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결정립크기와 집합조직제어를 통한 마그네슘 합금의 기계적 성질 개선

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Improvement of Mechanical Properties of Mg alloys through Control of Grain Size and Texture

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Abstract

The effects of lowering ECAP temperature during ECAP process and Post-ECAP annealing on microstructure, texture and mechanical properties of the AZ31 alloys have been investigated in the present study. The as-extruded materials were ECAP processed to 2 passes at 553K prior to subsequent pressing up to 6 passes at 523K or 493K. When this method of lowering ECAP temperature during ECAP was used, the rods could be successfully deformed up to 6 passes without any surface cracking. Grain refinement during ECAP process at 553K might have helped the material to endure further straining at lower deformation temperatures probably by increasing the strain accommodation effect by grain boundary sliding, causing stress relaxation. Texture modification during ECAP has a great influence on the strength of Mg alloys because HCP metals have limited number of slip systems. As slip is most prone to take place on basal planes in Mg at room temperature, the rotation of high fraction of basal planes to the directions favorable for slip as in ECAP decreases the yield stress appreciably. The strength of AZ31 Mg alloys increases with decrease of grain size if the texture is constant though ECAP deformation history is different. A standard positive strength dependence on the grain size for Mg alloys with the similar texture (**Fig. 1**) supports that the softening of ECAPed Mg alloys (a negative slope) typically observed despite the significant grain refinement is due to the texture modification where the rotation of basal planes occurs towards the orientation for easier slip. It could be predicted that if the original fiber texture is restored after ECAP treatment yielding marked grain refinement, yield stress as high as 500 MPa will be obtained at the grain size of ~1μm.

Differential speed rolling (DSR) with a high speed ratio between the upper and lower rolls was applied to alter the microstructure and texture of the AZ31 sheets. Significant grain refinement took place during the rolling owing to introduction of large shear deformation.

Grain size as small as 1.4 μm could be obtained at 423K after DSR. There was a good correlation between the (0002) pole intensity and tensile elongation. This result indicates that tensile ductility improvement in the asymmetrically rolled AZ31 Mg alloys is closely related to the weakening of basal texture during DSR. Further basal texture weakening occurred during annealing after DSR. According to Hall-Petch relation shown in **Fig. 1**, the strength of the asymmetrically rolled AZ31 is lower than that of the symmetrically rolled one when compared at the same grain size. This result was attributed to weakening of fiber texture during DSR. The DSRed AZ31, however, shows higher strength than the ECAPed AZ31 where texture has been completely replaced by a new texture associated with high Schmid factors

Key Words : Magnesium alloys, Severe deformation, grain size, texture

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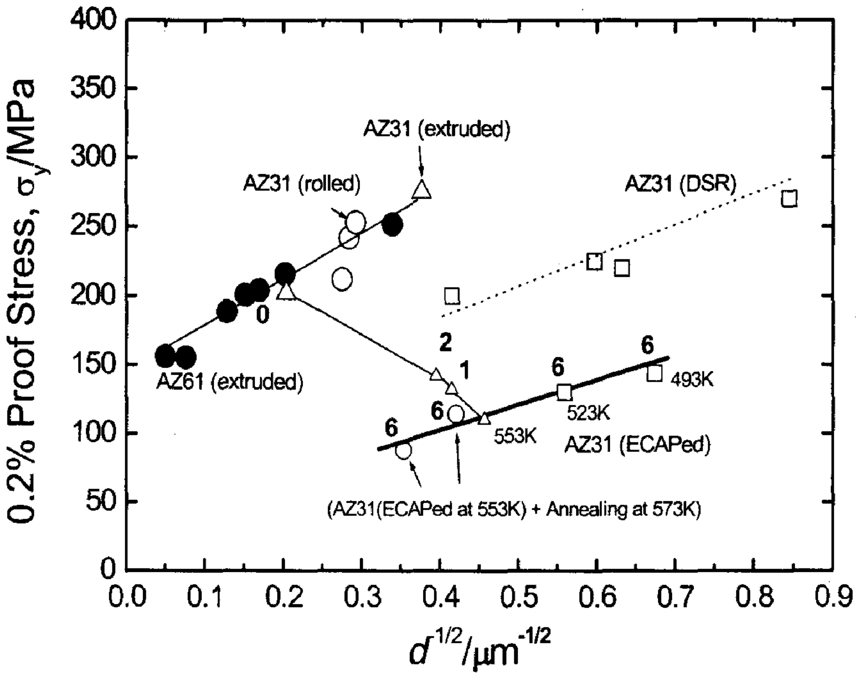

Fig. 1 Hall-Petch relation for the as-Extruded, as-rolled, ECAPed and DSRed AZ31 alloys