ICAM 2009
11th International Conference on Advanced Materials
Rio de Janeiro Brazil
September 20 - 25

High Strength and Ductility of DSR Processed Mg-Al-Zn Magnesium Alloys

H. G. Jeong

Eco Materials & Processing Department, Production Technology R&D Division, Korea Institute of Industrial Technology, 7-47, Songdo-Dong, Yeonsu-Gu, Incheon 406-840, Korea

E-mail: hgjeong@kitech.re.kr

Abstract – In this study, differential roll speed rolling was applied to AZ31, AZ61, AZ91 alloy sheet and subsequently secondary process by low temperature aging was carried out in order to investigate possible changes in microstructure and mechanical properties. In the all DSR specimens with rolling direction of route C, mechanical properties (ductility and strength) improves remarkably compared to those of as-extruded and DSR specimens with the other rolling routes. The feature of the route C specimen shows very uniform and ultrafine grained microstructure.

The most effective method of improving mechanical properties of magnesium alloys is through grain refinement using severe plastic deformation [1-2]. The differential roll speed rolling (DSR), where circumferential roll velocities differ, was conducted on specimens pre-heated to a temperature of 473K for 10min. In the DSR, the diameters of the upper and lower rolls were identical and the ratio of upper and lower roll speed was 3:1. During the DSR, the temperature of roll surface was maintained at 473K. From a starting thickness of 2mm, the thicknesses of the all plates were reduced to 0.5 mm (75% thickness reduction) by two passes of rolling. Between each pass, the specimens were re-heated for 5min. And for, two passes rolling, two routes with different rolling direction of unidirectional rolling (route A) and reverse rolling (route C) were adapted. In the route A rolling, after the first rolling, the specimen was not rotated back and forth and upside down so that the shear strain is introduced unidirectional throughout the rolling. In the route C rolling, after the first rolling, the specimen was rotated back and forth so that the shear strain is introduced alternatively between each pass. For the all specimens, tensile tests were conducted at an initial strain rate of 1×10^{-3} s^{-1} at room temperature. The tensile axes were determined for two kinds against the rolled direction; parallel (0^o) and perpendicular (90^o) to the rolled direction.

The measured yield stress and ultimate tensile strength, in DSR AZ31 with the route A, were 306MPa and 324MPa, respectively. It is should be noted that the strength values are very impressive compared with those of the as-extruded one (YS=192MPa, UTS=252MPa). In the present study for AZ31 alloy, the best compromise between strength and ductility was obtained in the route C. In the route C rolled sheet, the average yield stress and strength were 279MPa and 341MPa, respectively, and the average tensile elongation was 29%. Even though the magnesium alloys can be strengthened, with anisotropic of strength and ductility, by introducing the strong basal texture parallel to the rolling and extrusion directions, very high and uniform properties in strength and ductility were obtained in a limited rolling condition. Ultrafine-grains of 1-2 ㎛ were obtained in DSR sheet, which exhibits significantly improved properties in strength and ductility, compared with those of convention rolling or extrusion processes. (Fig. 1)

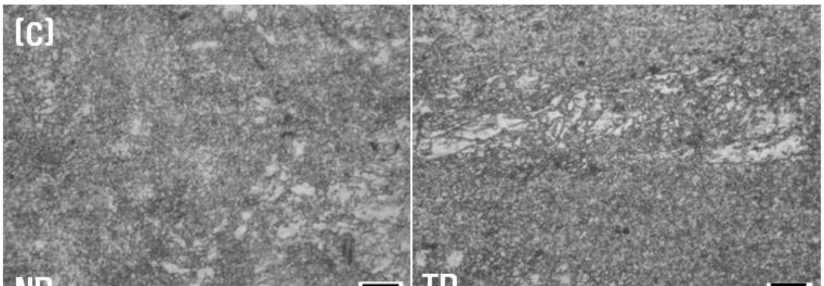

Figure 1: SEM images of DSR AZ31 with route C at 473K
(ND; normal direction, TD; transverse direction)

References

[1] K. H. Kim, D.N. Lee, Acta Mater. 49 (2001) 2583-2595.

[2] R. S. Mishra, S. L. Semiatin, C. Suryanrayana, N. N. Thadhani, T. C. Lowe, editors. Ultrafine grained materials. Warrendale (PA), TMS, 2000, pp. 173.