

## Mechanical Properties of 5083 Aluminum Alloy Sheets Produced by Isothermal Rolling

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The microstructure and mechanical properties of AA5083 aluminum alloy sheets consisting of well developed  $\beta$ -fiber texture were investigated. In order to maintain rolling textures after final annealing, the materials were rolled isothermally at 623 K by making use of heated rolls and reheating process every pass up to final thickness of 1 mm. The isothermal rolled sheets consisted of fine subgrain structures through the thickness with a high proportion of low angle boundary less than  $15^\circ$ . Tensile properties showed anisotropy clearly regarding elongation and Lankford value. In the isothermal rolled sheets, the elongation of  $0^\circ$  to rolling direction was below 20% and Lankford value of  $45^\circ$  to rolling direction was over 1.5. Therefore, the average Lankford value showed 1.0. The yield strength of the isothermal rolled sheets was about 40% higher than that of the cold rolled sheets because of subgrain structures. The low ductility of  $0^\circ$  to rolling direction on the isothermal rolled sheets seemed to reduce drawability at room temperature. The warm drawability of the isothermal rolled sheets improved and was superior to the cold rolled sheets because of increasing ductility and keeping higher strength than the cold rolled sheets.

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**Keywords:** isothermal rolling, aluminum-magnesium-manganese, Lankford value, drawability

### 1. Introduction

It was known in low-carbon steels that Lankford ( $r$ ) value had a good relationship with drawing formability.<sup>1)</sup> High Lankford value leads to excellent deep-drawability. It was also known that Lankford value was related to texture strongly in aluminum alloy sheets<sup>2)</sup> as well as low-carbon steels.<sup>3)</sup> Generally, main component in O-temper of aluminum alloy sheets is a {001}(100) Cube component. In such case, it is predicted by Taylor model that Lankford value is below 1.0, especially a significantly smaller one of  $45^\circ$  to rolling direction.<sup>2)</sup> Meantime, the texture consisted of the  $\beta$ -fiber ({011}(211) + {123}(634) + {112}(111)) after cold rolling in aluminum alloy sheets,<sup>4,5)</sup> and it was expected according to Taylor model that the  $\beta$ -fiber increased Lankford value of  $45^\circ$  to rolling direction.<sup>2)</sup> Such cold rolled sheets are not suitable for press forming because of low ductility. If a sheet is prepared with thermal stability in microstructure, high Lankford value with adequate ductility is gained by remaining  $\beta$ -fiber after a specified heat treatment.

In prior studies,<sup>6,7)</sup> it was revealed that AA7475 based aluminum alloy sheets containing zirconium by controlled warm rolling have the strong {011}(211) Brass component after the solution heat treatment at 753 K. These sheets had high Lankford values of  $45^\circ$  to rolling direction and increased strength by subgrain structure less than 3  $\mu\text{m}$ . It is hard to examine formability on heat-treatable alloy such as AA7475 aluminum alloy. The thermal stability of AA5083 aluminum alloys has been investigated by making use of plane strain compression test.<sup>8)</sup> Due to this study, it was found that AA5083 aluminum alloy sheets deformed at not lower than 623 K and under control of strain rate in  $5 \text{ s}^{-1}$  and below have the property of thermal stability.

In the present work, AA5083 aluminum alloy sheets were

prepared under control of temperature and strain rate according to the above results of the plane strain compression test. These materials were also investigated about microstructures and drawing formability comparing with conventional AA5083 aluminum alloy sheets produced by cold rolling.

### 2. Experimental Procedures

Samples of AA5083, of which the composition is given in Table 1, were prepared according to the procedure shown in Table 2. The alloy AA5083 was cast into slabs by a standard semi-continuous direct chill technique. The slab was homogenized at 738 K for 43.2 ks followed by machining with dimensions of 30 mm high, 170 mm wide and 170 mm long. The rolling equipment used in this work has two  $\phi 260$  mm work rolls mounted eight cylindrical heaters per roll<sup>9)</sup> to keep roll temperature near sample temperature. In this experiment, the peripheral velocity of the work rolls was 5 m/min, and the rolls were heated at  $643 \text{ K} \pm 1.5 \text{ K}$  in order to manufacture sheets isothermally to the final thickness of 1 mm. The above material machined was rolled at 623 K with re-heating at 623 K for about 900 s after every pass. Average strain rate of every pass was calculated roughly by the following equation.<sup>10)</sup>

$$\dot{\epsilon} = \frac{U_R}{\sqrt{R} \cdot h_0} \cdot \frac{2\sqrt{r}}{2-r} \quad (1)$$

Here,  $U_R$  is the peripheral velocity of roll (m/s),  $R$  is the radius of roll (m),  $h_0$  is the sample thickness before rolling (m) and  $r$  is the rolling reduction per pass. Then, the average strain rate per pass should be under  $5 \text{ s}^{-1}$ . Commercial machine oil was used in the isothermal rolling process. In

Table 1 Chemical composition of specimens (mass%).

Si	Fe	Cu	Mn	Mg	Cr	Zn	Ti	Al
0.04	0.05	<0.01	0.63	4.38	0.16	<0.01	0.02	Bal.

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# Mechanical Properties Of 5083 Aluminum Alloy Sheets

**Corleen Chesonis**

A decorative graphic consisting of a red and white circular shape, resembling a stylized 'C' or a partial circle, located to the right of the author's name.

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### **Table of Contents Mechanical Properties Of 5083 Aluminum Alloy Sheets**

1. Understanding the eBook Mechanical Properties Of 5083 Aluminum Alloy Sheets
  - The Rise of Digital Reading Mechanical Properties Of 5083 Aluminum Alloy Sheets
  - Advantages of eBooks Over Traditional Books
2. Identifying Mechanical Properties Of 5083 Aluminum Alloy Sheets
  - Exploring Different Genres
  - Considering Fiction vs. Non-Fiction
  - Determining Your Reading Goals
3. Choosing the Right eBook Platform
  - Popular eBook Platforms
  - Features to Look for in an Mechanical Properties Of 5083 Aluminum Alloy Sheets
  - User-Friendly Interface

4. Exploring eBook Recommendations from Mechanical Properties Of 5083 Aluminum Alloy Sheets
  - Personalized Recommendations
  - Mechanical Properties Of 5083 Aluminum Alloy Sheets User Reviews and Ratings
  - Mechanical Properties Of 5083 Aluminum Alloy Sheets and Bestseller Lists
5. Accessing Mechanical Properties Of 5083 Aluminum Alloy Sheets Free and Paid eBooks
  - Mechanical Properties Of 5083 Aluminum Alloy Sheets Public Domain eBooks
  - Mechanical Properties Of 5083 Aluminum Alloy Sheets eBook Subscription Services
  - Mechanical Properties Of 5083 Aluminum Alloy Sheets Budget-Friendly Options
6. Navigating Mechanical Properties Of 5083 Aluminum Alloy Sheets eBook Formats
  - ePub, PDF, MOBI, and More
  - Mechanical Properties Of 5083 Aluminum Alloy Sheets Compatibility with Devices
  - Mechanical Properties Of 5083 Aluminum Alloy Sheets Enhanced eBook Features
7. Enhancing Your Reading Experience
  - Adjustable Fonts and Text Sizes of Mechanical Properties Of 5083 Aluminum Alloy Sheets
  - Highlighting and Note-Taking Mechanical Properties Of 5083 Aluminum Alloy Sheets
  - Interactive Elements Mechanical Properties Of 5083 Aluminum Alloy Sheets
8. Staying Engaged with Mechanical Properties Of 5083 Aluminum Alloy Sheets
  - Joining Online Reading Communities
  - Participating in Virtual Book Clubs
  - Following Authors and Publishers Mechanical Properties Of 5083 Aluminum Alloy Sheets
9. Balancing eBooks and Physical Books Mechanical Properties Of 5083 Aluminum Alloy Sheets
  - Benefits of a Digital Library
  - Creating a Diverse Reading Collection Mechanical Properties Of 5083 Aluminum Alloy Sheets
10. Overcoming Reading Challenges
  - Dealing with Digital Eye Strain
  - Minimizing Distractions
  - Managing Screen Time
11. Cultivating a Reading Routine Mechanical Properties Of 5083 Aluminum Alloy Sheets
  - Setting Reading Goals Mechanical Properties Of 5083 Aluminum Alloy Sheets
  - Carving Out Dedicated Reading Time

12. Sourcing Reliable Information of Mechanical Properties Of 5083 Aluminum Alloy Sheets
  - Fact-Checking eBook Content of Mechanical Properties Of 5083 Aluminum Alloy Sheets
  - Distinguishing Credible Sources
13. Promoting Lifelong Learning
  - Utilizing eBooks for Skill Development
  - Exploring Educational eBooks
14. Embracing eBook Trends
  - Integration of Multimedia Elements
  - Interactive and Gamified eBooks

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