium

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Abstract

Using a Berkovich pyramidal indenter and an instrumented nanoindentation platform, dual stage nanoindentation creep tests, including loading to a pre-set load and holding at the constant load then unloading, were performed on polycrystalline pure magnesium at 300 K. Indentation tests were performed at four indentation loading rates of 0.05, 0.5, 5, and 50 mN/sec at constant load of 45 mN and holding time of 400 s. These were performed to assess indentation force-displacement response along with average indentation stress, indentation strain rate sensitivity and ambient temperature rate dependent plastic deformation response of the material. To this end, activation volume, a kinetic characteristic of plastic deformation, and density of mobile dislocations in plastically deforming material in the plastic zone around the indenter are discussed in detail. Uncertainties and sources of error, *i.e.* indentation size effect, surface roughness, and thermal drift, and pile-up/sink-in in measuring creep response through nanoindentation are provided in the current paper as well. The microstructure of the material was also studied through optical and scanning electron microscopy to further investigate the microstructure/property correlations in the tested polycrystalline pure magnesium. The results show the dependency of indentation stress, strain rate sensitivity, and activation volume upon depth and loading rate. According to the creep stress exponent measurements, the dominant mechanism of rate dependent plastic deformation for polycrystalline pure Mg at ambient temperature is attributed to obstacle limited dislocation glide. Finally, the contribution of mechanical twins in the plastic zone around the indenter in the studied polycrystalline pure magnesium is briefly discussed.

Key words: Pure Mg; Nanoindentation; Rate-dependent plastic deformation; Dislocation.