Chapter

Characteristics of Al-Mg Test Pieces with Fe Impurities Fabricated by Die Casting, Roll Casting, and Hot Forging

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Abstract

The suitability of Al-Mg alloys for recycling was investigated using energy-saving processes. The Al-Mg alloy is a non-heat-treatable alloy and has the advantage of energy saving in comparison with heat-treatable alloys. Al-Mg alloys with Mg contents ranging from 4.5–10% were tested. Die casting, cast-forging, and roll casting were selected as energy-saving processes, as they have the advantage of process saving. A single-roll caster equipped with a scraper was used as the roll-caster. Fe was added to the Al-Mg alloys at contents of 0.2%, 0.4%, 0.6%, and 0.8% to model recycled alloys used in automobile manufacture. In the selected processes, the tensile stress and 0.2% proof stress of the Al-Mg alloys were little influenced by the added Fe content, whereas the elongation tended to decrease as the Fe content increased. The process influenced the degree to which the Fe content affected the elongation, and it was found that a suitable Mg content for recycling depends on the target process.

Keywords: Al-Mg alloy, non-heat treatment aluminum alloy, Al-Mg alloy with Fe, die cast, cast-forging, roll-casting, recycle aluminum alloy

1. Introduction

Al-Mg alloys are non-heat-treatable aluminum alloys, which means they save energy in comparison with heat-treatable aluminum alloys. The Al-Si-Mg alloy, which is a heat-treatable aluminum alloy, is commonly used in automobile manufacture. For example, 6061 is used for forging, 6022 is used for sheet forming, and A357 and Silafont-37™ are used for casting and die casting. When aluminum alloys are used for automobile manufacture, Fe impurities are incorporated into the alloy, which causes AlSiFe intermetallic compounds to solidify when Al-Si-Mg alloys are recycled, reducing the Si content in the Al-Si-Mg alloy as AlSiFe intermetallic compound was crystallized. In Al-Mg-Si alloys, Mg_2Si precipitates during aging, causing the strength of the Al-Si-Mg alloy to increase. When the AlSiFe intermetallic compounds solidify, this can cause a shortage of Si for the Mg_2Si, and the strength may not increase sufficiently [1, 2]. As a result, Fe impurities have a reduced effect on Al-Mg alloys in comparison with Al-Si-Mg alloys. This is the second advantage of Al-Mg alloys over Al-Si-Mg heat-treatable alloys. Much less work has been done to investigate the effect of Fe impurities on the mechanical properties of Al-Mg alloys than for of Al-Si-Mg alloys [1–5].

To be suitable for the recycling of aluminum alloys, the selected process must satisfy the following two requirements: saving energy and improving the deterioration of the mechanical properties of the recycled alloy. In this paper, die casting, cast-forging, and roll casting were selected as the processes using the recycled Al-Mg alloys. Die casting can be used to produce aluminum alloy parts in one process with rapid solidification. Cast-forging has the advantage of energy-saving by process saving and the deformation effect, as the casting structure becomes the deformation structure [5, 6]. Roll casting has the advantage of energy-saving by process saving and rapid solidification. The intermetallic composition including Fe impurities becomes fine as a result of the rapid solidification.

In the recycling of aluminum alloys used for automobiles, the Fe content of the aluminum alloy is estimated to increase by 0.2% after shredding [7]. In this study, Fe contents of 0.2%, 0.4%, 0.6% and 0.8% were added to Al-Mg alloys to model recycled Al-Mg alloys. The addition of 0.8% Fe is considered to represent an alloy that has been recycled four times.

The Mg contents of the Al-Mg alloys used in this study were 4.5%, 6%, 8%, and 10%. The Mg content of 4.5% is near that of the 514.0 and 5182 aluminum alloys, and the Mg content of 8% is near that of 518.0. The four Fe contents were added to these four Al-Mg alloys, and test pieces were fabricated with the three selected processes. The mechanical properties were investigated via a tensile test. A deep drawing test was conducted on the plates made from the strips cast by the rolling caster. The suitability of the different Al-Mg alloys for recycling was then evaluated based on the obtained results.

2. Die casting

2.1 Die casting machine and die

A 500 kN cold chamber die casting machine (Hishinuma Machinery HC 50F) with an injection power of 100 kN and a sleeve diameter of 45 mm was used in this study. The plunger speed was 1.6 m/s. The test piece used for the tensile test and the spiral die used for the fluidity test are shown in **Figure 1**.

2.2 Fluidity test

The effects of the Mg and Fe contents on the fluidity were investigated. The results of the fluidity test are shown in **Figure 2**. The fluidity of the Al-Mg alloy

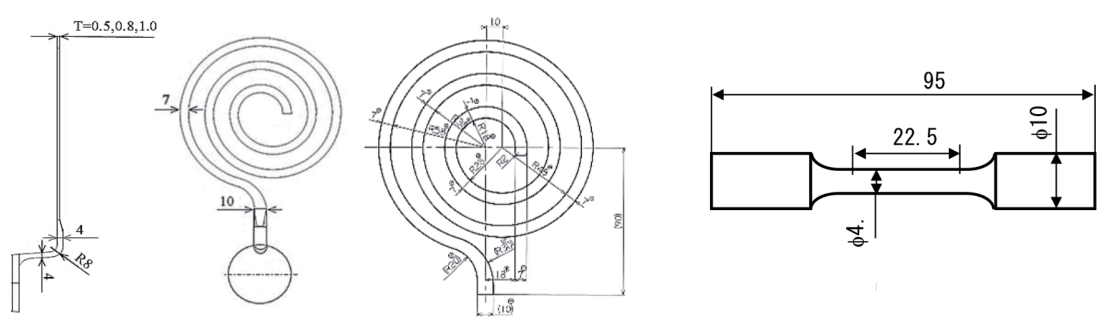

Figure 1.
Test piece for the spiral die for the fluidity test and the tensile test.

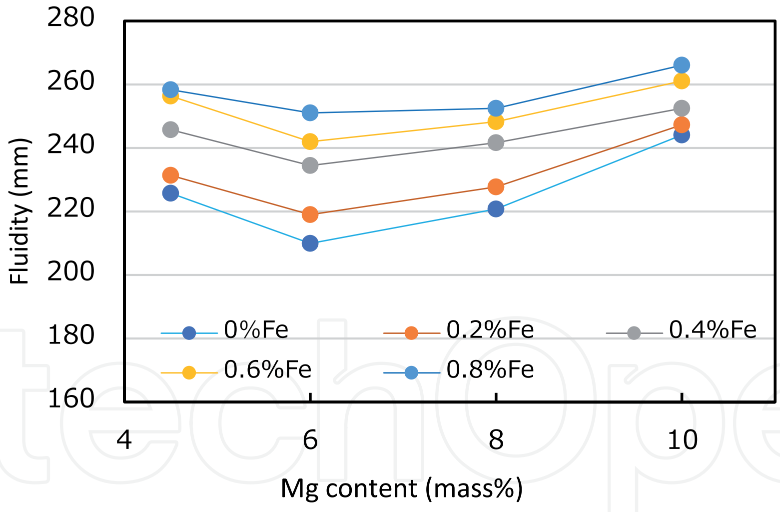

Figure 2.
Fluidity of Al-Mg alloys plotted against Mg content at different added Fe contents.

decreased with increasing Mg content until 6% Mg and then increased as the Mg content was increased beyond 6%. The fluidity was greatest at an Mg content of 10% and progressively decreased at contents of 4.5%, 8%, and 6%.

The fluidity increased with increasing Fe content, as shown in **Figure 2**. The flow stress at the semisolid condition decreased with increasing Fe content because the primary crystal became smaller and exhibited the mushy condition as the Fe content was increased. It is known that Fe is added to aluminum alloys during die casting to prevent the sticking of the solidification layer to the die. The heat transfer between the solidification layer and the die decreases with increasing Fe content because the contact condition between the solidification layer and the die worsens. As a result, the solidification time decreases and the fluidity increases. The increase of the Fe content during recycling; thus, does not make the fluidity worse but better.

2.3 Effect of Mg content on tensile test results

Figure 3 shows the results of the tensile test of the die-cast test pieces plotted against the Mg content. Both the tensile stress and the 0.2% proof stress gradually increased with increasing Mg content. The elongation was maximized at 6% Mg and remarkably decreased with further increases in the Mg content to 8% and 10% Mg. The elongation of the Al-6%Mg was 17.4%, which is excellent. The elongation of the Al-10%Mg was 4.7%, which is better than that of A383, a popular alloy for die casting in Japan. These Al-Mg alloys have 0.2% proof stresses and elongations that are better than those of A383. These results demonstrate that the Mg content should be selected based on the target user. If ductility is important, Al-6%Mg is better, whereas if strength is important, Al-8%Mg or Al-10%Mg is suitable.

2.4 Effect of added Fe content on tensile test results

The tensile stress, 0.2% proof stress, and elongation of different Al-Mg alloys are plotted against added Fe content in **Figures 4–6**, respectively. When Fe was added, the tensile stress of each Al-Mg alloy was the same as or better than that of the corresponding Al-Mg alloy without added Fe. In die casting using recycled

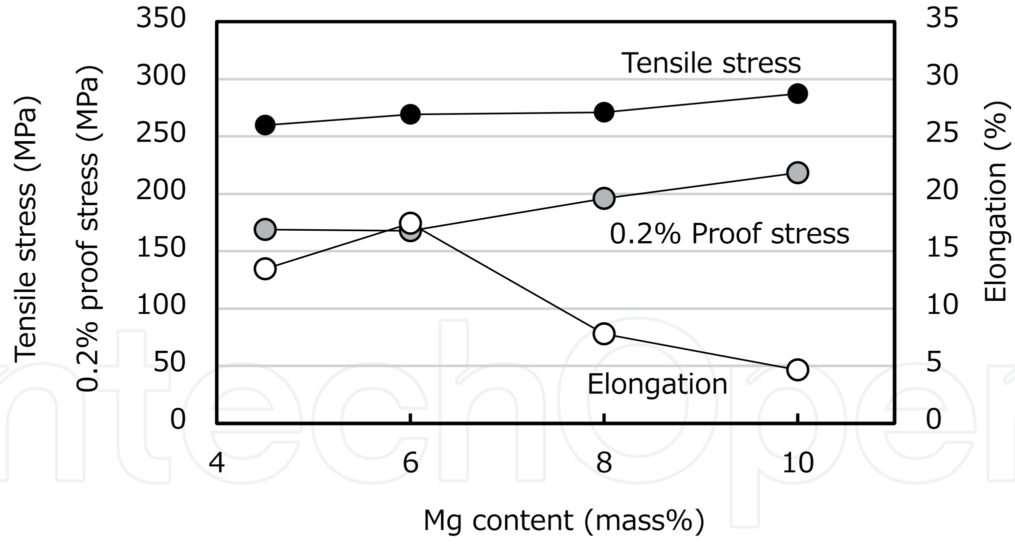

Figure 3.
Effect of the Mg content of the Al-Mg alloy on the result of the tensile test of the die-cast test piece.

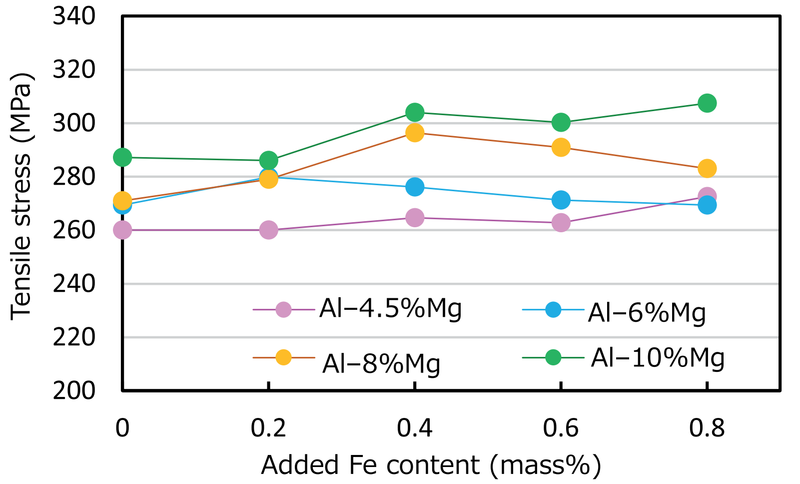

Figure 4.
Tensile stress of different die-cast Al-Mg alloys plotted against added Fe content.

Al-Mg alloys, it was clear that the tensile stress was not degraded by increasing Fe content.

The 0.2% proof stress of the Al-Mg alloys with different added Fe contents is shown in **Figure 5**. The results indicate that the 0.2% proof stress was not significantly affected by the addition of Fe. The 0.2% proof stress of the Al-8%Mg and Al-10%Mg increased with the addition of Fe.

The elongation of the Al-Mg alloys with different added Fe contents is shown in **Figure 6**. The amount of decrease in the elongation with increasing Fe content was dependent on the Mg content of the alloy. The elongation of the Al-4.5%Mg decreased substantially with the addition of 0.2% Fe but changed little with further increases in Fe content up to 0.8%. The elongation of the Al-4.5%Mg with 0.8%Fe was 10.2%. It was clear that the elongation of the Al-4.5%Mg was not greatly influenced by the Fe content for Fe contents above 0.2%. The reduction in the elongation from an Fe content of 0 to 0.2% was smaller at greater Mg contents. The elongation of the Al-6%Mg decreased almost linearly from 17.4–8% as the Fe content increased from 0.2% to 0.8%. At Fe contents of 0.2% and 0.4%, the elongation of the Al-6%Mg was greater than that of the Al-4.5%Mg. The elongations of the Al-8%Mg and the Al-10%Mg gradually decreased with increasing Fe content. The elongations of the Al-4.5%Mg, Al-6%Mg, and Al-8%Mg, each with 0.8%Fe, and the Al-10%Mg with 0.4%Fe were greater than

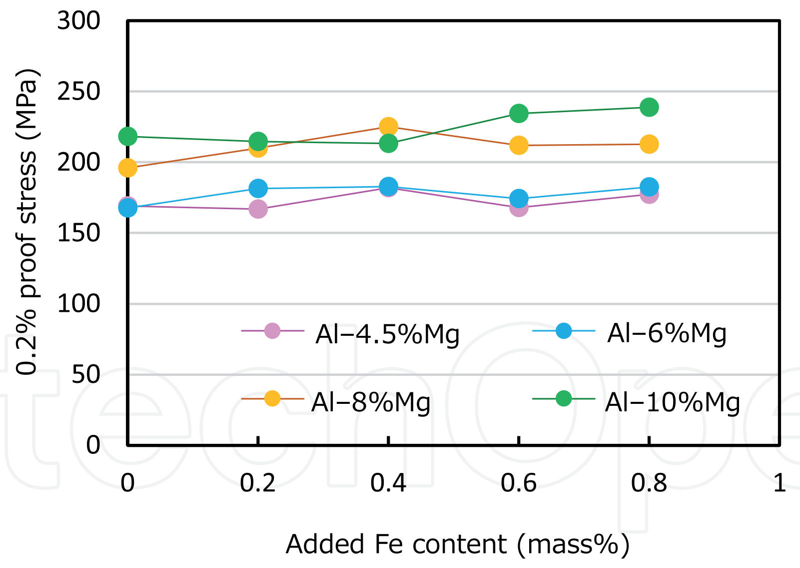

Figure 5.
The 0.2% proof stress of die-cast Al-Mg alloys plotted against added Fe content.

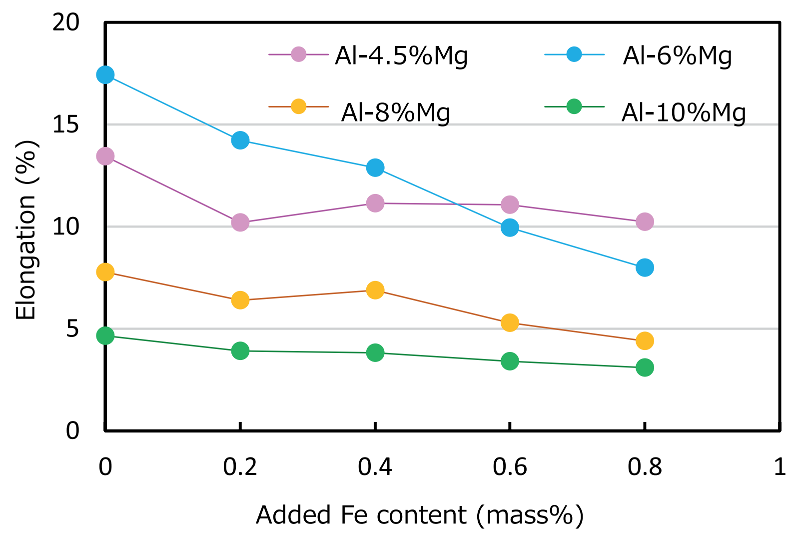

Figure 6.
Elongation of die cast Al-Mg alloys plotted against Fe content.

the elongation of the A383, which is 3.5%. This means that die-cast Al-Mg alloys may be suitable for recycling when die-cast Al-Mg alloys are used for automobile parts.

3. Cast-Forging

3.1 Model process of cast-forging

In cast-forging, a preform is cast near the net shape, which is suitable for forging. Processing and energy can be saved by cast-forging. The hot forging of a gravity-cast ingot was conducted as a model of cast-forging [8–10]. The process of gravity casting and hot forging is shown in **Figure 7**. This process is similar to cast-forging.

The cooling rate of the gravity-cast Al-4.5%Mg ingot was 30.6°C/s. A specimen was made for the tensile test and tested to investigate the mechanical properties of the ingot. A square bar was cut out from the as-cast ingot and heated at 500°C for 1 h. The forging was conducted at 50% reduction. The mechanical properties of the

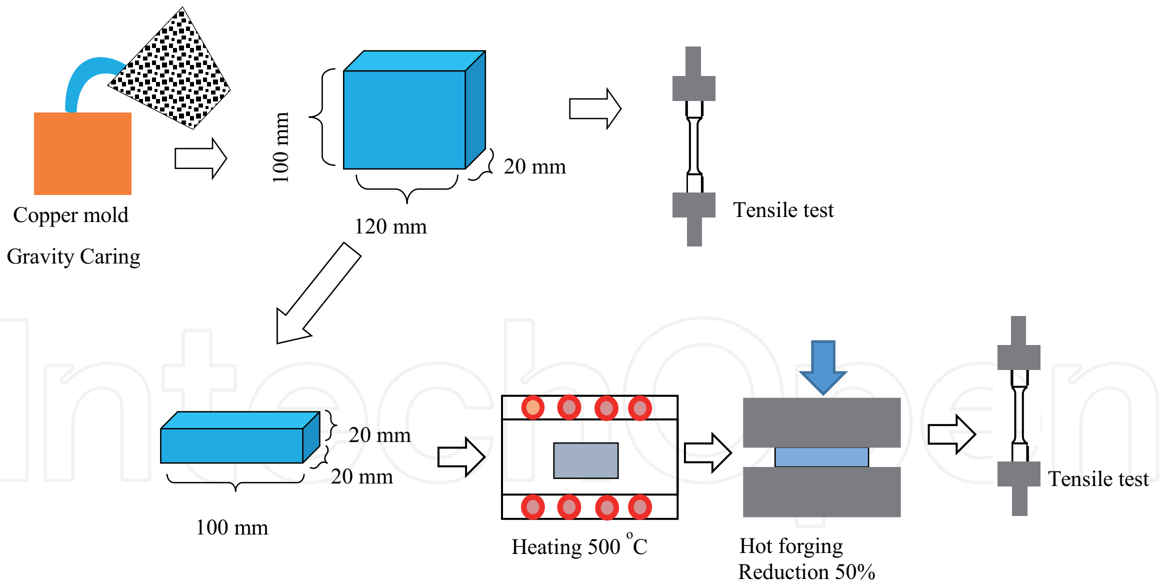

Figure 7.
Schematic of process from gravity casting to hot forging.

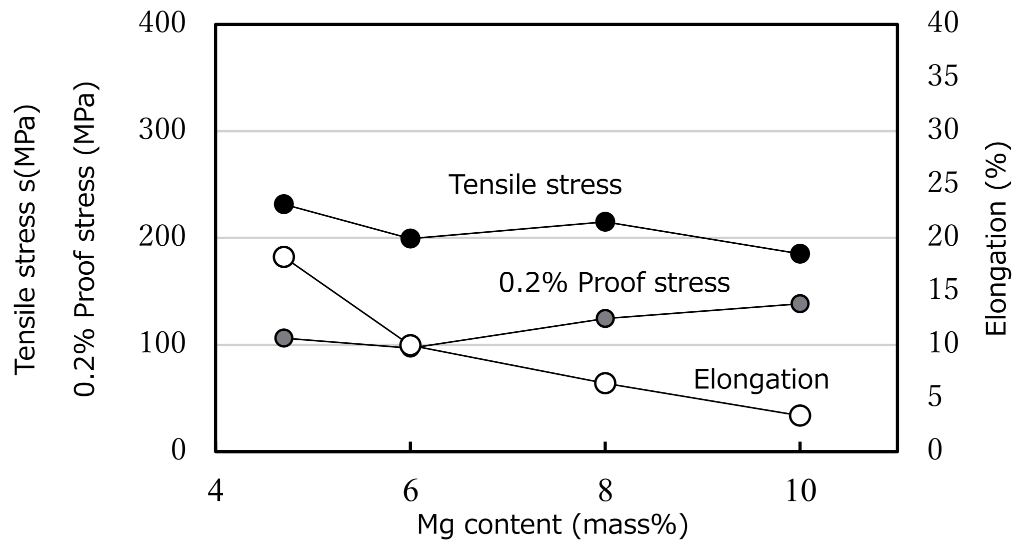

Figure 8.
Tensile test results for gravity-cast Al-Mg alloys.

hot-forged rectangular bar were investigated by tensile testing. The dimensions of the test piece are shown in **Figure 1a**.

3.2 Tensile test of gravity-cast ingot

The tensile test results for the gravity-cast Al-Mg alloys are plotted against the Mg content in **Figure 8**. As the Mg content increased from 4.5–10%, the tensile stress gradually decreased from 231 to 185 MPa, and the 0.2% proof stress gradually increased from 106 to 138 MPa. The elongation decreased greatly from 18–10% when the Mg content increased from 4.5–6%, after which it linearly decreased with further increases to the Mg content, down to 3% at an Mg content of 10%. The Mg content had a greater effect on the elongation than on the tensile stress or the 0.2% proof stress.

3.3 Tensile test of hot-forged gravity-cast ingot

The results of the tensile test of the hot-forged gravity-cast ingot are plotted against the Mg content in **Figure 9**. The tensile stress, 0.2% proof stress, and

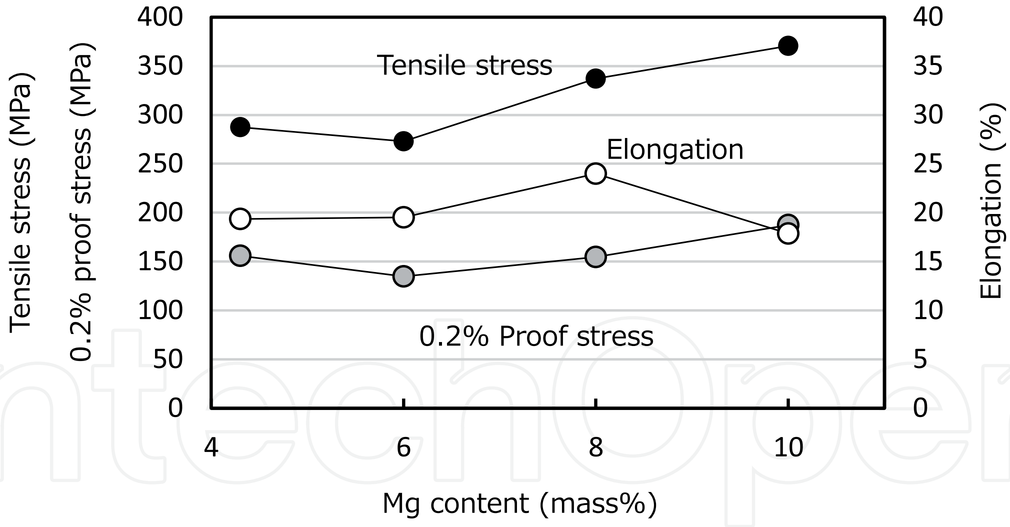

Figure 9.
Tensile test results for hot-forged gravity-cast Al-Mg alloys.

elongation of all Al-Mg alloys were increased by the hot forging. The tendencies of the tensile stress and elongation for the Mg content were also changed by the hot forging. The tensile stress increased with increasing Mg content. The increase (improvement) of the tensile stress became greater as the Mg content increased. At Mg contents of 4.5% and 10%, the tensile stress increased from 231 to 287 MPa and 185 to 270 MPa, respectively, which corresponds to respective increases of 56 and 185 MPa. When the Mg content was 8%, the elongation was maximized, and the elongation of the Al-10%Mg was the smallest among the alloys. The elongation of the hot-forged Al-8%Mg was 24%, and that of the Al-10%Mg was 17%. These results show that the hot-forged Al-Mg alloys have excellent strength and ductility.

Optical microscope images of the gravity-cast and hot-forged Al-Mg alloys are shown in **Figures 10** and **11**, respectively. The gravity-cast Al-Mg alloys had a dendrite microstructure, as shown in **Figure 10**; this is a typical structure for this type of casting. In contrast, there was not a dendrite structure in the hot-forged Al-Mg alloys, as shown in **Figure 11**, and the microstructure changed to a deformation structure as a result of the hot-forging. The grain size decreased as the Mg content increased until 8% Mg. This may contribute to the excellent mechanical properties of the Al-8%Mg alloy.

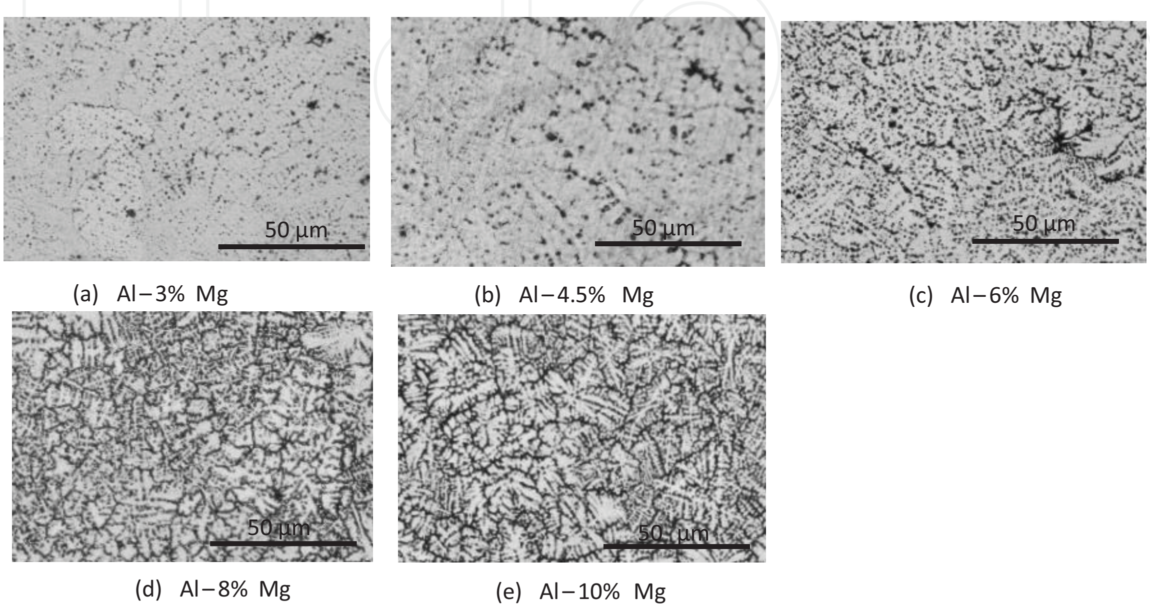

Figure 10.
Optical microscope images of gravity-cast Al-Mg alloys.

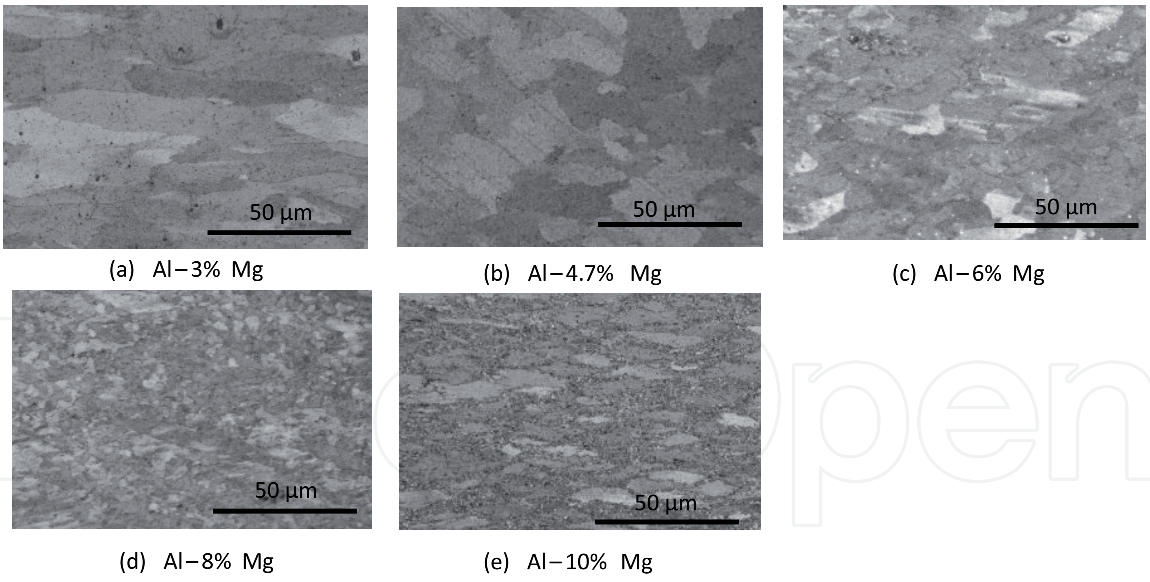

Figure 11.
Optical microscope images of hot-forged Al-Mg alloys.

3.4 Effect of Fe content on tensile test results for the hot-forged gravity-cast ingot

The tensile stress, 0.2% proof stress, and elongation of the different Al-Mg alloys are plotted against the added Fe content in **Figures 12–14**, respectively. The tensile stress was not influenced by the Fe content, as shown in **Figure 12**. The 0.2% proof stress of the Al-4.5%Mg was almost uniform, and that of other Al-Mg alloys increased gradually with increasing Fe content, as shown in **Figure 13**. The results are shown in **Figures 12** and **13** indicate that increasing the Fe content does not have a negative influence on the tensile stress or the 0.2% proof stress.

At Mg contents of 4.5%, 6%, and 10%, the elongation decreased with increasing Fe content, as shown in **Figure 14**. The elongations of the Al-8%Mg with 0.2% and 0.4%Fe were 27.6% and 24.6%, respectively, and the elongation of the Al-8%Mg without added Fe was 24.0%. When the Fe content was 0.2%,

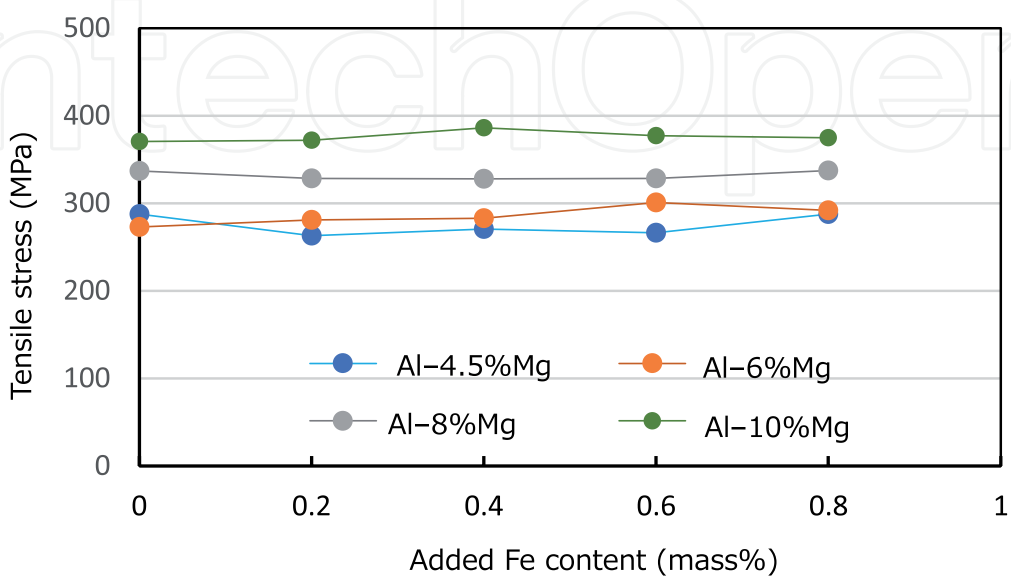

Figure 12.
Tensile stress of the hot-forged gravity-cast Al-Mg alloys plotted against Fe content.

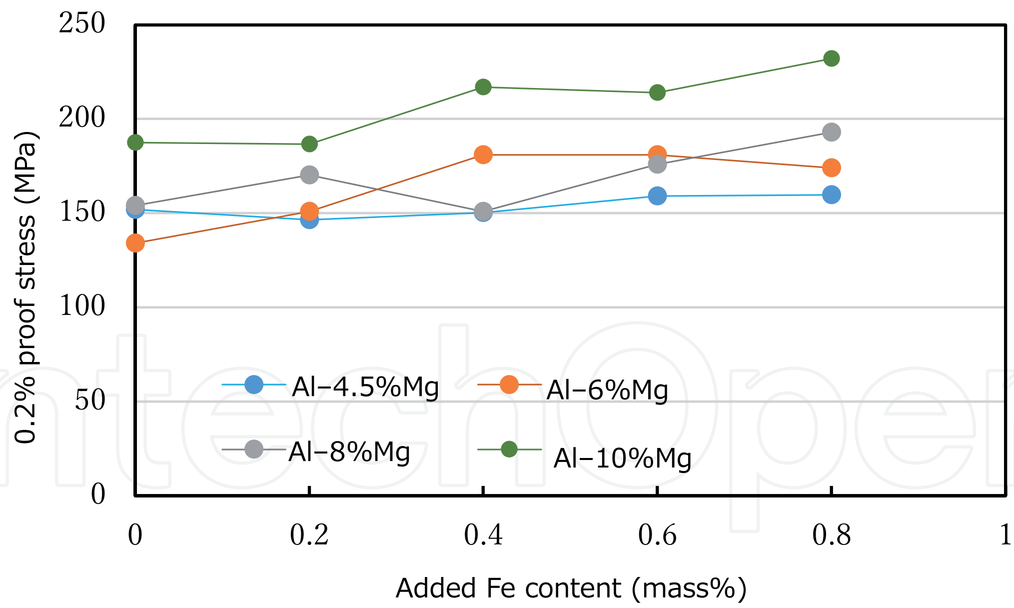

Figure 13.
The 0.2% proof stresses of the hot-forged gravity-cast Al-Mg alloys plotted against Fe content.

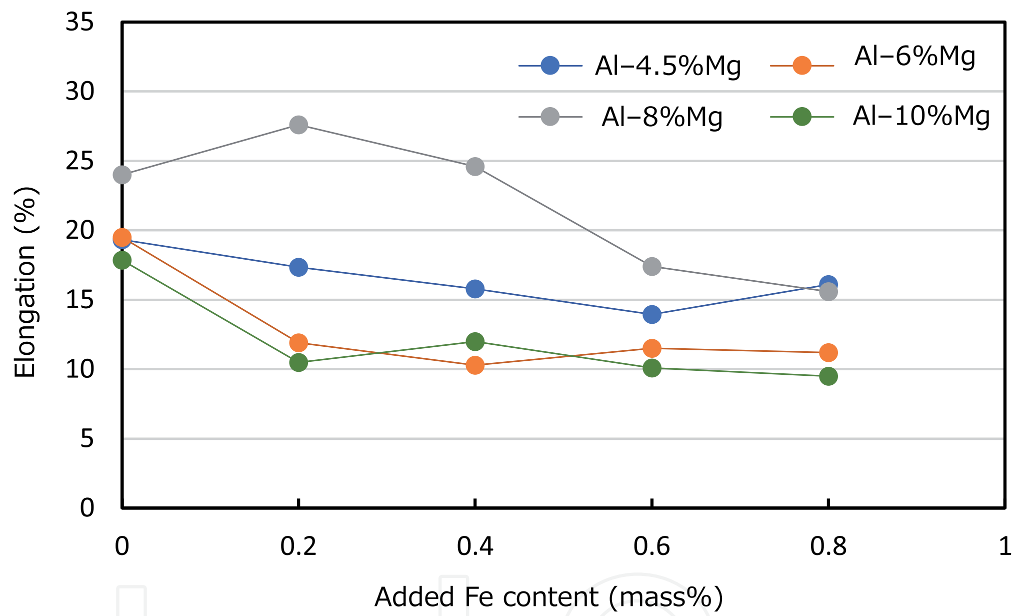

Figure 14.
Elongation of the hot-forged gravity-cast Al-Mg alloys plotted against Fe content.

the elongation did not decrease but increased. It is thought that the addition of Fe makes the elongation worse; however, in this case, the elongation increased. This means that when Fe impurities are incorporated during recycling, the elongation increases in comparison with that of the virgin alloy, demonstrating that upgrade recycling occurs. The elongation of the Al-8%Mg with 0.4%Fe was 24.6%, which means the added 0.4% Fe did not influence the elongation. The elongations of the Al-8%Mg with 0.6% and 0.8%Fe were 17.4% and 15.6%, respectively. The elongation of the hot-forged Al-8%Mg was excellent when the added Fe content was 0.8% or less. The elongation of the Al-10%Mg with 0.8%Fe was 9.5%, and that of the other Al-Mg alloys were greater than 9.5%. The hot-forged Al-Mg alloys have good elongation when Fe impurities are incorporated during recycling, with Al-8%Mg being particularly suitable for cast-forging and recycling.

4. Roll-casting

4.1 Single-roll caster equipped with a scraper

It is known that centerline segregation occurs between the solidification layers in Al-Mg alloy strips cast using a twin-roll caster (TRC). It is difficult to reproduce the occurrence of this type of centerline segregation in strips cast using twin-roll casters. In this study, a single-roll caster equipped with a scraper (SRCS) was used to cast Al-Mg alloys strips without centerline segregation [11].

In the SRCS, the molten metal is solidified on the side of the one roll, and a centerline does not form. The free solidified surface is scribed into a flat surface by the scraper. The scraper load was 0.2 N/mm, and no crack was formed on either surface of the strip because of the small scraper load. A copper roll was used to increase the cooling speed and roll speed. In the conventional TRC, steel rolls are used. The thermal conductivity of copper is much larger than that of steel, and the cooling ability of a copper roll is thus greater than that of a steel roll. The casting speed of the SRCS was 30 m/min, whereas the casting speed of a conventional TRC is usually slower than 2 m/min. The excellent cooling ability of the copper roll enabled high-speed roll casting. Schematic illustrations of the SRCS and the area near the scraper are shown in **Figure 15**. Cross-sections of Al-4.5%Mg strips cast using the high-speed TRC and the SRCS are shown in **Figure 16** [11, 12]. Centerline segregation occurred in the strip cast using the high-speed TRC and not in the strip cast using the SRCS.

4.2 Effect of Mg content on strip thickness and surfaces

Strips of Al-Mg alloys with Mg contents ranging from 4.5–10% could be continuously cast using the SRCS. The strip thickness is plotted against the Mg content in **Figure 17**. The strip became thicker as the Mg content increased. Two potential causes were considered to explain the relationship between the Mg content and the strip thickness. One is that the latent heat of the magnesium is smaller than that of the aluminum; thus, the latent heat of Al-Mg alloy decreases as the Mg content increases, which may then cause the strip thickness to increase with the Mg content. The other is that the amount of scribed and piled aluminum alloy under the scraper becomes greater as the Mg content increases, and the piled

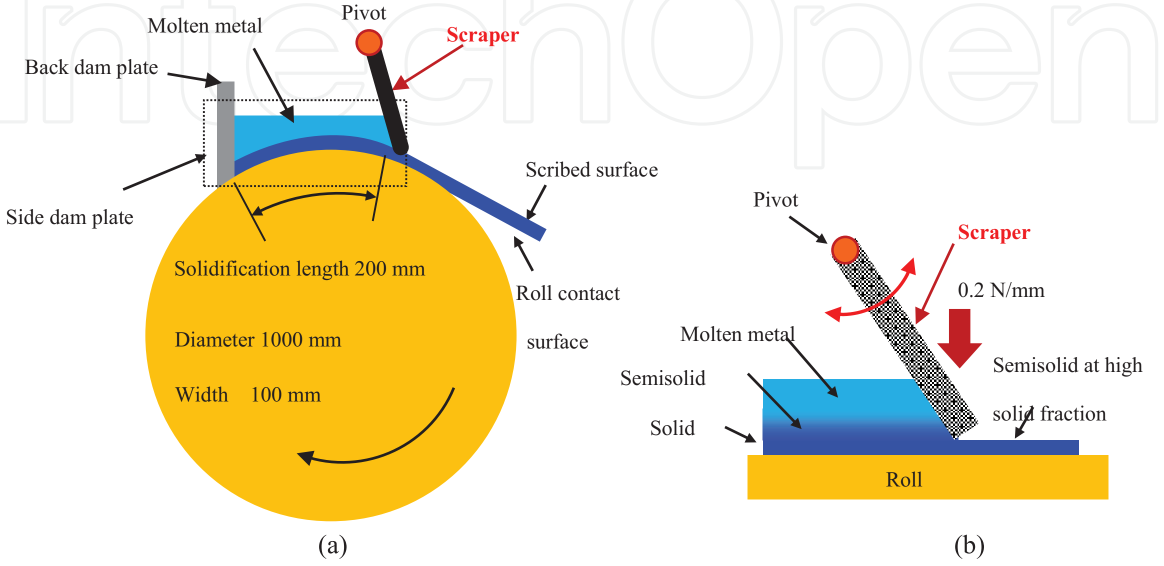

Figure 15.
Schematic illustrations of (a) a top-down view of a single-roll caster equipped with a scraper and (b) a view near the scraper.

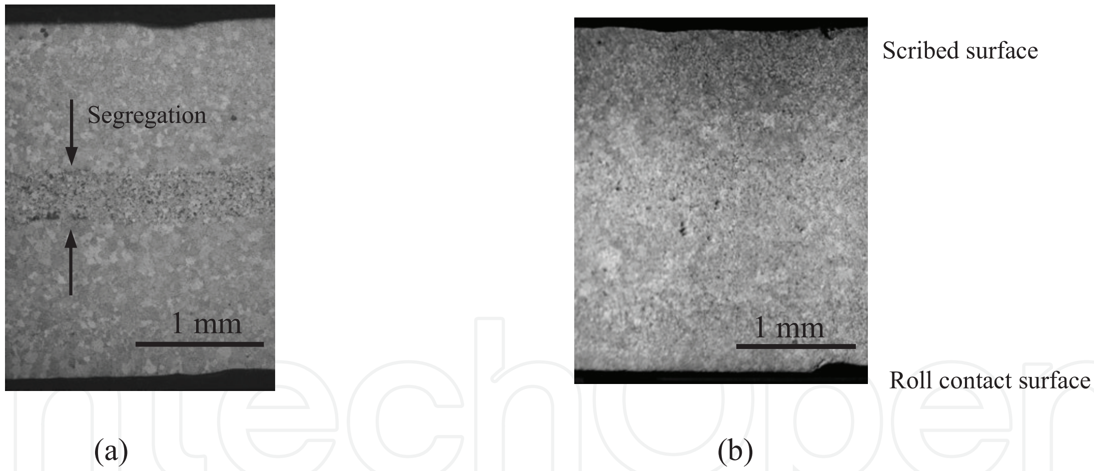

Figure 16.
Cross-sections of Al-4.5%Mg alloys cast using (a) a high-speed twin-roll caster and (b) a single-roll caster equipped with a scraper. The casting speed was 30 m/min.

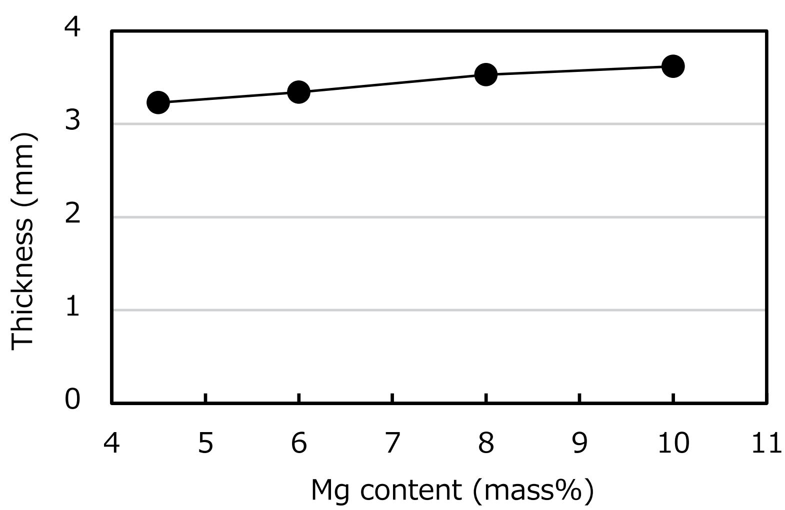

Figure 17.
Strip thickness plotted against Mg content.

aluminum alloy becomes a part of the strip [12]. Therefore, the strip becomes thicker as the Mg content increases.

The surfaces of the Al-Mg alloy strips are shown in **Figure 18**. The scribed surface did not have a metallic luster, whereas the roll contact surface did. The Mg content did not influence the surface condition.

4.3 Mechanical properties of roll cast Al-Mg alloy strips

The mechanical properties of the roll-cast Al-Mg alloy strips were tested by the tensile test. The cast strip was cold-rolled down to 1 mm and annealed at 360°C for 90 min. The dimensions of the test piece for the tensile test are shown in **Figure 19**.

The results of the tensile test are shown in **Figure 20**. The tensile stress increased monotonically at a gradual rate with increasing Mg content. The 0.2% proof stress was almost constant at different Mg contents. The elongation increased with increasing Mg content up to 8% Mg and then substantially decreased at 10% Mg. Comprehensively, judging from the tensile test, the Al-8%Mg showed the best mechanical properties.

A deep drawing test was then conducted to investigate the ability of sheet forming. The cast strip was cold-rolled down to 1 mm and annealed at 360°C for 90 min. The diameter of the punch used for the deep drawing test was 32 mm. The

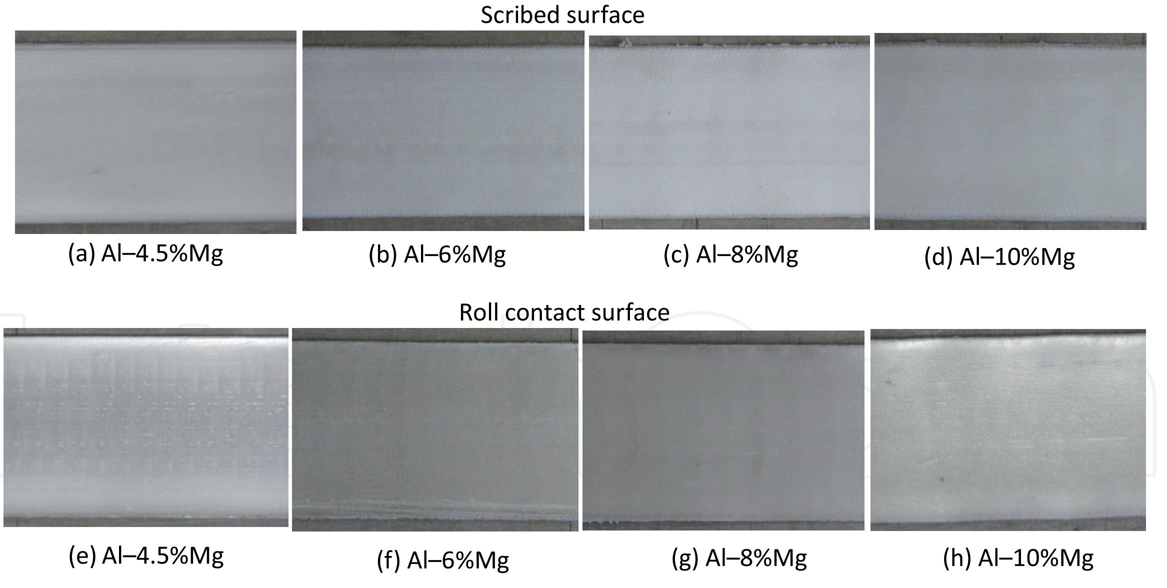

Figure 18.
Surfaces of as-cast Al-Mg alloy strips.

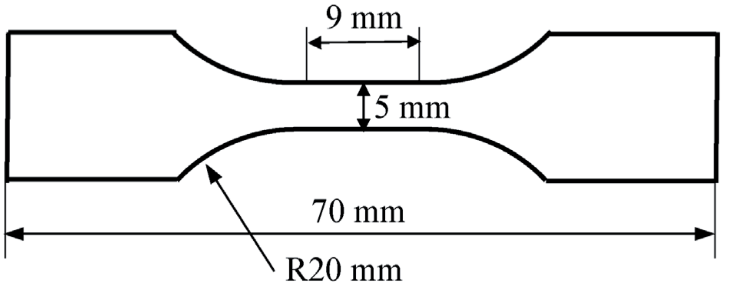

Figure 19.
Size of a test piece for the tensile test.

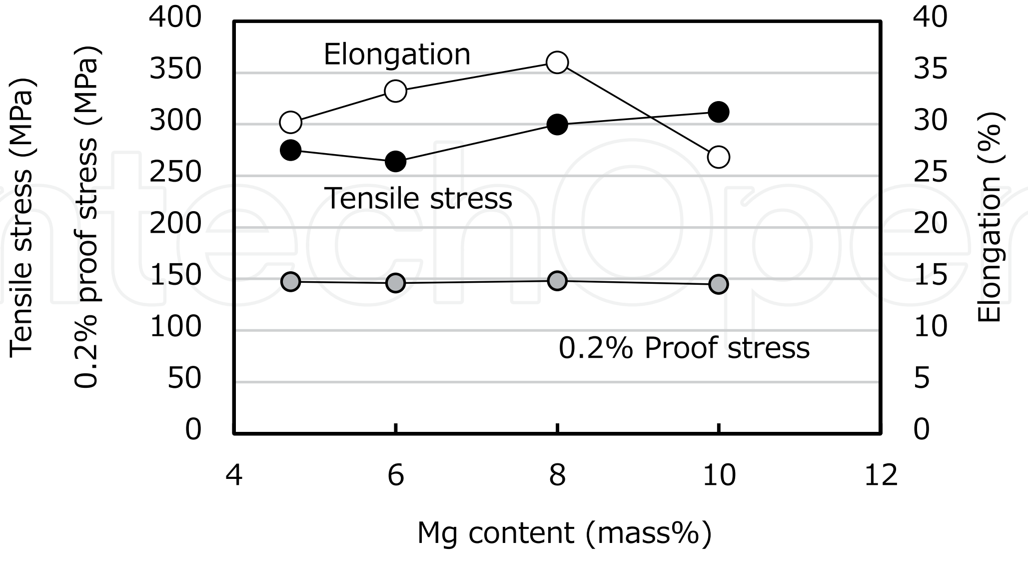

Figure 20.
Tensile test results for roll-cast Al-Mg alloys with different Mg contents.

deep drawing test was conducted under two conditions: with the roll-contact side of the strip facing outward and with the scribed surface facing outward. The results of the deep drawing test are shown in **Figure 21**. The limiting drawing ratio (LDR, the maximum ratio of circular blanks to the diameter of the die) of Al-4.5%Mg was 2.0 regardless of which side of the strip was facing outward. The LDR decreased

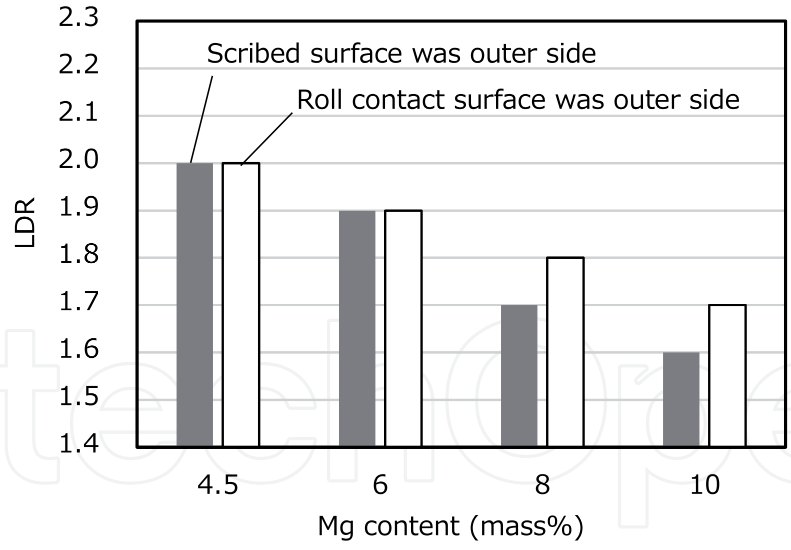

Figure 21.
Limiting drawing ratio at different Mg contents.

with increasing Mg content. When the Mg content was 4.5% or 6%, the LDR was not affected by which side faced outward; in contrast, when the Mg content was 8% or 10%, the LDR was better when the roll-contact side faced outward. The difference between the LDRs in these two cases is not suitable for sheet forming. The Al-4.5%Mg was most suitable for sheet forming. The optimal Mg content for deep drawing was different from that obtained from the elongation in the tensile test. These results demonstrate that 514.0 aluminum alloy is suitable for sheet forming, and 518.0 aluminum alloy is suitable for the easy shape plate, which needs strength and elongation. This shows that the choice of Mg content depends on the purpose. The forming ability is the most important property for sheets used in automobile manufacture, and thus the Al-4.5%Mg is suitable for this purpose. The Al-4.5%Mg was used to make the model alloy of recycled Al-Mg alloys.

4.4 Mechanical properties of Al-4.5%Mg with Fe

Impurities of 0.2%, 0.4%, 0.6%, and 0.8% Fe were added to the Al-4.5%Mg to model the recycled Al-Mg alloy. The Al-4.5%Mg with Fe could be cast into a strip, as the addition of the Fe did not affect the ability of the roll casting; however, the addition of the Fe makes the strip hard and brittle. Edge cracks with lengths of 3 mm or less occurred in the Al-4.5%Mg with 0.8%Fe, and the cold rolling could be conducted on the strip down to 1 mm without breaking. When the added Fe content was less than 0.6%, edge cracking did not occur. The surfaces of the as-cast and the cold-rolled strips of the Al-4.5%Mg and the Al-4.5%Mg with 0.8%Fe are shown in **Figure 22**. There was no difference between the scribed and roll-contact surfaces of the cold-rolled virgin Al-4.5%Mg and Al-4.5%Mg with 0.8%Fe strips. It is thought that the increase in the Fe content does not affect the surface properties of the Al-4.5%Mg sheet cast by the SRCS after cold rolling.

Cross-sections of the virgin Al-4.5%Mg and Al-4.5%Mg with 0.8%Fe strips are shown in **Figure 23**. The grain of the as-cast Al-4.5%Mg strip was almost uniform in the thickness direction. In the as-cast strip of Al-4.5%Mg with 0.8%Fe, the grain of the roll-contact side of the strip was finer than that of the scribed side. The effect of cooling speed on the grain size of the Al-4.5%Mg with 0.8%Fe was more apparent than in the Al-4.5%Mg. This is the influence of the added Fe. The Fe formed a crystal nucleus, and many crystals were made. As a result, the grain number increased and the grain size became small near the roll-contact side. The structure became a fine deformation structure after cold rolling and annealing.

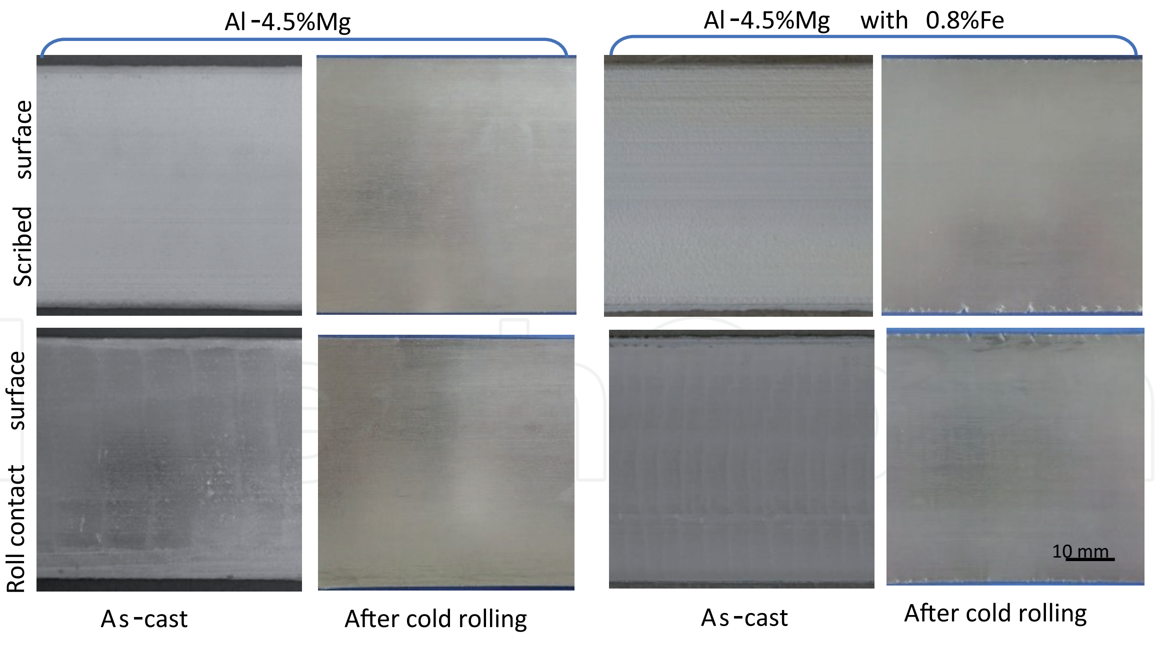

Figure 22.
Surfaces of as-cast and cold rolled strips of Al-4.5%Mg and Al-4.5%Mg with 8%Fe.

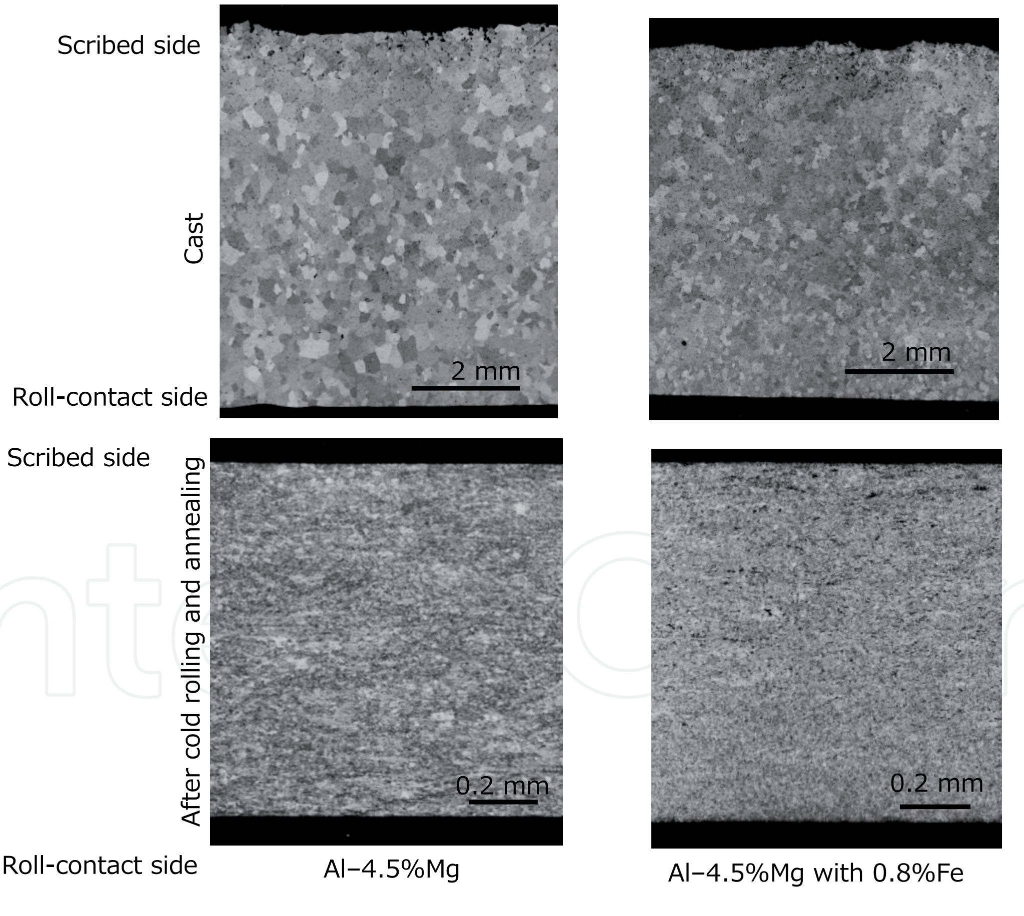

Figure 23.
Cross-sections of as-cast strip and cold rolled and annealed strip of Al-4.5%Mg and Al-4.5%Mg with 0.8%Fe. Annealing: 360°C for 90 min.

The results of the tensile test of the Al-4.5%Mg with Fe are shown in **Figure 24**. The tensile stress was almost uniform for the added Fe content. The 0.2% proof stress gradually increased with increasing Mg content, and the elongation very gradually decreased. The elongations of the Al-4.5%Mg and Al-4.5%Mg with 0.8%Fe were 30.3% and 28.6%, respectively. The reduction of the elongation with the addition of Fe

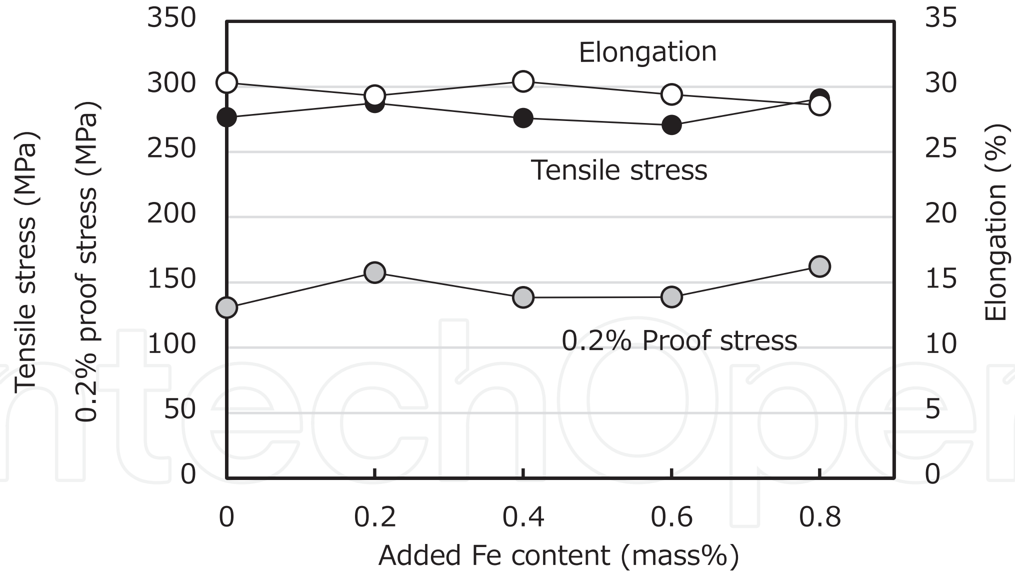

Figure 24.
Result of tensile test of Al-4.5%Mg with Fe.

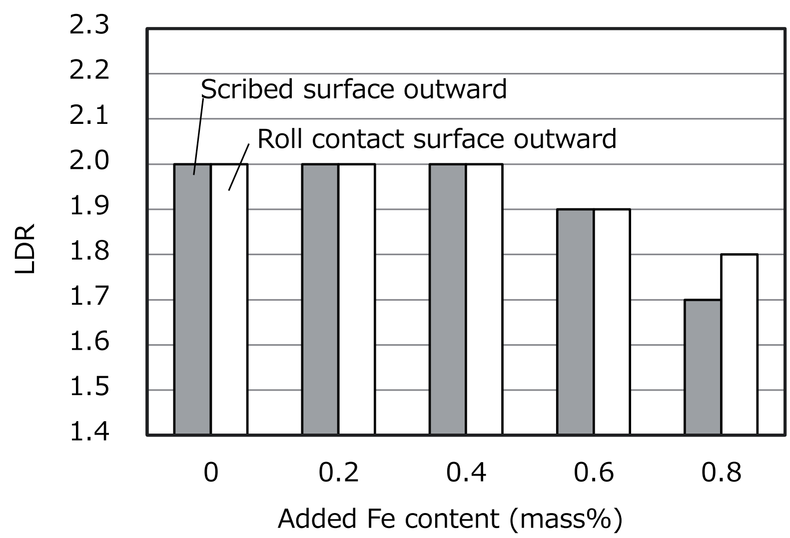

Figure 25.
Limiting drawing ratio of Al-4.5%Mg with different Fe Contents.

was very small. The intermetallic compound including Fe may be very fine because of the rapid solidification of the rolling caster, and it did not make the elongation worse.

The LDR of Al-4.5%Mg with Fe is shown in **Figure 25**. The LDR did not decrease from 2.0 until the addition of 0.4% Fe. When the Fe content was 0.6%, the LDR was 1.9. The LDR when the scribed surface faced outward was the same as that when the roll contact surface faced outward until the Fe content was 0.6%. Therefore, the ultimate addition of Fe to the Al-4.5%Mg was 0.4%.

5. Conclusions

5.1 Die casting

The fluidity of the Al-Mg alloy decreased with increasing Mg content until 6% Mg and then increased as the Mg content was increased beyond 6%. The fluidity was greatest at an Mg content of 10% and progressively decreased at contents of 4.5%, 8%, and 6%. The fluidity increased with increasing Fe content.

The tensile strength and the 0.2% proof stress increased with increasing Mg content. The elongation of the Al-6%Mg was greater than that of the Al-4.5%Mg. The addition of Fe did not degrade the tensile stress and the 0.2% proof stress. The elongation was reduced by the addition of Fe. The elongations of the Al-4.5%Mg with 0.8%Fe and Al-6%Mg with 0.8%Fe were 10% and 8%, respectively. These elongations were as good as those obtained during die casting. The amount of decrease in the elongation of the Al-4.5%Mg was smaller than that of the Al-6%Mg. The Al-4.5%Mg is suitable for recycling when the recycled alloy was die-cast.

5.2 Cast-forging

The mechanical properties of the gravity-cast Al-Mg alloys were increased by hot-forging. The tensile strength and the 0.2% proof stress increased as the Mg content increased. The elongation of Al-8%Mg was greater than that of the other Al-Mg alloys considered in this study. The addition of Fe did not degrade the tensile stress or the 0.2% proof stress. The elongation of all alloys except for the Al-8%Mg was degraded by the addition of the Fe. The elongation of the Al-8%Mg with 0.2%Fe was greater than that of the Al-8%Mg, and that of the Al-8%Mg with 0.4%Fe was the same as that of the Al-8%Mg. The elongation of the Al-8%Mg with 0.8%Fe was 15.6%, which is sufficiently large for a forged aluminum alloy. Al-8%Mg is thus suitable for cast-forging.

5.3 Roll casting

As the Mg content was increased, the tensile stress gradually increased, whereas the 0.2% proof stress remained almost constant. The elongation of the Al-8%Mg was greater than those of the other Al-Mg alloys. The LDR decreased as the Mg content increased. Therefore, the Al-4.5%Mg was selected as the most suitable for sheet forming among the roll-cast Al-Mg alloys. The tensile stress of the Al-4.5%Mg was almost uniform for the added Fe content. The 0.2% proof stress gradually increased with increasing Mg content, and the elongation very gradually decreased. The elongations of the Al-4.5%Mg and Al-4.5%Mg with 0.8%Fe were 30.3% and 28.6%, respectively. The LDR was 2.0 until an Fe content of 0.4%, and then it decreased with increasing Fe content for Fe contents greater than 0.6%. This shows that twice-recycled Al-4.5%Mg (Al-4.5%Mg with 0.4%Fe) cast using the roll-caster can be used for sheet forming.

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