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비대칭 압연한 마그네슘 합금판재의 집합조직 발달

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Texture Evolution of Asymmetrically Rolled Mg Alloy Sheets

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Abstract

Asymmetric rolling, where circumferential velocities of the upper and lower rolls differ, can be one method to change texture of magnesium alloy sheet by introducing shear deformation throughout the thickness of a sheet. In this study, the texture, microstructure and mechanical properties of AZ31 Mg sheets has been investigated during the symmetrical rolling procedure and the asymmetric rolling procedures of different roll speeds with different roll diameters.

Texture of Mg alloy sheets were evaluated by using X-ray diffraction and ODFs were calculated using ADC method. The major texture of rolled specimens can be expressed by ND//(0001) fiber texture. The major fiber texture changed according to the rolling processes and such a slight difference of texture changes the formability of sheets. The mechanical properties were enhanced during asymmetrical rolling.

Key Words : Magnesium, AZ31, Asymmetrical Rolling, Texture

2. Introduction

Sheet magnesium is currently being tested in various application areas. However, the rolled Mg alloys often exhibit relatively low strength and poor press formability at room temperature. This limited ductility is attributed to the limited slip system in HCP crystal structure and the configuration of basal planes in magnesium alloys, because the critical resolved shear stresses of the non-basal slip systems are much higher than that of the basal slip system at room temperature. In the basal fiber texture of ND//(0001) orientations generally developed by rolling processes, the configuration of basal planes is parallel to the rolling direction and basal slip system is very hard to be activated. Therefore, it is important to weaken or change the basal fiber texture component to improve the formability of magnesium alloy sheet [1,2,3].

Asymmetric rolling, where circumferential velocities of the upper and lower rolls differ, can be one method to change texture of magnesium alloy sheet by introducing shear deformation throughout the thickness of a sheet. Watanabe et al.[4] used asymmetric rolling, in which the ratio of the circumferential velocities of the upper and lower rolls was 1.25 with the same roll diameter, to produce the AZ31 sheets with grain sizes of 11-12 μ m. Some improvement in tensile elongation from 9 to15% was achieved. Kim et al.[5] showed that asymmetric rolling, in which the ratio of the upper roll diameter to the lower roll diameter was 1.5 with the same revolution per minute, reduced the intensity of the basal texture. In this study, the texture, microstructure and mechanical properties of AZ31 Mg sheets has been investigated during symmetrical rolling procedure and the asymmetric rolling procedures of different roll speeds with different roll diameters.

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2. Experimental

The material used in this study was commercial AZ31 Mg alloy sheet with a thickness of 4mm. The diameter of the lower roll was 5 times larger than that of upper roll and the ratio of upper to lower roll speed was around 5 in the case of asymmetrical rolling procedures. The rolling specimens were pre-heated to a temperature of 573K and held for 30 min. From the initial thickness of 4.0mm, the specimens were rolled to 1.0mm (75% reduction).

Normal rolling procedure was also conducted under the same process conditions for comparison. The total rolling reduction of 75% and rolling temperature were same in symmetric and asymmetric rolling. However, the reduction per pass was different. The initial specimens of 4 mm thick were rolled asymmetrically by 5 passes and rolled symmetrically by 4, 6 or 12 passes.

The rolling temperature was also changed to 523 and 623 K to understand the effect of rolling temperature on texture evolution in symmetrical rolling procedures.

The evolution of textures during rolling was studied at the center layer (s=0.0) and surfaces layers (s=1.0) of rolled sheets. The (1010), (0002) and (1011) pole figures were measured up to a tilting angle of 75 degrees using the Schultz reflection method of Bruker D8 Advance X-ray equipment and orientation distribution function (ODF) was calculated by ADC method.

3. Results

These asymmetrically and symmetrically rolled sheets show clean surface without any side crack. The textures of as-received sheet and symmetrically rolled AZ31 sheets were strongly developed basal fiber texture of ND//(0001) fiber texture. The intensity of basal fiber texture increased as the rolling temperature increased. The intensity of basal fiber texture also increased as the rolling reduction per pass decreased. However, the basal pole of the surface texture, which is shown in the specimen of as-received or symmetrically rolled sheet, was split toward rolling direction (RD). A small part of basal pole rotated from ND toward the opposite direction of RD on large roll side surface of asymmetrically rolled sheets. The basal poles in the initial fiber texture rotated from ND around TD with both directions on small roll side surface. The surface textures of AZ31 Mg sheet rolled asymmetrically at 573K by reduction of 75% were shown in figure 1. Figure 2 shows texture of AZ31 Mg sheet rolled symmetrically by reduction of 75%.

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참 고 문 헌

[1] W.J. Kim, S.I. Hong, Y.S. Kim, S.H. Min, H.T. Jeong, J.D. Lee, Acta Mater. 51 (2003) 3293.
[2] W.J. Kim, H.T. Jeong, Mater. Trans. 46 (2005) 251.
[3] W.J. Kim, J.B. Lee, W.Y. Kim, H.T. Jeong, H.G. Jeong, Scripta Mater. 56 (2007) 309.
[4] H. Watanabe, T. Mukai, K. Ishikawa, J. Mater. Sci. 39 (2004) 1477
[5] S.H. Kim, B.S. You, C.D. Yim, Y.M. Seo, Mater. Lett. 59 (2005) 3876

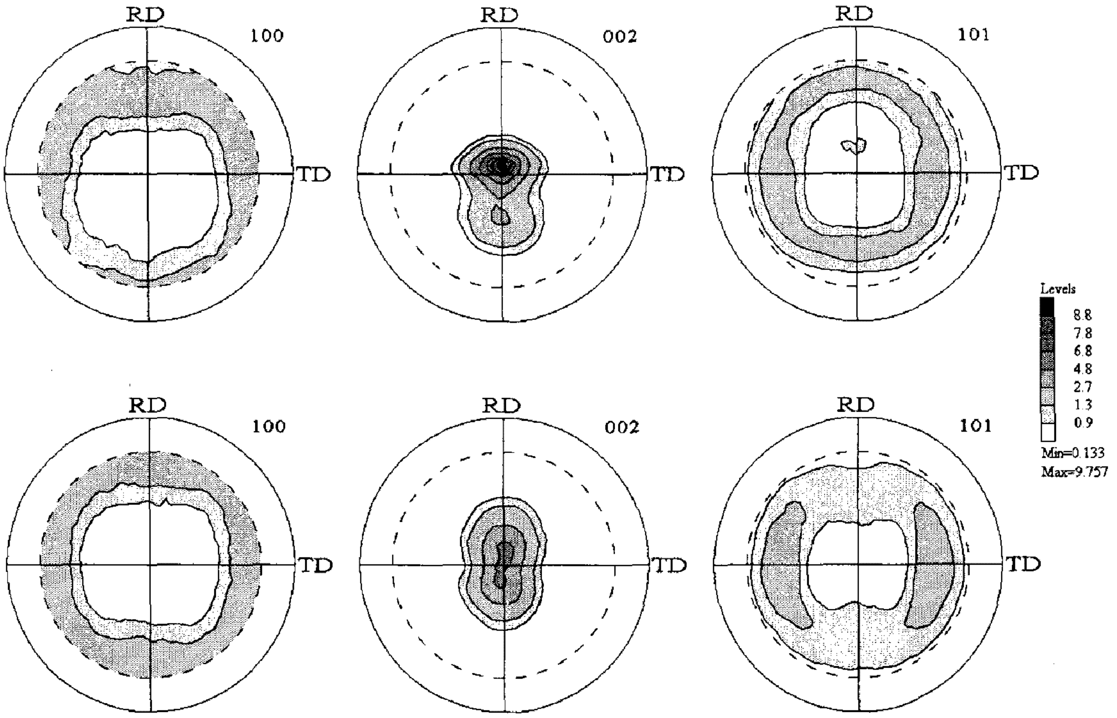

Fig. 1 (100), (002) and (101) pole figures of (a) large roll side and (b) small roll side of asymmetrically rolled AZ31 Mg alloy sheet

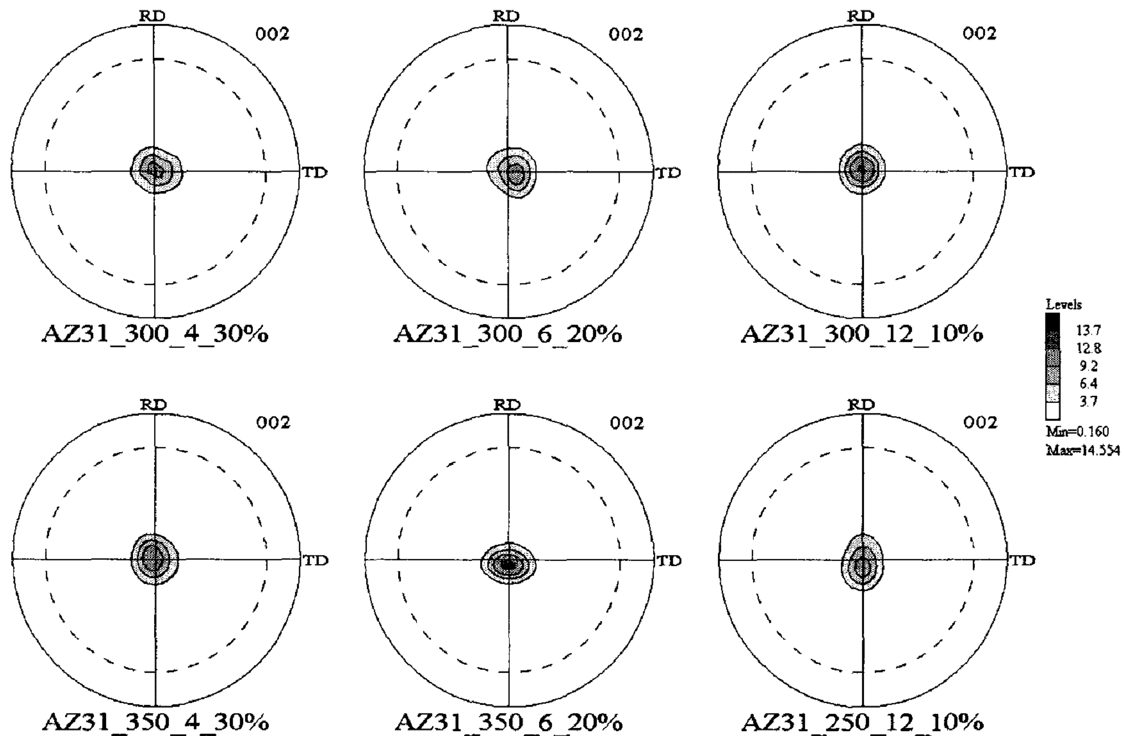

Fig. 2 (002) pole figures of symmetrically rolled AZ31 Mg alloy sheet by 4, 6 and 12 passes at 573, 523 and 623K