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# Effect of Processing Methods on Texture Evolution in AZ31 Mg Alloy Sheet

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***Abstract*****—**Textures of AZ31 Mg alloy sheets were evaluated by using neutron diffraction method in this study. The AZ31 sheets were fabricated either by conventional casting and subsequent hot rolling or strip casting. The effect of warm rolling was investigated using the AZ31 Mg alloy sheet produced by conventional casting. Warm rolling of 30% thickness reduction per pass was possible without any side-crack at temperatures as low as 200°C under the roll speed of 30 m/min. The initial microstructure of conventionally cast specimen was found to be partially recrystallized structures. Grain refinement was found to occur actively during the warm rolling. The (0002),(10-10) (10-11),and (10-12) complete pole figures were measured using the HANARO FCD (Neutron Four Circle Diffractometer) and ODF were calculated. The major texture of all specimens can be expressed by ND//(0001) fiber texture. Texture of hot rolled specimen showed the strongest fiber component, while that of strip cast sheet seemed to be similar to random distribution.

***Keywords*****—**Mg alloy, texture, pole figure, ODF, neutron diffraction, warm rolling.

## I. Introduction

MAGNESIUM fabrication for automotive application is again under active development in the lights of weight reduction and better driving performance of passenger cars. Successful development of rolling process, coupled with lower prices of Mg alloys, could encourage the use of Mg alloy sheets in automobiles [1]. In this regards, the use of continuous twin-roll casting of Mg alloys has been again attracting increasing attention of researchers. The alloys produced by twin-roll casting and rolling technology were found to exhibit homogeneity of microstructure, refined grain size, reduced segregation and a dense distribution of fine particles with Mg solid solution [2].

At the moment, however, the production of magnesium sheet is usually carried out using a multistage hot rolling process and the wrought alloy AZ31 is exclusively used. An optimized thermomechanical treatment leads to finely recrystallized microstructure [3]. Depending on grain size and heat treatment, the mechanical properties of AZ31 sheet metal are competitive to conventional Al-sheet material used for car body applications [4].

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On the other hand, for industrial application of magnesium sheet metal, the establishment of texture and formability control is urgently necessitated. In the present study, Texture of AZ31 Mg alloy was evaluated by using neutron scattering method using two kinds of Mg sheet material fabricated by conventional and strip casting, respectively.

## II. Experimental Procedures

The material used in this study was AZ31B Mg alloy sheet. The thickness of sheet produced by ingot casting and subsequent billet rolling was 6mm, and that produced by strip casting was 5mm, respectively. For experimental rolling of the sheet by conventional rolling, the samples $110\times100mm^2$ in dimensions were machined. Warm rolling was performed under various reductions-per-pass at the temperature of 200°C, and at the roll speed of 30m/min. All specimens were soaked for 1hr at respective runs. After each rolling experiment, surface of specimen was examined to check whether the side-cracking occurred.

Microstructure of rolled specimens was also observed by optical microscopy and the tensile tests were conducted to measure the mechanical properties. The textures of AZ31 Mg alloys were analyzed on plane normal to the rolling direction using the specimens of $10\times10\times10mm^3$. The $(0002)$, $(10\bar{1}0)$, $(10\bar{1}1)$, and $(10\bar{1}2)$ complete pole figures were measured using the HANARO FCD (Neutron Four Circle Diffractometer) with mosaic Gemonochromator. The wavelength of the neutron beam for this monochromator is 0.997Å. The effective beam size at the sample position is 30mm in diameter.

## III. Results and Discussion

Fig. 1 shows the microstructure of AZ31 Mg sheets. While the Mg sheet of conventional casting and subsequent hot rolling showed partially recrystallized and cast structures that of strip casting showed fully recrystallized equi-axed structure.

Fig. 2 shows the four complete pole figures and ODFs of three AZ31 Mg alloy sheets fabricated by different procedures. The pole figures and ODFs of specimens produced by hot rolling and subsequent warm rolling were shown in Fig. 2 and 3. Those of specimen manufactured by strip casting were in Fig. 4.

The major texture components of all three specimens can be expressed by ND//(0001) fiber texture. The texture of hot rolled AZ31 Mg alloy sheets showed strong ND//(0001) fiber texture, while that of strip casting was similar to random. As shown in Fig. 3, warm rolling of 17 % thickness reduction per pass,

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conducted at temperatures as low as 200°C under the roll speed of 30 m/min, was found to weaken the fiber component.

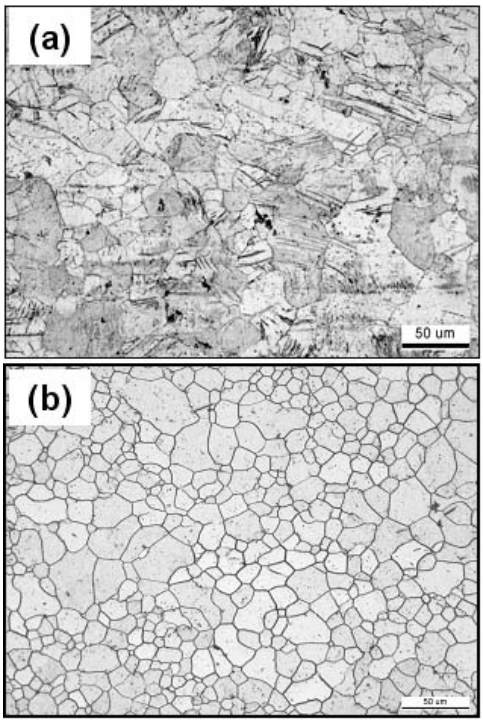



Fig. 1 Typical microstructures of AZ31 Mg alloy sheets produced by (a) conventional casting and (b) strip casting

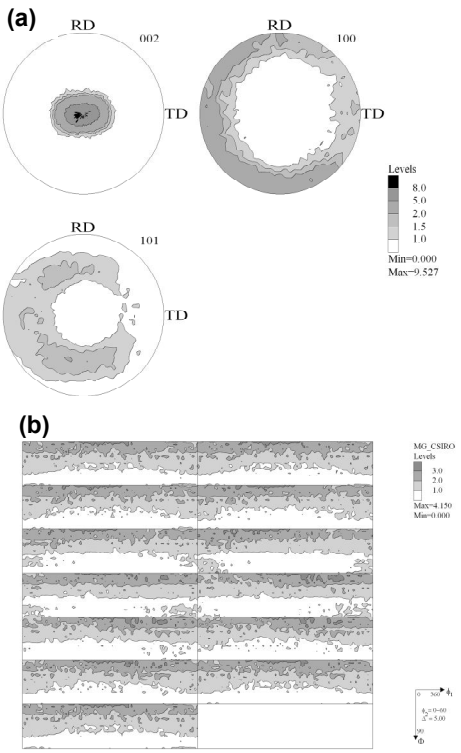



Fig. 2 The complete pole figures (a) and ODF (b) of specimen produced by hot rolling

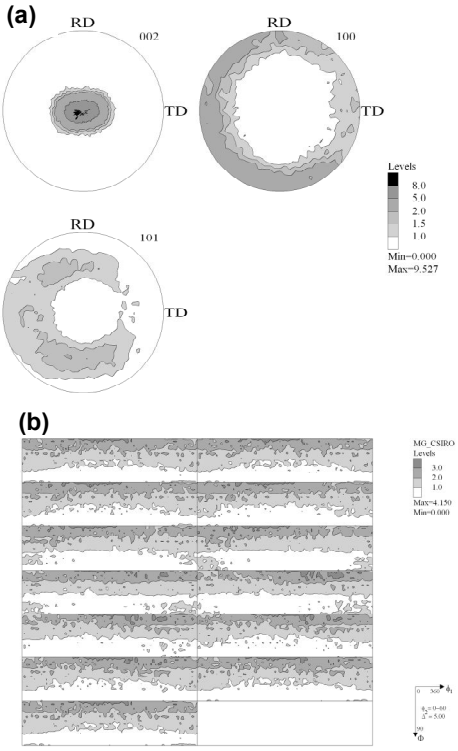



Fig. 3 The complete pole figures (a) and ODF (b) of specimen produced by warm rolling

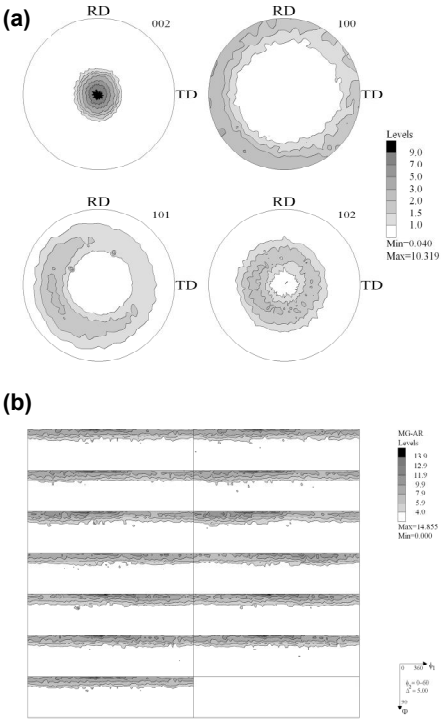



Fig. 4 The complete pole figures (a) and ODF (b) of specimen produced by strip casting

## IV. Conclusions

Textures of AZ31 Mg alloy sheets, fabricated either by conventional casting and subsequent hot rolling or strip casting, were evaluated by using neutron diffraction method in this study. The initial microstructure of conventionally cast specimen was a partially recrystallized one. The (0002) , $(10\bar{1}0)$ , $(10\bar{1}1)$ ,and $(10\bar{1}2)$ complete pole figures were measured and ODF were calculated. The major texture of all specimens can be expressed by ND//(0001) fiber texture. Texture of hot rolled specimen showed the strongest fiber component, while that of strip cast sheet seemed to be similar to a random distribution. Warm rolling of 17% thickness reduction per pass, conducted at temperatures as low as 200$^{o}$C under the roll speed of 30 m/min, was found to weaken the fiber texture.

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