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THE RECRYSTALLIZATION BEHAVIOR AND DEFORMATION MECHANISM OF AN AZ80 Mg ALLOY RINGS UNDER DYNAMIC LOADING

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Magnesium alloys offer an alternative to steels and aluminum alloys due to their low density and relatively high specific strength. The application potentials are, however, impeded by poor formability. This is attributed to their hexagonal closed packed (h.c.p.) crystal structure with limited slip systems and low stacking fault energy.

Forming at high strain rates as with the electro-magnetic forming (EMF) is found to leads to sharp increase in the elongation to failure. A common way of studying the EMF formability of metals and alloys is the expanding ring method. The aim of the present study is to reveal the microstructure evolution of a commercial AZ80 alloy through the progress and extent of recrystallization during high strain deformation. The influence of the deformation conditions on grain size, grain boundaries character, texture, dislocations and twinning is systematically investigated using EBSD and TEM. Micro-texture analysis was carried out by the method of orientation distribution function (ODF). Recrystallization degree was quantitatively analyzed through the analysis of average internal misorientation approach. Qualitative description of defects was obtained by the weak beam dark filed (WBDF) method.

At high deformation rate $(4.4 \cdot 10^3 - 5.4 \cdot 10^3 [sec^{-1}])$, a sharp increase in the strain to failure of AZ80 alloy up to 0.20 was found, while only 0.11 was obtained through quasistatic loading. The results show that at early stages of deformation, the microstructure consist of fine equiaxed grains with a strong non-axisymmetric (0002) basal texture and high fraction of Low Angle Grain boundaries (LAGBs), suggesting initial recrystallization. As the deformation continues the density of local misorientation surrounding tension twin boundaries (TB) increase drastically. This is reflected by high density of <a>-type dislocations, piled-up and tangled, at tension TBs. Therefore, TB act as barriers to dislocation motion and cause work hardening. In turn, additional slip systems (prismatic and pyramidal) with high critical resolved shear stress (CRSS) are activated. Thus, larger uniform elongation is obtained. The decrease in both the basal texture and the fraction of tension twinning along with high fraction of High Angle Grain Boundaries (HAGBs) support this scenario.