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Measuring and modeling the anisotropic, high strain rate deformation of Al alloy, 7085, plate in T711 temper

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ABSTRACT

Al alloy 7085 in the T711 temper has been proposed as a lightweight metallic armor material. The room temperature constitutive response is assessed by compression testing at quasi-static (0.001 s^{-1}) and dynamic (1000 s^{-1}) strain rates along the rolling (RD), transverse (TD), and normal (ND) directions. The flow strength, plastic strain anisotropy (r-values) and texture evolution is measured along each direction. While the flow stress exhibits only mild anisotropy, the compressive r-values revealed strong strain anisotropy, with values close to 0.4 for RD, 0.8 for TD, and 0.6-0.8 for ND. The fracture response was also found to be anisotropic, with ND showing a lower compressive ductility as compared to the RD and TD. The level of anisotropy is essentially independent of the strain rate. However, flow softening and localization are more evident at dynamic rates. By employing self-consistent polycrystal plasticity simulation, the relative contributions of initial crystallographic texture, latent hardening and anisotropic grain shape effects were explored. The simulation results suggest that the ND and TD r-values are strongly affected by anisotropic grain shape, whereas the RD is rather insensitive to grain shape. Although the polycrystal model correctly predicts the mild flow strength anisotropy, the predicted strain anisotropy (variations in r value) are higher than that observed experimentally. Interestingly, assuming the grain shape to be equiaxed gives the best overall results, which suggests that the morphological texture does not play a major role in determining the anisotropy of materials such as the present heat treatable Al alloy.

Keywords: B. Texture evolution B. anisotropic material B. Constitutive behavior C. Kolsky bar C. crystal plasticity