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Mechanical response and texture evolution of AZ31 alloy at large strains for different strain rates and temperatures

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ABSTRACT

In order to study the behavior of material under finite deformation at various strain rates, the responses of AZ31 Mg sheet are measured under uniaxial (tension and compression) and multiaxial (simple shear) loadings along rolling direction (RD), 45° to rolling direction (DD), 90° to rolling direction (TD), and normal to the sheet (ND) to large strains. The material exhibits positive strain rate sensitivity (SRS) at room and elevated temperatures; the SRS is more pronounced at high temperatures and lower strain rates. The *r*-value of the material under tensile loading at room temperatures is higher in TD at lower strain rate. Texture measurements on several failed specimens are reported under tension and simple shear after finite plastic deformation of about 20% equivalent strain. The as-received material exhibits a strong fiber with equal fractions of grains having the *c*-axis slightly tilted away from the sheet normal towards both +RD and −RD. Pole figures obtained after tensile loading along the rolling direction (RD) show that the texture of the material strengthens even at low strains, with *c*-axis perpendicular to the sheet plane and prism planes lining up in a majority of grains. However, the tensile loading axis along TD does not lead to similar texture strengthening; the *c*-axis distribution appears to be virtually unchanged from the virgin state. The pole figures obtained after in-plane compression along RD brings the *c*-axes of the grains parallel to the loading direction. The pole figures after simple shear loading show that the *c*-axis rotates to lie on the sheet plane consistent with a compression axis 45° away on the sheet plane.

1. Introduction

Weight reduction of automobiles has emerged as one of the most attractive options for significant advances in both fuel efficiency and the resulting reduction in CO_2 emissions (Aghion et al., 2001). With increased efforts to bring the cost down, magnesium alloys are finding increasing use in the automotive field to take advantage of their high strength-to-weight ratio. In addition, magnesium alloys find use in biomedical application due to the good biocompatibility of Zn and Mn alloying additions to Mg (Zhang et al., 2009). The combination of poor formability at room temperature, high ductility at elevated temperatures, and asymmetric response of wrought Mg alloy under compression and tension (Hilditch et al., 2009) limit the use of magnesium alloys for widespread structural applications. It is of significant interest to study the thermo-mechanical

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