한국소성가공학회 2008년도 춘계학술대회 논문집 pp. 477~479

알루미늄 비대칭압연 집합조직

사이드무로드 아크라모프[1] · 김인수[1#]

Texture of Asymmetric Rolled Aluminum sheets

S. Akramov[1], Insoo Kim[1#]

Abstract

Drawability and other mechanical properties of sheet metals are strongly dependent on their crystallographic orientations. In this paper the formability of the AA 5052 Al alloy sheets was investigated after asymmetric rolling and subsequent heat treatment. In most cases, after asymmetric rolling specimens showed a fine grain size and subsequent heat treated specimens showed that the ND // <111> texture component were observed. The anisotropy of formability is often described by the plastic strain ratios (r-value) as a function of the angle to the rolling direction in sheet metal. For a good formability, a high r-value is required in sheet metals. In the asymmetry rolled and subsequent heat treated Al alloy sheet, the variation of the plastic strain ratios have been investigated in this study. The plastic strain ratios of the asymmetry rolled and subsequent heat treated AA 5052 Al alloy sheets were higher than those of the original Al sheets. These could be related to the formation of ND // <111> texture components through asymmetric rolling in Al sheet.

Key Words: Aluminum sheet, Shear Deformation, Texture, Plastic strain ratio, Formability, r-value

1. 서 론

In the past decade, many researchers are interested in optimization of the formability of the aluminum alloys in order to replace low carbon steels. Using shear deformation processes can be obtained very fine grained materials with high strength but limited formability properties.

It has been found that the deformation in metals sheets of <111> plane parallel to the sheet surface helps to increase the r-value and variation of the textures decreasing Δr-values. However, due to the high energy stored in the deformed state and the existence of structural heterogeneities, annealing conditions are critical and unwanted structures may form. [1–5]. In the present paper investigation of the AA 5052 Al alloy sheet was asymmetrically rolled with high reduction ratio without lubricant to investigate the effects of the severe shear deformation on plastic strain ratio of subsequent heat treated AA 5052 Al alloy sheet.

2. 실험 방법

Sheet of commercial AA 5052 aluminum alloy was used to obtain a severe deformation by asymmetrical rolling process with rolls diameter ratios 1.5. The sheet samples, with dimensions of 60mm x 40mm x 3mm, were prepared from a sheet along the rolling direction. Then these plates were annealed at 500 ° C for 1 hour to homogenize the initial grain size through thickness (named initial Al sheet). The annealed Al sheets were then asymmetrically rolled to different reductions ranging from 0 to 80% on a laboratory asymmetrical rolling mill with roll ratio1.5. Hence we will observe only 80% asymmetrically rolled samples in 3 passes. To obtain high friction ratio no lubricant was used during

1. 금오공과대학교 신소재시스템공학부
교신저자: 금오공과대학교 신소재시스템공학부,
E-mail: iskim@kumoh.ac.kr

rolling process. To obtain the information of the texture change in the frictionally rolled and heat treated samples, the incomplete pole figures of (111), (200), and (220) for each sample were measured by using X-ray goniometer [5]. After the asymmetrical rolling, to study the formability of the asymmetrical rolled Al sheets, samples were annealed at the temperature of 300°C for 20 min in an air condition. It was tensile tested to obtain the r-value along the angles of 0°, 45°, 90° to rolling direction. The average r-value ($\bar{r}$ -value), and Δr-value was obtained from the measured and calculated r-value data. The average measured r-value ($\bar{r}$ -value) was calculated by the use of $\bar{r} = (r_0 + 2r_{45} + r_{90}) / 4$, and Δr-value was calculated by the use of $\Delta r = (r_0 - 2r_{45} + r_{90}) / 2$. Here, the $r_{0,45}$, and r_{90} mean the r-value of along the angles of 0°, 45°, and 90° to rolling direction, respectively.

3. 결과 및 토의

Texture measurements were performed at one tenth (S=0.9) thickness and half thickness (S=0) of the asymmetrically rolled sheets. (111), (200), and (220) pole figures were obtained by using the Cu-Kα radiation with the Schultz reflection method.

Fig. 2 shows (111) pole figures the change in texture of the AA 5052 aluminum alloy sheet after heat treatment at 300°C for 20min compared to the texture without heat treatment and initial Al sample. Strong cube component is observed in initial Al sheet Fig. 1(a,d). At one tenth of thickness layer Fig. 1 (a, b and c) after 90% asymmetric rolling the strong cube component is distorted and γ-fiber ND//<1 1 1>, {001}<110> were observed. In case of subsequent heat treatment for 20min at 300°C intensity of the <111> pole and rotated cube texture component slightly increased.

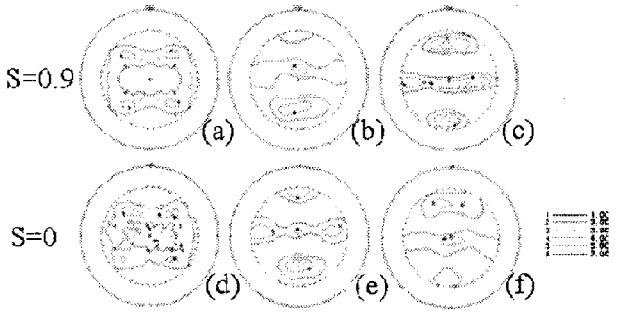

Fig.1. (111) Pole figures from one tenth surface layer S=0.9 (a) initial Al sheet, (b) 80% asymmetric rolled, (c) 80% asymmetric rolled and subsequent heat treated at 300C for 20min. From center layer S=0 (d) initial Al sheet, (e) 80% asymmetric rolled, (f) 80% asymmetric rolled and subsequent heat treated at 300C for 20min.

Table 1 shows also the variation of average r-value ($\bar{r}$-value), and Δr-value that obtained from the measured r-value data. The average r-values of the 80% asymmetrical rolled and subsequent heat-treated at 300°C is higher than that of the initial specimen. The average r-values of the asymmetrically rolled measured Al sheet are higher than that of the initial Al sheet.

Table 1. The Comparison of measured r-value, $\bar{r}$, and $|\Delta r|$ of the 80% cold rolled Al sheet data.

Conditions of samples	r-value			$\bar{r}$	$\|\Delta r\|$
	0°	45°	90°		
Initial specimen (500°C/1 hr)	0.752	0.472	0.813	0.628	0.437
80% asymmetrical rolled (300°C/20 min)	0.448	1.223	0.533	0.856	0.302

4. 결 론

In the present study the plastic properties of AA 5052 Aluminum sheet during asymmetric cold rolling was investigated using tensile test. The following conclusions are summarized from this research work:

(1) The average r-values of the asymmetric cold rolled with measured Al sheet is higher than that of the initial Al sheet.

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