



(11)

EP 4 339 316 A1

(12)

EUROPEAN PATENT APPLICATION
published in accordance with Art. 153(4) EPC

(43) Date of publication:
20.03.2024 Bulletin 2024/12

(21) Application number: **22807671.7**

(22) Date of filing: **28.04.2022**

(51) International Patent Classification (IPC):
C22C 21/00 ^(2006.01) **C22F 1/04** ^(2006.01)
B22D 21/04 ^(2006.01) **B22D 17/00** ^(2006.01)

(52) Cooperative Patent Classification (CPC):
B22D 17/00; B22D 21/04; C22C 21/00; C22F 1/04

(86) International application number:
PCT/KR2022/006090

(87) International publication number:
WO 2022/240023 (17.11.2022 Gazette 2022/46)

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME
Designated Validation States:
KH MA MD TN

(30) Priority: **14.05.2021 KR 20210062469**

(71) Applicant: **LG Electronics Inc.**
Yeongdeungpo-gu
Seoul 07336 (KR)

(72) Inventors:
• **KIM, Jihae**
Seoul 06772 (KR)
• **JUNG, Chulho**
Seoul 06772 (KR)
• **SONG, Kichang**
Seoul 06772 (KR)

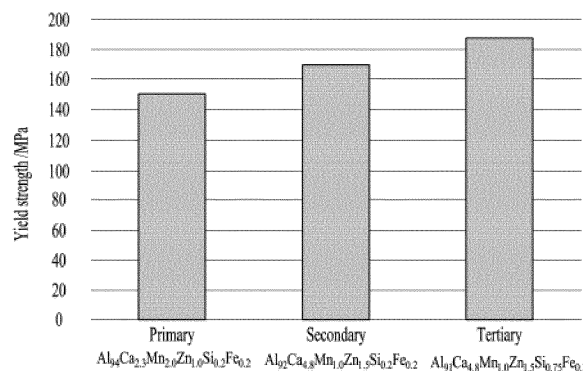
(74) Representative: **Ter Meer Steinmeister & Partner**
Patentanwälte mbB
Nymphenburger Straße 4
80335 München (DE)

(54) **ALUMINUM ALLOY, METHOD FOR MANUFACTURING SAME, AND PARTS USING SAME**

(57) The present invention is applicable to various devices such as home appliances, and relates to an aluminum alloy, a method for manufacturing same, and parts using same. The present invention relates to an aluminum alloy for die casting, comprising 2.0 wt% to 6.0

wt% of calcium (Ca), 1.0 wt% to 3.0 wt% of manganese (Mn), 0.1 wt% to 1.0 wt% of silicon (Si), 0.1 wt% to 0.5 wt% of iron (Fe), balance aluminum (Al), and inevitable impurities, wherein the grain size of the aluminum alloy is 10 μm to 50 μm .

FIG. 2



Description

Technical Field

- 5 **[0001]** The present disclosure is applicable to various devices such as home appliances, and relates to an aluminum alloy, a method for producing the same, and a part using the same.

Background

- 10 **[0002]** Die casting is a precise casting method that manufactures a part or the like of the same shape as a mold by injecting molten metal into the mold that has been precisely processed to match a shape of a component of a device, such as the required part, that is, a casting shape. The parts or products manufactured by such die casting are also referred to as die castings.
- 15 **[0003]** Because such die casting manufactures castings with very accurate dimensions, there is almost no need for a subsequent process such as a surface treatment. Therefore, the die casting may be said to be a casting method suitable for mass-production.
- [0004]** In general, an aluminum alloy is widely used as a material for the die casting. Castings made of the aluminum alloy are used in a wide variety of fields, and various types of aluminum alloys are used depending on main purposes.
- 20 **[0005]** Such aluminum alloy may be used in various parts. For example, a sturdy external product such as a TV stand and various parts used inside home appliances such as a washing machine and a refrigerator may be made of the aluminum alloy.
- [0006]** Therefore, for the aluminum alloy to be used in such external product or various parts, various mechanical properties may be required. For example, corrosion resistance, castability, mechanical strength, and the like at a certain level or higher may be required for the aluminum alloy.
- 25 **[0007]** Additionally, mass-producibility may be required to manufacture the various parts with such aluminum alloy.
- [0008]** For example, a gravity die-casting (GDC) method is not capable of the mass-production. Additionally, in such GDC method, an element such as Ti, Cr, or Zr is used as an additive to achieve grain refinement to improve the corrosion resistance of the aluminum alloy.
- [0009]** Not only are these additives expensive, but a process using these additives may add a process step and increase a process time.
- 30 **[0010]** Therefore, measures to overcome such problems are required.

Summary

Technical Problem

- 35 **[0011]** The present disclosure is to provide an aluminum alloy with improved corrosion resistance and castability, a method for producing the same, and a part using the same.
- [0012]** In addition, the present disclosure is to provide an aluminum alloy that does not require an additional painting process to enhance corrosion resistance thereof, a method for producing the same, and a part using the same.
- 40 **[0013]** In addition, the present disclosure is to provide an aluminum alloy with intermetallic compounds evenly distributed and dispersed, a method for producing the same, and a part using the same.

Technical Solutions

- 45 **[0014]** A first aspect for achieving the above purpose provides an aluminum alloy for die casting including a composition of 2.0 to 6.0 % by weight of calcium (Ca), 1.0 to 3.0 % by weight of manganese (Mn), 0.1 to 1.0 % by weight of silicon (Si), 0.1 to 0.5 % by weight of iron (Fe), balance aluminum (Al), and inevitable impurities, wherein a size of grains of the aluminum alloy is in a range of 10 to 50 μm .
- 50 **[0015]** In one implementation, the composition may further contain 1.0 to 1.5 % by weight of zinc (Zn).
- [0016]** In one implementation, the composition may further contain 0.01 to 0.1 % by weight of magnesium.
- [0017]** In one implementation, the content of manganese may be in a range of 0.8 to 1.5 % by weight.
- [0018]** In one implementation, the content of iron (Fe) may be in a range of 0.1 to 0.3 % by weight.
- [0019]** In one implementation, the composition may not contain at least one of Ti, Zr, and Cr.
- 55 **[0020]** In one implementation, Ti, Zr, and Cr may be materials used for grain refinement during the die casting process.
- [0021]** In one implementation, the content of silicon may be in a range of 0.1 to 0.2 % by weight.
- [0022]** A second aspect for achieving the above purpose provides a part manufactured via die casting with an aluminum alloy includes the aluminum alloy with a composition of 2.0 to 6.0 % by weight of calcium (Ca), 1.0 to 3.0 % by weight

of manganese (Mn), 0.1 to 1.0 % by weight of silicon (Si), 0.1 to 0.5 % by weight of iron (Fe), balance aluminum (Al), and inevitable impurities, wherein a size of grains of the aluminum alloy is in a range of 10 to 50 μm .

[0023] A third aspect for achieving the above purpose provides a method for producing an aluminum alloy using die casting including melting an ingot, cleaning molten metal, injecting the molten alloy into a mold, performing injecting by applying a pressure, and opening the mold and extruding a product, wherein the aluminum alloy has a composition of 2.0 to 6.0 % by weight of calcium (Ca), 1.0 to 3.0 % by weight of manganese (Mn), 0.1 to 1.0 % by weight of silicon (Si), 0.1 to 0.5 % by weight of iron (Fe), balance aluminum (Al), and inevitable impurities.

[0024] In one implementation, the pressure may be in a range of 125 to 130 kgf/cm².

Advantageous Effects

[0025] According to the embodiment of the present disclosure, there are following effects.

[0026] First, according to the embodiment of the present disclosure, the mechanical properties including the corrosion resistance and the castability of the aluminum alloy may be improved.

[0027] In addition, according to the embodiment of the present disclosure, no additional painting process is required to enhance the corrosion resistance of the aluminum alloy, so that the number of processes and the process time may be reduced, thereby reducing the costs.

[0028] In addition, according to the embodiment of the present disclosure, it is to provide the aluminum alloy with the intermetallic compounds evenly distributed and dispersed.

[0029] Furthermore, according to another embodiment of the present disclosure, there are additional effects not mentioned herein. Those of ordinary skill in the art may understand it through the full text of the specification and drawings.

Brief Description of the Drawings

[0030]

FIG. 1 is a diagram showing examples of a product and a part that may be manufactured using an aluminum alloy according to an embodiment of the present disclosure.

FIG. 2 is a graph showing a yield strength of a sample produced using an aluminum alloy according to Present Example of the present disclosure.

FIG. 3 is a photograph of salt spray evaluation and powder detergent evaluation results of spiders manufactured via aluminum alloys according to Present Example and Comparative Example.

FIG. 4 shows photographs of a surface of a spider manufactured via an aluminum alloy according to Comparative Example.

FIG. 5 shows photographs of a surface of a spider manufactured via an aluminum alloy according to Present Example of the present disclosure.

FIG. 6 is a conceptual diagram showing propagation of grains and cracks in an aluminum alloy according to Comparative Example.

FIG. 7 is a conceptual diagram showing propagation of grains and cracks in an aluminum alloy according to Present Example of the present disclosure.

FIG. 8 is a flowchart showing a method for producing an aluminum alloy according to Present Example of the present disclosure.

Detailed Description

[0031] Reference will now be made in detail to embodiments of the present disclosure, examples of which are illustrated in the accompanying drawings. Wherever possible, the same reference numbers will be used throughout the drawings to refer to the same or like parts, and redundant description thereof will be omitted. As used herein, the suffixes "module" and "unit" are added or used interchangeably to facilitate preparation of this specification and are not intended to suggest distinct meanings or functions.

[0032] In describing embodiments disclosed in this specification, relevant well-known technologies may not be described in detail in order not to obscure the subject matter of the embodiments disclosed in this specification. In addition, it should be noted that the accompanying drawings are only for easy understanding of the embodiments disclosed in the present specification, and should not be construed as limiting the technical spirit disclosed in the present specification.

[0033] Furthermore, although the drawings are separately described for simplicity, embodiments implemented by combining at least two or more drawings are also within the scope of the present disclosure.

[0034] In addition, when an element such as a layer, region or module is described as being "on" another element, it is to be understood that the element may be directly on the other element or there may be an intermediate element

between them.

[0035] According to one embodiment of the present disclosure, an aluminum alloy for die casting may be produced with a composition of 2.0 to 6.0 % by weight of calcium (Ca), 1.0 to 3.0 % by weight of manganese (Mn), 0.1 to 1.0 % by weight of silicon (Si), 0.1 to 0.5 % by weight of iron (Fe), balance aluminum (Al), and inevitable impurities.

[0036] In this regard, more specifically, the content of manganese in the above composition may be in a range of 0.8 to 1.5 % by weight. Additionally, more specifically, the content of iron (Fe) in the above composition may be in a range of 0.1 to 0.3 % by weight.

[0037] In other words, the aluminum alloy with improved corrosion resistance and castability may be obtained using the composition presented above, but the corrosion resistance and the castability of the aluminum alloy may be further improved via the more specifically limited contents of manganese and/or iron as described above.

[0038] In one example, such composition of the aluminum alloy for the die casting may further contain 1.0 to 1.5 % by weight of zinc (Zn).

[0039] Additionally, 0.1 to 0.01 % by weight of magnesium may be further contained.

[0040] In other words, according to another embodiment of the present disclosure, the aluminum alloy for the die casting may be produced with the composition of 2.0 to 6.0 % by weight of calcium (Ca), 0.8 to 1.5 % by weight of manganese (Mn), 1.0 to 1.5 % by weight of zinc (Zn), 0.1 to 1.0 % by weight of silicon (Si), 0.1 to 0.3 % by weight of iron (Fe), balance aluminum (Al), and inevitable impurities.

[0041] Such composition of the aluminum alloy for the die casting may not contain at least one of Ti, Zr, and Cr.

[0042] Additionally, such composition of the aluminum alloy for the die casting may not contain Ti, Zr, and Cr.

[0043] Such Ti, Zr, and Cr may be materials used for grain refinement during an aluminum die casting process.

[0044] For example, when producing the aluminum alloy using a gravity die-casting (GDC) method, an element such as Ti, Cr, or Zr, which is an additive, may be added to achieve the grain refinement to improve the corrosion resistance.

[0045] On the other hand, in the present disclosure, the aluminum alloy may be produced using a high pressure die-casting (HPDC) method. As a result, the aluminum alloy with particularly excellent corrosion resistance may be produced.

[0046] The HPDC method used in the present disclosure has a fast cooling speed, so that the grain refinement is achieved without adding the specific element (Ti, Cr, Zr, or the like). Such aluminum alloy according to the present disclosure may exhibit equivalent corrosion resistance when compared to the aluminum alloy produced by the GDC method with the specific element added as the additive.

[0047] As such, in the present disclosure, the aluminum alloy with the excellent corrosion resistance may be realized without adding the specific element (Ti, Cr, Zr, or the like) for the grain refinement. This has a cost reduction effect of an expensive raw material and shortens a production time as an additional flux treatment process is omitted.

[0048] The composition of the aluminum alloy in the present disclosure as described above, a part using the same, and a method for producing the same will be described in detail below with reference to the drawings.

[0049] FIG. 1 is a diagram showing examples of a product and a part that may be manufactured using an aluminum alloy according to an embodiment of the present disclosure.

[0050] Referring to (A) in FIG. 1, the aluminum alloy according to one embodiment of the present disclosure may be used in a part of a washing machine 10. As a specific example, the aluminum alloy may be used in various cast products or parts that may be manufactured via a die casting process.

[0051] Referring to (B) in FIG. 1, a spider 11, which is a part that may be used in the washing machine as in (A) in FIG. 1, is shown. Additionally, referring to (C) in FIG. 1, a hub 12, which is a part that may be used in the washing machine as in (A) in FIG. 1, is shown.

[0052] The spider 11 may be mounted on a driver of the washing machine 10 in a type including a drum type and a top loading type, and the hub 12 may be mounted on a portion of connection with a motor of the washing machine 10.

[0053] The spider 11 and the hub 12 are parts that are continuously driven when the washing machine 10 is in operation and require durability and also corrosion resistance because they may always be in contact with water, a detergent, and the like. Furthermore, glossiness may be important because the spider 11 and the hub 12 are able to be visible from the outside when the washing machine 10 is in operation and are likely to come into contact with laundry.

[0054] Therefore, the durability, the corrosion resistance, the glossiness, as well as castability are very important properties for the part made of such aluminum alloy. Therefore, the composition of the aluminum alloy is required to satisfy a certain level of durability, corrosion resistance, glossiness, and castability.

[0055] The aluminum alloy according to one embodiment of the present disclosure may be used in an external product for an electronic product such as a TV stand, in addition to the washing machine described above. For example, the aluminum alloy may be applied to various parts, such as a base, a bracket, and a cover, constituting the TV stand.

[0056] FIG. 2 is a graph showing a yield strength of a sample produced using an aluminum alloy according to Present Example of the present disclosure.

[0057] When the spider was primarily manufactured using an aluminum alloy with a composition of $\text{Al}_{94}\text{Ca}_{2.3}\text{Mn}_{2.0}\text{Zn}_{1.0}\text{Si}_{0.2}\text{Fe}_{0.2}$, the yield strength was approximately 150 MPa.

[0058] Thereafter, when the content of calcium (Ca) was changed to secondarily produce an aluminum alloy with a

composition of $\text{Al}_{92}\text{Ca}_{4.8}\text{Mn}_{1.0}\text{Zn}_{1.5}\text{Si}_{0.5}\text{Fe}_{0.2}$, the yield strength was approximately 170 MPa, which is higher than that of the primarily manufactured sample. The secondary sample may be produced based on Present Example 1 of the present disclosure.

[0059] In one example, when the spider was manufactured with a tertiary sample with a composition of $\text{Al}_{91}\text{Ca}_{4.8}\text{Mn}_{1.0}\text{Zn}_{1.5}\text{Si}_{0.75}\text{Fe}_{0.2}$ by adjusting the content of silicon (Si), it may be seen that the yield strength was increased to 190 MPa. The tertiary sample may be produced based on Present Example 2 of the present disclosure. Hereinafter, Present Example of the present disclosure may correspond to one or more of Present Example 1 and Present Example 2.

[0060] As such, the contents of potassium (Ca) and silicon (Si), which are some of main components, may be changed in the composition, and the changed composition may be applied to the product such as the spider, depending on a required performance.

[0061] As mentioned above, because the content of silicon (Si) is related to the glossiness of the aluminum alloy product, the content of silicon may be reduced even when the yield strength is reduced to a certain extent within an allowable limit range of the product.

[0062] FIG. 3 is a photograph of salt spray evaluation and powder detergent evaluation results of spiders manufactured via aluminum alloys according to Present Example and Comparative Example.

[0063] In this regard, compositions of the aluminum alloys according to Comparative Example and Present Example of the present disclosure are as shown in Table 1 below.

Table 1

	Al	Si	Mg	Ca	Mn	Fe
Comparative Example	Equal to or lower than 90.0	9.6~10.6	2.5~3.0	-	0.5~0.6	0.6~0.7
Present disclosure	Equal to or higher than 90.0	Equal to or lower than 1.0	Equal to or lower than 0.1	2.0~6.0	1.0~3.0	Equal to or lower than 0.5

[0064] Such composition of the aluminum alloy according to Present Example of the present disclosure summarized in Table 1 is roughly including the composition of the aluminum alloy for the die casting described above.

[0065] That is, the composition of Present Example of the present disclosure summarized in Table 1 may fall within the range of the composition with 2.0 to 6.0 % by weight of calcium (Ca), 1.0 to 3.0 % by weight of manganese (Mn), 0.1 to 1.0 % by weight of silicon (Si), 0.1 to 0.5 % by weight of iron (Fe), balance aluminum (Al), and inevitable impurities.

[0066] In comparison with the above composition, it may be seen that the composition of Comparative Example contains 2.5 to 3.0 % by weight of magnesium (Mg) and 9.6 to 10.5 % by weight of silicon (Si) as main components, and trace amounts of manganese (Mn) and iron (Fe) are added to the composition.

[0067] The salt spray evaluation in FIG. 3 was conducted over 1000 hours. Additionally, the powder detergent evaluation was conducted over 456 hours.

[0068] As shown in the photograph in FIG. 3, the salt spray evaluation and powder detergent evaluation results show that little change in a surface occurred in Present Example of the present disclosure, compared to Comparative Example. In other words, it may be seen that the salt spray evaluation and powder detergent evaluation results were greatly improved compared to the results in the comparative example.

[0069] FIG. 4 shows photographs of a surface of a spider manufactured via an aluminum alloy according to Comparative Example. Additionally, FIG. 5 shows photographs of a surface of a spider manufactured via an aluminum alloy according to Present Example of the present disclosure.

[0070] FIG. 4 shows results of an anodizing experiment of the spider manufactured via the aluminum alloy according to Comparative Example. In addition, FIG. 5 shows results of an anodizing experiment of the spider manufactured via the aluminum alloy according to Present Example of the present disclosure.

[0071] (A) and (B) in each of FIGS. 4 and 5 show a scanning electron microscope (SEM) photograph and an electron probe X-ray microanalyzer (EPMA) photograph, respectively.

[0072] Referring to the anodizing results in FIG. 4, it may be seen that a large amount of precipitates were generated and the surface became rough in the case of aluminum alloy according to Comparative Example. These were confirmed to be precipitates of silicon (Si) and copper (Cu). Precipitates containing silicon as a main component were observed throughout the entire surface. A size of the precipitate was identified to be in a range approximately from 10 to 20 μm . As such, smut may occur because of silicon and pores may occur because of copper. Therefore, it may be seen that it is difficult to render a high-gloss color during the anodizing in Comparative Example.

[0073] On the other hand, referring to the anodizing results of Present Example of the present disclosure shown in FIG. 5, it may be seen that almost no precipitation of silicon and copper occurred. Referring to (A) in FIG. 5, the silicon (Si) precipitates may be seen on a portion of the surface, but the overall surface has a high gloss.

[0074] As such, according to Present Example of the present disclosure, a deep color may be rendered and a clear color expression may be achieved by adjusting a component ratio of silicon (Si), excluding copper (Cu), and minimizing magnesium (Mg).

[0075] FIG. 6 is a conceptual diagram showing propagation of grains and cracks in an aluminum alloy according to Comparative Example, and FIG. 7 is a conceptual diagram showing propagation of grains and cracks in an aluminum alloy according to Present Example of the present disclosure.

[0076] (A) in FIG. 6 schematically shows a surface shape of the aluminum alloy according to Comparative Example. Grains and grain boundaries exist on the surface of such aluminum alloy. In this regard, intermetallic compounds such as Al_6Mn and $Al_{13}Fe_4$ are mainly distributed on the grain boundaries, which have an unstable structure.

[0077] When the cracks propagate for some reason in the aluminum alloy with the structure as in Comparative Example, as shown in (B) in FIG. 6, the intermetallic compounds distributed on the grain boundaries are not able to prevent the propagation of the cracks, which may lead to a decrease in a fracture strength.

[0078] (A) in FIG. 7 schematically shows a surface shape of the aluminum alloy according to Present Example of the present disclosure. It may be seen that the intermetallic compounds are evenly distributed or dispersed across the entire surface in the aluminum alloy according to Present Example of the present disclosure.

[0079] Such aluminum alloy with the intermetallic compounds evenly distributed or dispersed across the entire surface may be achieved by the grain refinement.

[0080] In general, in a case of an aluminum alloy produced by a gravity casting (GC) method or the gravity die-casting (GDC) method, a grain size may be approximately $100\ \mu m$.

[0081] Additionally, in the case of the aluminum alloy produced using the typical high pressure die-casting (HPDC) method, a grain size may be smaller than the grain size described above. Referring to (A) in FIG. 7, it may be seen that the grain size has been greatly reduced compared to that in FIG. 6.

[0082] In this regard, when the cracks occur along the grain boundaries, as shown in (B) in FIG. 7, the crack may not continue to propagate along the grain boundaries and may stop at a certain level. As a result, the fracture strength of the aluminum alloy may be improved.

[0083] The grain size of such aluminum alloy according to Present Example of the present disclosure may be in a range of 10 to $50\ \mu m$. Additionally, because the intermetallic compounds are evenly distributed or dispersed across the entire surface of the aluminum alloy, the intermetallic compounds may be located inside such grains. That is, according to Present Example of the present disclosure, mechanical properties of the aluminum alloy may be improved based on the size of the refined grain.

[0084] Normally, corrosion of metals, including the aluminum alloy, may occur via a process of pitting → propagation → re-passivation. Additionally, the pitting may mainly occur at the grain boundaries.

[0085] When the number of grain boundaries on the entire surface of the metal is small, that is, when the size of the grains is great, connection of the grain boundaries is clear, and a phenomenon in which the pitting greatly propagates along an area of the grain boundaries is able to occur (corrosion propagation).

[0086] However, as in the case of the aluminum alloy according to Present Example of the present disclosure, when the grains are refined, the grain boundaries may become unclear (the boundaries may be broken intermittently) and the propagation may stop after the pitting occurs.

[0087] Such aluminum alloy according to Present Example of the present disclosure may not contain at least one of Ti, Zr, and Cr. Characteristically, the aluminum alloy according to Present Example of the present disclosure may not contain all of Ti, Zr, and Cr.

[0088] Ti, Zr, and Cr may be materials related to the grain refinement, but according to Present Example of the present disclosure, a desired level of the grain refinement may be achieved without containing Ti, Zr, and Cr.

[0089] As mentioned above, the grain size of the aluminum alloy according to Present Example of the present disclosure may be in the range of 10 to $50\ \mu m$.

[0090] In one example, as described above with respect to the secondary sample (Present Example 1), the content of silicon (Si) in the aluminum alloy may be 0.2 % by weight or smaller. For example, the content of silicone may be in a range of 0.1 to 0.2 % by weight.

[0091] Silicon (Si) is a unique raw material and has a color (dark gray). Therefore, as the content of silicon increases, the unique color of the silicon element may appear on the alloy surface. For example, as the content of silicon increases, stains resulted from silicon or the precipitates thereof may occur on the alloy surface.

[0092] Therefore, depending on Examples, when high glossiness is required, the content of silicon may be lowered.

[0093] According to Present Example of the present disclosure, when the aluminum alloy has the composition described above and the content of silicon is in the range of 0.1 to 0.2 % by weight, such aluminum alloy may be used in a product or a part that has sufficient mechanical properties and high gloss.

[0094] The aluminum alloy according to Present Example of the present disclosure as described above may be produced to have the composition described above. In addition, the aluminum alloy according to Present Example of the present disclosure having the above characteristics may be produced with the composition described above and a

production method to be described below. Characteristics of such production method will be described in detail below.
[0095] FIG. 8 is a flowchart showing a method for producing an aluminum alloy according to Present Example of the present disclosure.

[0096] Referring to FIG. 8, the method for producing the aluminum alloy using the die casting according to Present Example of the present disclosure may include melting an ingot (S10), cleaning the molten metal (S20), injecting (pouring) the molten alloy into a mold (S30), performing injection by applying a pressure (a high-pressure injection) (S40), and opening the mold and extruding the product after solidification (S50).

[0097] With this production method, the aluminum alloy with the composition of 2.0 to 6.0 % by weight of calcium (Ca), 1.0 to 3.0 % by weight of manganese (Mn), 0.1 to 1.0 % by weight of silicon (Si), 0.1 to 0.5 % by weight of iron (Fe), the remaining aluminum (Al), and inevitable impurities as described above may be produced.

[0098] Such aluminum alloy production method may use the high pressure die-casting (HPDC) method. As a result, the aluminum alloy with the particularly excellent corrosion resistance may be produced.

[0099] The HPDC method used in the present disclosure has the fast cooling speed, so that the grain refinement is achieved without adding the specific element (Ti, Cr, Zr, or the like). The aluminum alloy according to Present Example of the present disclosure may exhibit the equivalent corrosion resistance when compared to the aluminum alloy produced by the GDC method with the specific element added as the additive.

[0100] As such, in the present disclosure, the aluminum alloy with the excellent corrosion resistance may be realized without adding the specific element (Ti, Cr, Zr, or the like) for the grain refinement. This has the cost reduction effect of the expensive raw material and shortens the production time as the additional flux treatment process is omitted.

[0101] Hereinafter, the method for producing the aluminum alloy using the die casting according to Present Example of the present disclosure will be briefly described.

[0102] First, the melting of the ingot (S10) may correspond to a process of melting the raw materials to achieve the composition described above. Such melting process may occur at approximately 700 °C.

[0103] Thereafter, the cleaning of the molten metal (S20) may include a process of removing dross after adding a degassing agent to the ingot.

[0104] Then, in the pouring of the molten alloy (S30), the molten alloy is injected into the mold.

[0105] Thereafter, the performing of the injection (S40) may be performed by applying the pressure to push the molten alloy into the mold at the high-pressure.

[0106] In general, in the HPDC method, pressure setting in a range of 9.5 MPa (97 kgf/cm²) to 13.5 MPa (138 kgf/cm²) is possible.

[0107] Present Example of the present disclosure is characterized in that a pressure in a range of 125 to 130 kgf/cm² is used for the grain refinement. In other words, the pressure in the range of 125 to 130 kgf/cm² may be used during the molding process to achieve the desired level of grain refinement without adding the specific element (Ti, Cr, Zr, or the like). Additionally, such pressure condition may be related to the alloy composition described above.

[0108] A target fracture strength may be achieved using such alloy composition and/or pressure condition. In other words, the grain refinement may be achieved using such alloy composition and/or pressure condition, so that the inter-metallic compounds (Al₃Fe/Al₄Mn or Al₆Mn and Al₁₃Fe₄) are evenly dispersed, thereby improving the strength of the aluminum alloy.

[0109] Thereafter, in the opening of the mold and extruding the product (S50), after the molten alloy material is solidified, a cooling process is performed and the mold is opened to take out the product.

[0110] In this regard, in the opening of the mold and extruding the product (S50), a cooling time of the aluminum alloy may be shorter than that (usually about 10 seconds) of an existing production method. Because of such fast cooling speed, a grain growth may be completed in a short time. Therefore, the grain size may be reduced to the desired level. The cooling time of such aluminum alloy may be 3 to 5 seconds.

[0111] For the grain to be created during the production process of the aluminum alloy, a metal nucleus must be created and grow and the grain boundary must be formed at a boundary of the growth where the growth meets a growth of another nucleus.

[0112] For example, when a total amount of specific material that may become grains is 100, for example, even with 5 nuclei, the total amount may be reached via the grain growth when the cooling speed is slow. However, when the cooling speed is fast, the grain growth is suppressed and the total amount is not able to be reached. In this case, more than 5 nuclei are needed to achieve thermodynamic equilibrium, and the total amount may be reached with more than 5 nuclei. In other words, the grains may be refined.

[0113] In other words, the grain may be refined because the grain growth is completed in a short time. Additionally, the mechanical properties of the aluminum alloy may be improved with such grain refinement.

[0114] As described above, according to the embodiment of the present disclosure, the aluminum alloy with the excellent corrosion resistance may be realized without adding the specific element (Ti, Cr, or Zr) for the grain refinement.

[0115] As a result, in addition to the cost reduction effect of the raw material, the process such as the additional flux treatment may be omitted, so that the production time is shortened.

[0116] Additionally, according to the embodiment of the present disclosure, the aluminum alloy with the improved corrosion resistance and castability may be provided.

[0117] Additionally, according to the embodiment of the present disclosure, the aluminum alloy with the improved corrosion resistance while maintaining the strength and the castability of the existing aluminum alloy may be provided.

[0118] In this regard, the additional painting process may not be required to enhance the corrosion resistance.

[0119] As such, according to the embodiment of the present disclosure, the aluminum alloy casting with high corrosion resistance, castability, and strength may be provided.

[0120] Using such improved aluminum alloy, the spider, a door hinge, or the like of the washing machine may be manufactured.

[0121] In addition, according to the embodiment of the present disclosure, the high-gloss anodizing casting that may be manufactured via the die casting may be provided. Such casting may be used to manufacture various appliances (the TV stand or the like) and the external product for the home appliances.

[0122] The above description is merely illustrative of the technical spirit of the present disclosure. It will be apparent to those skilled in the art that various modifications and variations can be made in the present disclosure without departing from the spirit and scope of the disclosure.

[0123] Therefore, the embodiments disclosed in the present disclosure are merely illustrative of the technical spirit of the present disclosure. The scope of the technical spirit of the present disclosure is not limited by these embodiments.

[0124] The scope of the present disclosure should be construed by the appended claims, and all technical ideas within the scope equivalent thereto should be construed as being within the scope of the present disclosure.

Industrial applicability

[0125] The present disclosure may be applied to various devices such as the home appliances, and may provide the aluminum alloy, the method for producing the same, and the part using the same.

Claims

1. An aluminum alloy for die casting, the aluminum alloy comprising:

a composition of 2.0 to 6.0 % by weight of calcium (Ca), 1.0 to 3.0 % by weight of manganese (Mn), 0.1 to 1.0 % by weight of silicon (Si), 0.1 to 0.5 % by weight of iron (Fe), balance aluminum (Al), and inevitable impurities, wherein a size of grains of the aluminum alloy is in a range of 10 to 50 μm .

2. The aluminum alloy of claim 1, wherein the composition further contains 1.0 to 1.5 % by weight of zinc (Zn).

3. The aluminum alloy of claim 1, wherein the composition further contains 0.01 to 0.1 % by weight of magnesium.

4. The aluminum alloy of claim 1, wherein the content of manganese is in a range of 0.8 to 1.5 % by weight.

5. The aluminum alloy of claim 1, wherein the content of iron (Fe) is in a range of 0.1 to 0.3 % by weight.

6. The aluminum alloy of claim 1, wherein the composition does not contain at least one of Ti, Zr, and Cr.

7. The aluminum alloy of claim 1, wherein Ti, Zr, and Cr are materials used for grain refinement during the die casting process.

8. The aluminum alloy of claim 1, wherein the content of silicon is in a range of 0.1 to 0.2 % by weight.

9. A part manufactured via die casting with an aluminum alloy, the part comprising:

the aluminum alloy with a composition of 2.0 to 6.0 % by weight of calcium (Ca), 1.0 to 3.0 % by weight of manganese (Mn), 0.1 to 1.0 % by weight of silicon (Si), 0.1 to 0.5 % by weight of iron (Fe), balance aluminum (Al), and inevitable impurities, wherein a size of grains of the aluminum alloy is in a range of 10 to 50 μm .

10. The part of claim 9, wherein the composition further contains 1.0 to 1.5 % by weight of zinc (Zn).

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11. The part of claim 9, wherein the composition further contains 0.01 to 0.1 % by weight of magnesium.

12. The part of claim 9, wherein the content of silicon is in a range of 0.1 to 0.2 % by weight.

5 13. The part of claim 9, wherein the composition does not contain at least one of Ti, Zr, and Cr.

14. The part of claim 9, wherein the content of manganese is in a range of 0.8 to 1.5 % by weight.

10 15. The part of claim 9, wherein the content of iron (Fe) is in a range of 0.1 to 0.3 % by weight.

16. A method for producing an aluminum alloy using die casting, the method comprising:

melting an ingot;

cleaning molten metal;

15 injecting the molten alloy into a mold;

performing injecting by applying a pressure; and

opening the mold and extruding a product,

wherein the aluminum alloy has a composition of 2.0 to 6.0 % by weight of calcium (Ca), 1.0 to 3.0 % by weight of manganese (Mn), 0.1 to 1.0 % by weight of silicon (Si), 0.1 to 0.5 % by weight of iron (Fe), balance aluminum (Al), and inevitable impurities.

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17. The method of claim 16, wherein the pressure is in a range of 125 to 130 kgf/cm².

18. The method of claim 16, wherein a size of grains of the aluminum alloy is in a range of 10 to 50 μ m.

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19. The method of claim 16, wherein the content of silicon is in a range of 0.1 to 0.2 % by weight.

20. The method of claim 16, wherein the composition does not contain at least one of Ti, Zr, and Cr.

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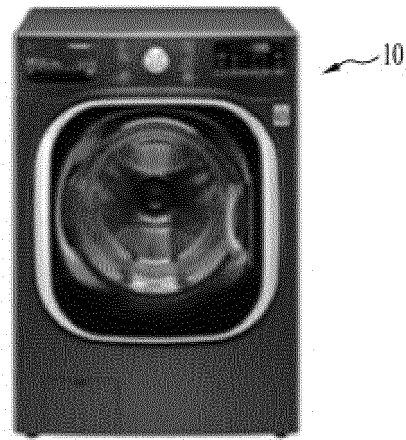
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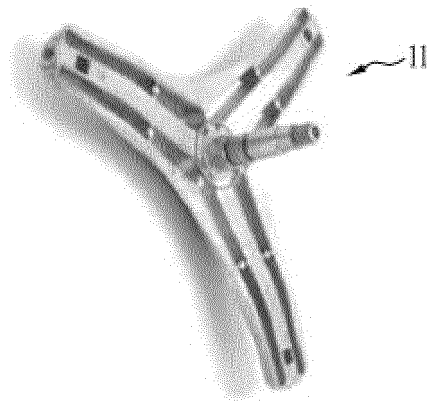
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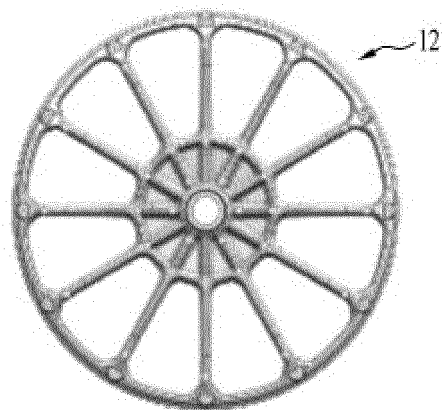
FIG. 1



(A)



(B)



(C)

FIG. 2

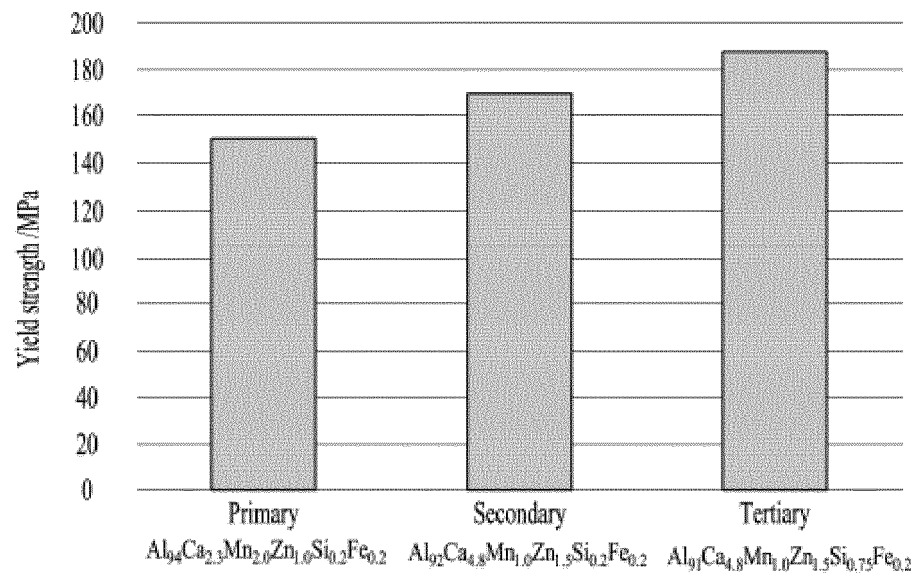
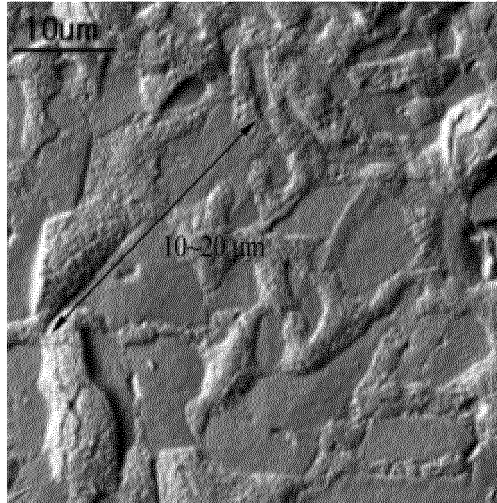


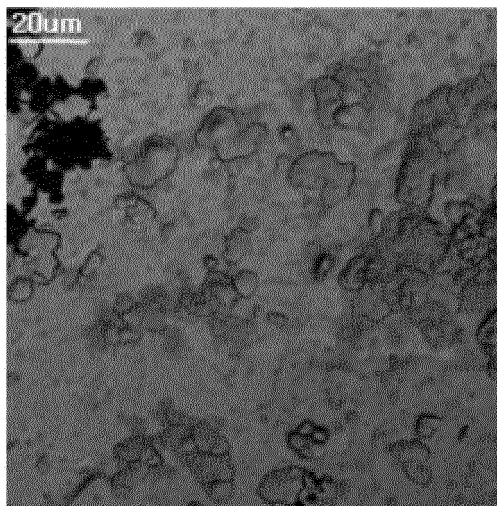
FIG. 3

Division	Comparative example	Present example
Salt spray evaluation results (1000h)		
Powder detergent evaluation results (456h)		

FIG. 4

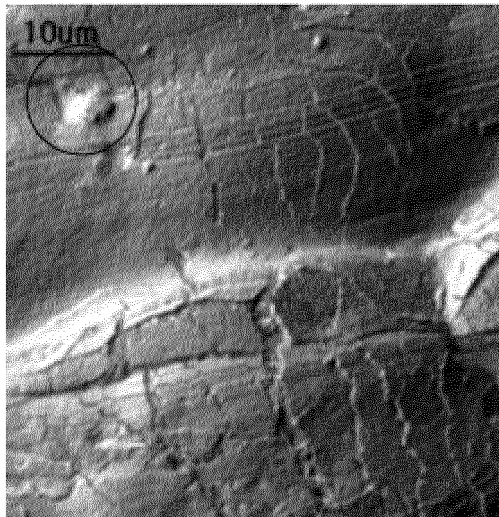


(A)

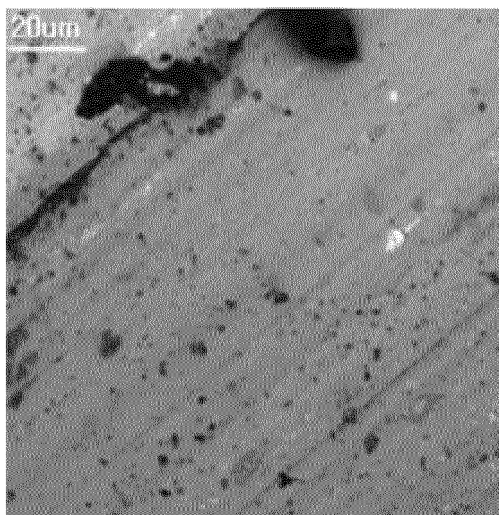


(B)

FIG. 5



(A)



(B)

FIG. 6

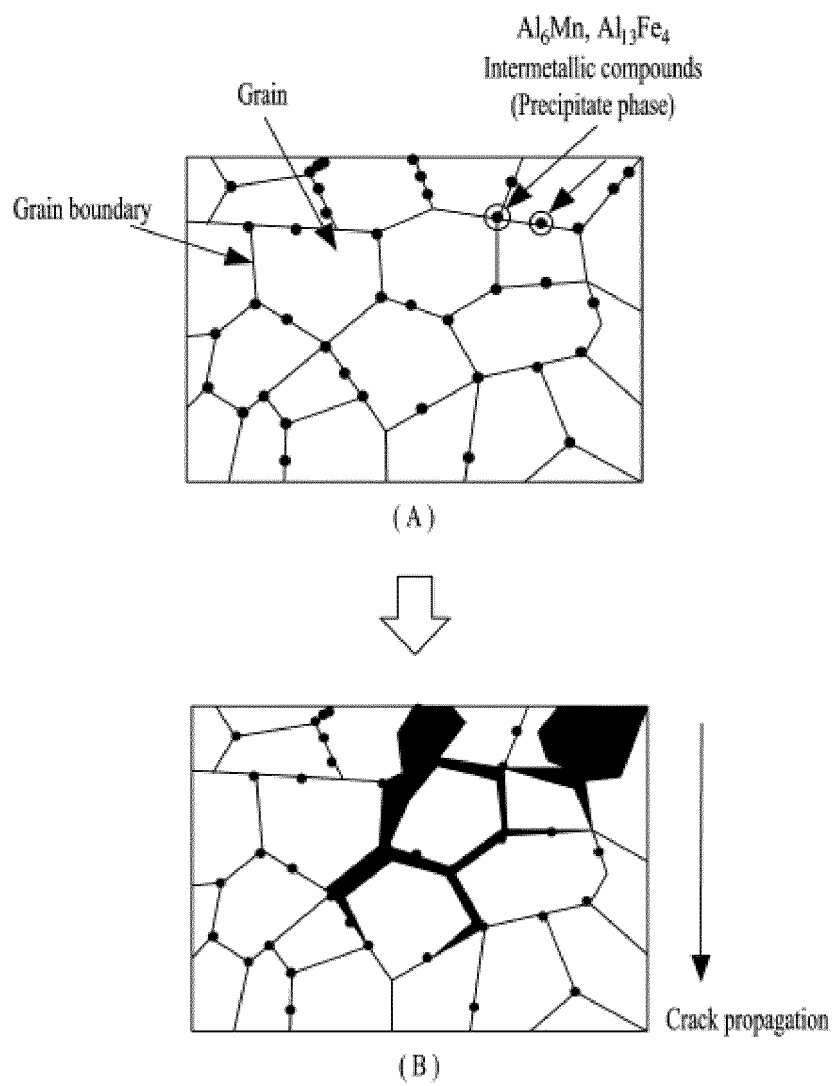


FIG. 7

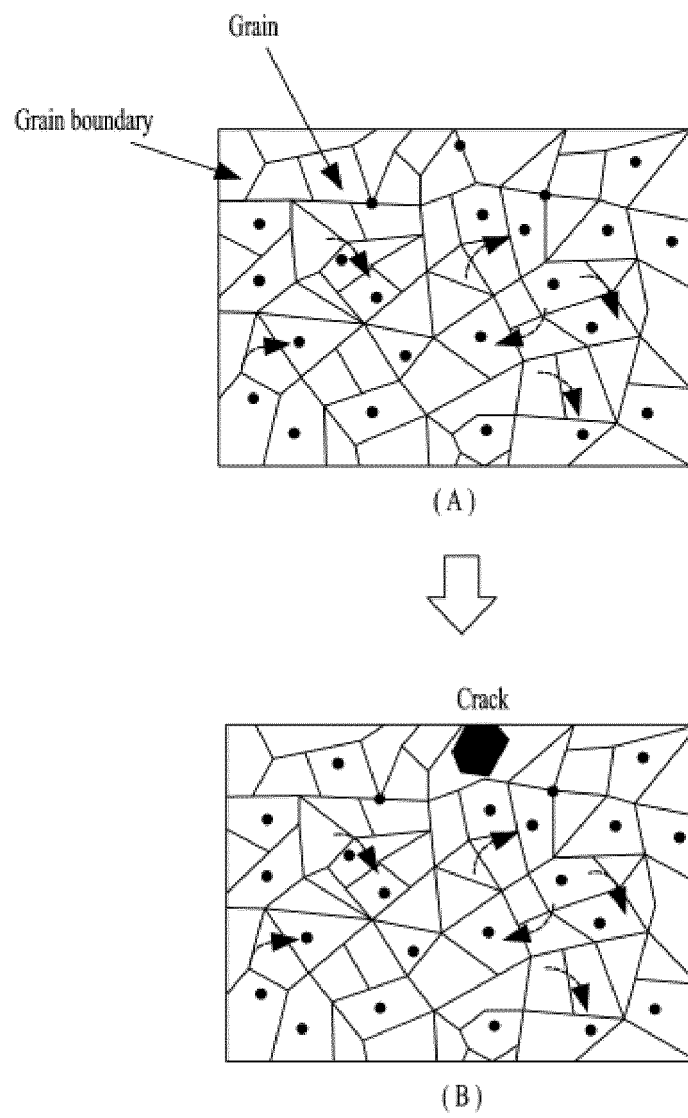
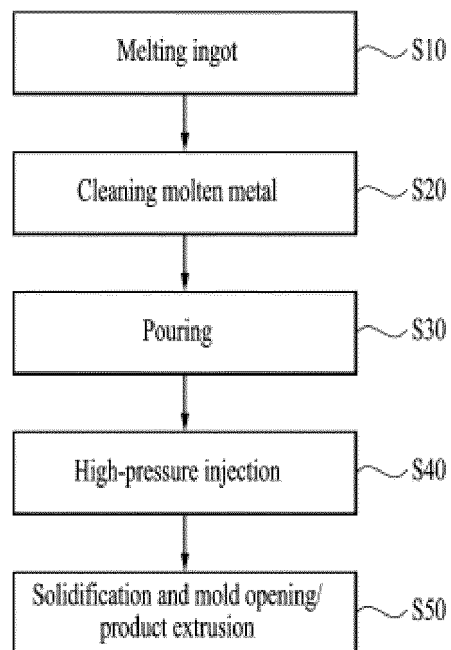


FIG. 8



INTERNATIONAL SEARCH REPORT

International application No.

PCT/KR2022/006090

A. CLASSIFICATION OF SUBJECT MATTER

C22C 21/00(2006.01)i; C22F 1/04(2006.01)i; B22D 21/04(2006.01)i; B22D 17/00(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

C22C 21/00(2006.01); B22D 17/00(2006.01); C22C 1/03(2006.01); C22C 21/02(2006.01); C22C 21/06(2006.01);
C22C 21/08(2006.01); C22C 21/10(2006.01)

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Korean utility models and applications for utility models: IPC as above
Japanese utility models and applications for utility models: IPC as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

eKOMPASS (KIPO internal) & keywords: 알루미늄(aluminum), 칼슘(calcium), 망간(manganese), 실리콘(silicon), 철(iron), 아연(zinc), 마그네슘(magnesium), 다이캐스팅(die casting), 압력(pressure), 결정립(grain)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 4126448 A (MOORE et al.) 21 November 1978 (1978-11-21) See claims 1, 3 and 10.	1-20
A	JP 2000-355722 A (NIPPON LIGHT METAL CO., LTD. et al.) 26 December 2000 (2000-12-26) See paragraph [0012] and claim 4.	1-20
A	CN 102796925 A (GUANGDONG HONGTAI TECHNOLOGY CO., LTD. et al.) 28 November 2012 (2012-11-28) See claim 1.	1-20
A	KR 10-2004-0068021 A (ALUMINIUM RHEINFELDEN GMBH) 30 July 2004 (2004-07-30) See paragraph [0035] and claim 1.	1-20
A	JP 2004-162140 A (TOYOTA MOTOR CORP. et al.) 10 June 2004 (2004-06-10) See paragraph [0038] and claim 1.	1-20

☐ Further documents are listed in the continuation of Box C.☒ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

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"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

18 August 2022

Date of mailing of the international search report

22 August 2022

Name and mailing address of the ISA/KR

Korean Intellectual Property Office
Government Complex-Daejeon Building 4, 189 Cheongsaro, Seo-gu, Daejeon 35208

Facsimile No. +82-42-481-8578

Authorized officer

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.

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		US 6824737 B2	30 November 2004
JP 2004-162140 A	10 June 2004	None	

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