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(54) ALUMINUM ALLOY FOR DIE CASTING, AND DIE-CAST ALUMINUM ALLOY USING SAME

(57) Provided are an aluminum alloy for die casting, suitable for important safety-related components in automobiles without significantly worsening corrosion resistance even though containing Cu at a ratio capable of providing an effect of improving mechanical characteristics, and an aluminum alloy die cast obtained through die-casting the alloy. More specifically, the present invention is directed to an aluminum alloy for die casting containing, in wt%, $0.03\% < Cu \leq 0.7\%$, $6.0\% < Si \leq 11.0\%$, $0.15\% \leq Mg \leq 0.50\%$, $0.05\% \leq Fe \leq 0.6\%$, $0.05\% \leq Ti \leq 0.25\%$, $Mn \leq 0.8\%$, $0.10\% \leq Cr \leq 0.40\%$, and, for the remaining portion, Al and unavoidable impurities.

Fig. 2

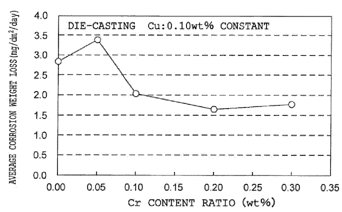

Fig.2-1 RELATIONSHIP BETWEEN CORROSION RESISTANCE AND Cr CONTENT RATIO AFTER DIE-CASTING

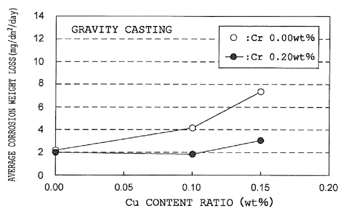

Fig.2-2 RELATIONSHIP BETWEEN CORROSION RESISTANCE AND Cu,Cr CONTENT RATIO AFTER GRAVITY CASTING

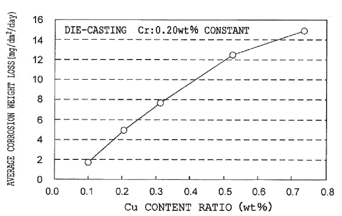

Fig.2-3 RELATIONSHIP BETWEEN CORROSION RESISTANCE AND Cu CONTENT RATIO AFTER DIE-CASTING

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Description

TECHNICAL FIELD

[0001] The present invention relates to an aluminum alloy for die casting, having excellent mechanical properties and corrosion resistance, and an aluminum alloy die cast produced using the alloy.

BACKGROUND ART

[0002] Since aluminum alloys are lightweight and superior in moldability and mass producibility, aluminum alloys are widely used as a material for components in various fields such as automobiles, industrial machines, aircrafts, and electrical home appliances.

[0003] Among those, in automotive applications, for the purpose of weight reduction of a vehicle body and fuel savings associated therewith, application of aluminum alloy die casts to the body and suspension parts has expanded. Components using aluminum alloys have been adopted in large numbers in recent years as described above. On the other hand, since such components are mostly important safety-related components, there are demands regarding not only mechanical characteristics such as proof strength and ductility, but also corrosion resistance for withstanding usage over an extended period of time in view of the required durability and usage environments. Although existing alloys can satisfy mechanical properties demanded for such components, there are situations where satisfactory corrosion resistance cannot be provided.

[0004] One example of a technology for solving such a problem proposed as a suitable material for safety constituent elements such as automobile wheels (car wheels) is, as disclosed in the following Patent Literature 1, an aluminum alloy for die cast containing silicon by 9.5 to 11.5 wt%, magnesium by 0.1 to 0.5 wt%, manganese by 0.5 to 0.8 wt%, iron by 0.15 wt% at maximum, copper by 0.03 wt% at maximum, zinc by 0.10 wt% at maximum, titanium by 0.15 wt% at maximum, and, as the remaining portion, aluminum and 30 to 300 ppm of strontium as a permanent atomization agent.

[0005] According to this technology, since the content ratio of Cu that causes corrosion of an aluminum alloy through galvanic action is limited to 0.03 wt% at maximum, an aluminum alloy for die cast having high corrosion resistance can be provided.

CITATION LIST

[PATENT LITERATURE]

[0006] [PTL 1] Japanese Patent No. 3255560

SUMMARY OF THE INVENTION

PROBLEMS TO BE SOLVED BY THE INVENTION

[0007] However, when the content ratio of Cu is limited as described above in order to improve corrosion resistance, usage of a scrap material becomes practically impossible, resulting in not only the inability to economically produce an aluminum alloy but also a hindrance for building a recycling-oriented society. Although Cu has the effect of improving mechanical characteristics such as tensile strength and 0.2%-proof strength of an aluminum alloy, such effect cannot be expected when the content ratio of Cu is limited to not higher than 0.03 wt%.

[0008] Thus, the main objective of the invention is to provide an aluminum alloy for die casting, suitable for important safety-related components in automobiles without significantly worsening corrosion resistance even though containing Cu at a ratio capable of providing an effect of improving mechanical characteristics, and an aluminum alloy die cast obtained through die-casting the alloy.

SOLUTION TO THE PROBLEMS

[0009] A first aspect of the present invention is an aluminum alloy for die casting "containing, in wt%, $0.03\% < Cu \leq 0.7\%$, $6.0\% < Si \leq 11.0\%$, $0.15\% \leq Mg \leq 0.50\%$, $0.05\% \leq Fe \leq 0.6\%$, $0.05\% \leq Ti \leq 0.25\%$, $Mn \leq 0.8\%$, $0.10\% \leq Cr \leq 0.40\%$, and, for the remaining portion, Al and unavoidable impurities".

[0010] With this aspect, since Cu can be contained within a range higher than 0.03 wt% but not higher than 0.7 wt%, usage of a recycled material becomes possible, and mechanical characteristics such as tensile strength and 0.2%-proof strength can be improved in particular. In addition to containing Cu within the above described range, since Cr is contained by not lower than 0.10 wt% but not higher than 0.40 wt%, deterioration of corrosion resistance can be prevented.

[0011] As described above, with the present invention, by simply containing seven types of elemental components at a predetermined ratio, as a result of an interaction from those, an ingot of an aluminum alloy for die casting having not only excellent castability and mechanical characteristics but also excellent corrosion resistance can be produced safety and easily.

[0012] With respect to aluminum alloy for die casting of the present invention, preferably, at least one selected from Na, Sr, and Ca is added by 30 to 200 ppm, and Sb is added by 0.05 to 0.20 wt%. By doing so, it is possible to reduce the size of particles of eutectic Si and further improve strength and toughness of the aluminum alloy.

[0013] In addition, adding B by 1 to 50 ppm is also preferable. By doing so, crystal grains of the aluminum alloy can be miniaturized even when the amount of Si is particularly small and when a casting method having a low cooling rate is used, and, as a result, elongation of the aluminum alloy can be improved.

[0014] A second aspect of the present invention is an aluminum alloy die cast obtained through die-casting the aluminum alloy for die casting according to the first aspect.

[0015] Since the aluminum alloy die cast obtained through die-casting the aluminum alloy for die casting of the present invention can be mass produced with fine castability and is superior in not only mechanical properties such as tensile strength and hardness but also in corrosion resistance; the aluminum alloy die cast is most suitable in use applications such as, for example, important safety-related components for automobiles.

ADVANTAGEOUS EFFECTS OF THE INVENTION

[0016] With the present invention, an aluminum alloy for die casting, suitable for such as important safety-related components in automobiles without significantly worsening corrosion resistance even though containing Cu at a ratio capable of providing an effect of improving mechanical characteristics, and an aluminum alloy die cast obtained through die-casting the alloy can be provided.

BRIEF DESCRIPTION OF THE DRAWINGS

[0017]

[FIG. 1] FIG. 1 includes graphs each showing the relationship between content ratio of Cu and a mechanical characteristic in an aluminum alloy for die casting.

[FIG. 2] FIG. 2 includes graphs showing the relationship between corrosion resistance and the content ratios of Cu and Cr in an aluminum alloy for die casting.

[FIG. 3] FIG. 3 includes graphs each showing the relationship between content ratio of Ti and a mechanical characteristic in an aluminum alloy for die casting.

DESCRIPTION OF EMBODIMENTS

[0018] In the following, embodiments of the present invention will be described in detail with specific examples.

[0019] An aluminum alloy for die casting of the present invention (hereinafter, also simply referred to as "aluminium alloy") contains, in wt%, 0.03% < Cu (copper) ≤ 0.7%, 6.0% < Si (silicon) ≤ 11.0%, 0.15% ≤ Mg (magnesium) ≤ 0.50%, 0.05% ≤ Fe (iron) ≤ 0.6%, 0.05% ≤ Ti (titanium) ≤ 0.25%, Mn (manganese) ≤ 0.8%, 0.1% ≤ Cr (chromium) ≤ 0.4%, and, for the remaining portion, Al (aluminum) and unavoidable impurities as approximately. In the following, properties of each of the elements will be described.

[0020] Cu (copper) is an important element for improving abrasion resistance, mechanical strength, and hardness of an aluminum alloy.

[0021] The content ratio of Cu with respect to the whole weight of the aluminum alloy is preferably within a range of higher than 0.03 wt% but not higher than 0.7 wt% as described above. When the content ratio of Cu is not higher than 0.03 wt%, the effect of improving the mechanical characteristics described above cannot be obtained, whereas, when the content ratio of Cu is higher than 0.7 wt%, problems occur such as a significant reduction in corrosion resistance, reduction in elongation, increase in specific gravity, and increase in raw-material cost.

[0022] It should be noted that when a particularly high corrosion resistance is necessary for an aluminum alloy to be obtained, the content ratio of Cu is preferably set within a range of higher than 0.03 wt% but not higher than 0.2 wt%.

[0023] Si (silicon) is an important element for improving castability and ensuring fluidity when the aluminum alloy is molten.

[0024] The content ratio of Si with respect to the whole weight of the aluminum alloy is preferably within a range of not lower than 6.0 wt% but not higher than 11.0 wt% as described above. When the content ratio of Si is lower than 6.0 wt%, ensuring fluidity of a molten metal becomes difficult, and, when cases regarding molding with an ordinary die casting that is used frequently in general are considered, application to large-sized components is hampered. On the other hand, when the content ratio of Si is higher than 11.0 wt%, elongation of the alloy is reduced.

[0025] Within an aluminum alloy, Mg (magnesium) mainly exists as Mg_2Si or in a solid-solution state in an Al base metal, and is a component that provides proof strength and tensile strength to the aluminum alloy but, when being contained by an excessive amount, has an adverse effect on castability and corrosion resistance.

[0026] The content ratio of Mg with respect to the whole weight of the aluminum alloy is preferably within a range of not lower than 0.15 wt% but not higher than 0.5 wt% as described above. When the content ratio of Mg is lower than 0.15 wt%, the advantageous effect described above cannot be sufficiently obtained, whereas when the content ratio of Mg is higher than 0.5 wt%, elongation and corrosion resistance of the alloy are reduced.

[0027] Fe (iron) is known to have a soldering prevention effect during die-casting. However, Fe causes crystallization of a needle shape crystal in the form of Al-Si-Fe, reduces the toughness of the aluminum alloy, and, when being added in a large quantity, causes melting to be difficult at a suitable temperature.

[0028] The content ratio of Fe with respect to the whole weight of the aluminum alloy is preferably within a range from 0.05 to 0.6 wt% as described above. When the content ratio of Fe is lower than 0.05 wt%, the soldering prevention effect during die-casting becomes insufficient, whereas when the content ratio of Fe is higher than 0.6 wt%, although the soldering prevention effect becomes sufficient, toughness of the alloy reduces and the melting temperature rises to cause deterioration of castability.

[0029] Ti (titanium) has an effect of miniaturizing crystal grains, and is generally said to be an element capable of reducing casting cracks and particularly improving elongation among the mechanical characteristics.

[0030] The content ratio of Ti with respect to the whole weight of the aluminum alloy is preferably within a range of not lower than 0.05 wt% but not higher than 0.25 wt% as described above. When the content ratio of Ti is lower than 0.05 wt%, miniaturizing crystal grains in the aluminum alloy becomes difficult, whereas when the content ratio of Ti is higher than 0.25 wt%, melting of the aluminum alloy becomes difficult, and the aluminum alloy may partially remain not melted.

[0031] As described later, with the aluminum alloy having the composition of the present invention, a new finding was uncovered in which, as a result of an interaction within the component composition, associated with an increase in the content ratio Ti within a range of not higher than about 0.25 wt%, tensile strength and 0.2%-proof strength of the aluminum alloy improve while the elongation is almost completely not affected.

[0032] Similarly to Fe described above, Mn (manganese) is used mainly for preventing soldering of the aluminum alloy and a mold during die-casting. Similarly to Fe, Mn also causes melting to be difficult at a suitable temperature when being contained in a large quantity. Thus, in the present invention, the content ratio of Mn with respect to the whole weight of the aluminum alloy is limited to not higher than 0.8 wt%.

[0033] It should be noted that, although describing a limitation regarding the lower limit of the content ratio of Mn in particular is not necessary, Mn is preferably contained by not lower than 0.2 wt% in order to significantly exert the soldering prevention effect.

[0034] Similarly to Fe and Mn described above, in addition to preventing soldering of the aluminum alloy and a mold during die-casting, Cr (chromium) is an element having an effect of improving corrosion resistance of the alloy.

[0035] The content ratio of Cr with respect to the whole weight of the aluminum alloy is preferably within a range of not lower than 0.1 wt% but not higher than 0.4 wt% as described above. When the content ratio of Cr is lower than 0.1 wt%, the advantageous effect described above cannot be sufficiently obtained, whereas when the content ratio of Cr is higher than 0.4 wt%, no further addition effect can be obtained even when the added amount is increased.

[0036] When the content ratios of Cu, Si, Mg, Fe, Ti, Mn, and Cr are adjusted in accordance with the content ratios described above, it is possible to obtain a base metal of an aluminum alloy for die cast having, with a highly safe but simple formulation, not only excellent castability and mechanical characteristics but also excellent corrosion resistance.

[0037] Other than each of the elemental components described above, at least one element selected from the group consisting of Na (sodium), Sr (strontium), Ca (calcium), and Sb (antimony) may be added as a modification material. By adding such a modification material, it is possible to reduce the size of eutectic Si particles, and further improve strength and toughness of the aluminum alloy.

[0038] The added ratio of the modification material with respect to the whole weight of the aluminum alloy is preferably within a range of 30 to 200 ppm when the modification material is Na, Sr, and Ca, and within a range of 0.05 to 0.20 wt% when the modification material is Sb. When the added ratio of the modification material is lower than 30 ppm (0.05 wt% in the case with Sb), miniaturizing eutectic Si particles in the aluminum alloy becomes difficult, whereas when the added ratio of the modification material is higher than 200 ppm (0.20 wt% in the case with Sb), eutectic Si particles in the aluminum alloy are sufficiently miniaturized, and no further addition effect can be obtained even when the added amount is increased.

[0039] Furthermore, B (boron) may be added instead of or together with the modification material. By adding B in such manner, the crystal grains of the aluminum alloy are miniaturized, and elongation of the alloy can be improved. It should be noted that such an advantageous effect becomes significant when the amount of Si is small and when a casting method having a low cooling rate is used.

[0040] The added ratio of B with respect to the whole weight of the aluminum alloy is preferably within a range from 1 to 50 ppm. When the added ratio of B is lower than 1 ppm, miniaturizing crystal grains in the aluminum alloy becomes difficult, whereas when the added ratio of B is higher than 50 ppm, crystal grains in the aluminum alloy are sufficiently miniaturized, and no further addition effect can be obtained even when the added amount is increased.

[0041] When the aluminum alloy for die casting of the present invention is to be produced, first, a raw material designed to contain, at the predetermined ratio described above, each of the elemental components of Al, Cu, Si, Mg, Fe, Ti, Mn, and Cr is prepared (if necessary, the modification material, etc., described above may be added). Next, the raw material is placed in a melting furnace such as a sealed melting furnace or a melting furnace with a fore hearth to melt the elemental components. With respect to the melted raw material, i.e., molten metal of the aluminum alloy, refinement treatments such as an inclusion removal treatment and a dehydrogenation treatment are performed if necessary. Then, the refined molten metal is casted in a predetermined mold and solidified in order to form the molten metal of the aluminum alloy into an alloy base metal ingot and the like.

[0042] Furthermore, after casting the aluminum alloy die cast using the aluminum alloy for die casting of the present invention, a solution treatment and an aging treatment, etc., are performed if necessary. By performing the solution treatment and the aging treatment on the aluminum alloy die cast in such manner, mechanical properties of the aluminum alloy cast can be improved.

Examples

[0043] In the following, although the present invention will be described specifically by means of Examples, the present invention is not limited to the Examples.

[0044] Mechanical properties (specifically, tensile strength, elongation, and 0.2%-proof strength) of various types of alloys below were measured by a method described next. More specifically, by using an ordinary die casting machine (DC135EL manufactured by Toshiba Machine (Co., Ltd.)) having a clamping force of 135 ton, die-casting was performed at an injection speed of 1.0 m/s with a casting pressure of 60 MPa to produce a round bar test piece in compliance with ASTM (American Society for Testing and Material) standard. Then, tensile strength, elongation, and 0.2%-proof strength were measured for the round bar test piece in the as-cast condition by using a universal testing machine (AG-IS 100kN) manufactured by Shimadzu Corp.

[0045] In addition, alloy components of each type of alloys were measured by using a solid emission spectrophotometer (Thermo Scientific ARL 4460 manufactured by Thermo Fisher Scientific Inc.).

[0046] Furthermore, corrosion resistance was evaluated with a (neutral) salt spray test compliant with Japanese Industrial Standards JIS Z2371. The test was performed by using CASS Test Instrument CASSER-ISO-3 manufactured by Suga Test Instruments Co., Ltd.

<u>Influence of Cu on physical properties of aluminum alloy</u>

[0047] Table 1 shows the component compositions and each of the mechanical properties (tensile strength, elongation, and 0.2%-proof strength) of aluminum alloys for die cast produced by changing the content ratio of Cu as well as making adjustments such that alloy components other than Cu were set at a certain ratio within the range of the present invention.

[Table 1]

Table 1. Relationship between change in content ratio of Cu and physical properties of aluminum alloys

	Alloy components (wt%) (remaining portion being Al and unavoidable impurities)							Mechanical properties			Notes
	Cu	Si	Mg	Fe	Mn	Ti	Cr	Tensile strength (MPa)	Elongation (%)	0.2%-proof strength (MPa)	
Alloy 1	0.00	8.06	0.34	0.35	0.41	0.11	0.20	303	9.1	140	
Alloy 2	0.01	8.01	0.34	0.36	0.42	0.11	0.20	305	9.7	142	
Alloy 3	0.03	8.04	0.34	0.35	0.42	0.11	0.20	309	10.8	146	Example of present invention
Alloy 4	0.05	7.99	0.34	0.36	0.42	0.11	0.20	311	11.0	146	Example of present invention
Alloy 5	0.09	8.00	0.34	0.35	0.41	0.11	0.19	311	11.1	145	Example of present invention
Alloy 6	0.14	8.01	0.34	0.35	0.41	0.11	0.20	308	9.5	143	Example of present invention
Alloy 7	0.20	8.15	0.35	0.36	0.42	0.10	0.19	315	10.1	142	Example of present invention
Alloy 8	0.29	7.98	0.34	0.35	0.42	0.10	0.20	322	10.0	146	Example of present invention
Alloy 9	0.38	7.98	0.35	0.36	0.42	0.11	0.20	322	9.4	148	Example of present invention
Alloy 10	0.48	7.88	0.34	0.34	0.41	0.11	0.19	327	10.0	149	Example of present invention
Alloy 11	0.69	7.95	0.34	0.35	0.41	0.10	0.19	335	9.3	155	Example of present invention
Alloy 12	1.07	8.02	0.32	0.34	0.39	0.11	0.19	344	8.4	160	

[0048] As shown in Table 1, when the content ratio of Cu was within a range of about not higher than 1.0 wt%, tensile strength (see FIG. 1-1) and 0.2%-proof strength (see FIG. 1-2) of the aluminum alloys were improved associated with rising of the content ratio of Cu.

[0049] On the other hand, elongation of the aluminum alloys tended to become lower when the content ratio of Cu is higher than 0.7 wt%.

[0050] It should be noted that alloys 3 to 11 in Table 1 are alloy compositions within a range of the present invention, i.e., alloys of Examples.

Corrosion resistance improvement effect by containing Cr

[0051] Table 2 is a table showing the relationship between corrosion resistance and each aluminum alloy composition depending on the casting method.

[0052] Here, those obtained through die-casting in Table 2 were casted with a method similar to that of the samples used for measurement of the mechanical characteristics described above. On the other hand, for those obtained through gravity casting in Table 2, an aluminum alloy adjusted to have certain components was placed in a mold to undergo gravity casting, processed into a sample (corrosion resistance evaluation test piece) for the salt spray test compliant with JIS Z2371 similarly to die-casting, and the salt spray test was performed on the sample.

[Table 2]

Table 2. Relationship between corrosion resistance and each aluminum alloy composition depending on casting method

	Alloy components (wt%) (remaining portion being Al and unavoidable impurities)							Casting method	Average corrosion weight loss (mg/dm^2/day)	Notes
	Cu	Si	Mg	Fe	Mn	Ti	Cr			
Alloy 13	0.10	8.05	0.34	0.35	0.40	0.10	0.00	Die-casting	2.85	
Alloy 14	0.10	7.91	0.34	0.35	0.40	0.10	0.05	Die-casting	3.40	
Alloy 15	0.10	7.97	0.34	0.35	0.39	0.10	0.10	Die-casting	2.03	Example of present invention
Alloy 16	0.10	7.94	0.34	0.36	0.40	0.10	0.20	Die-casting	1.67	Example of present invention
Alloy 17	0.10	8.00	0.34	0.35	0.39	0.10	0.30	Die-casting	1.78	Example of present invention
Alloy 18	0.20	7.95	0.34	0.35	0.39	0.10	0.19	Die-casting	4.95	Example of present invention
Alloy 19	0.31	8.01	0.34	0.35	0.39	0.10	0.20	Die-casting	7.55	Example of present invention
Alloy 20	0.52	8.01	0.34	0.35	0.39	0.10	0.20	Die-casting	12.30	Example of present invention
Alloy 21	0.73	8.06	0.34	0.35	0.39	0.10	0.20	Die-casting	14.73	
Alloy 22	0.00	8.04	0.35	0.35	0.40	0.10	0.00	Gravity casting	2.18	
Alloy 23	0.10	8.02	0.35	0.35	0.40	0.10	0.00	Gravity casting	4.15	

(continued)

	Alloy components (wt%) (remaining portion being Al and unavoidable impurities)							Casting method	Average corrosion weight loss (mg/dm^2/day)	Notes
	Cu	Si	Mg	Fe	Mn	Ti	Cr			
Alloy 24	0.15	8.01	0.35	0.35	0.40	0.10	0.00	Gravity casting	7.37	
Alloy 25	0.00	7.96	0.34	0.35	0.40	0.10	0.20	Gravity casting	1.96	
Alloy 26	0.10	7.88	0.35	0.35	0.40	0.10	0.20	Gravity casting	1.81	Example of present invention
Alloy 27	0.15	7.88	0.35	0.35	0.40	0.10	0.20	Gravity casting	3.06	Example of present invention

[0053] As shown in Table 2, with casting articles obtained through die-casting, when the content ratio of Cu was set constant to 0.10 wt%, corrosion weight loss was lowered and corrosion resistance was improved when the content ratio of Cr was not lower than 0.10 wt% (see FIG. 2-1).

[0054] In addition, with the casting articles obtained through die-casting, when the content ratio of Cr was set constant to 0.20 wt%, corrosion weight loss also increased and corrosion resistance tended to deteriorate associated with a rise in the content ratio of Cu from 0.10 wt% to 0.73 wt% (see FIG. 2-3).

[0055] Furthermore, with casting articles obtained through gravity casting, although corrosion resistance of alloys deteriorated associated with a rise in the content ratio of Cu; containing Cr by 0.20 wt% was shown to be able to significantly reduce corrosion weight loss and improve corrosion resistance (see FIG. 2-2).

[0056] It should be noted that alloys 15 to 20, 26, and 27 in Table 2 are alloy compositions within a range of the present invention, i.e., alloys of Examples.

<u>Influence of Ti on physical properties of aluminum alloy</u>

[0057] Table 3 shows the component compositions and each of the mechanical properties (tensile strength, elongation, and 0.2%-proof strength) of aluminum alloys for die cast produced by changing the content ratio of Ti as well as making adjustments such that alloy components other than Ti were set at a certain ratio within the range of the present invention.
[Table 3]

Table 3. Relationship between change in content ratio of Ti and physical properties of aluminum alloys

	Alloy components (wt%) (remaining portion being Al and unavoidable impurities)							Mechanical properties			Notes
	Cu	Si	Mg	Fe	Mn	Ti	Cr	Tensile strength (MPa)	Elongation (%)	0.2%-proof strength (MPa)	
Alloy 28	0.11	7.94	0.35	0.35	0.40	0.01	0.20	300	10.0	134	
Alloy 29	0.11	7.99	0.35	0.35	0.39	0.04	0.20	304	10.5	138	
Alloy 30	0.11	7.91	0.35	0.35	0.39	0.09	0.20	311	11.6	143	Example of present invention
Alloy 31	0.11	7.98	0.35	0.36	0.40	0.13	0.20	309	10.4	144	Example of present invention
Alloy 32	0.11	7.91	0.35	0.36	0.40	0.19	0.20	313	11.2	145	Example of present invention
Alloy 33	0.11	7.95	0.35	0.36	0.39	0.23	0.20	314	10.5	148	

[0058] As shown in Table 3, when teh content ratio of Ti was within a range of about not Higher than 0.25 wt%, tensile strength (see FIG. 3-1) and 0.2%-proof strength (see FIG. 3-2) of the aluminum alloys were improved associated with rising of the content ratio of Ti.

[0059] On the other hand, elongation of the aluminum alloys did not show a significant difference depending on the content ratio of Ti within a range of about not higher than 0.25 wt% (FIG. 3-3).

[0060] It should be noted that alloys 30 to 32 in Table 3 are alloy compositions within a range of the present invention, i.e., alloys of Examples.

Claims

1. An aluminum alloy for die casting comprising, in wt%, $0.03\% < Cu \leq 0.7\%$, $6.0\% < Si \leq 11.0\%$, $0.15\% \leq Mg \leq 0.50\%$, $0.05\% \leq Fe \leq 0.6\%$, $0.05\% \leq Ti \leq 0.25\%$, $Mn \leq 0.8\%$, $0.10\% \leq Cr \leq 0.40\%$, and, for the remaining portion, Al and unavoidable impurities.

2. The aluminum alloy for die casting according claim 1, wherein at least one selected from Na, Sr, and Ca is added by 30 to 200 ppm.

3. The aluminum alloy for die casting according to claim 1 or 2, wherein Sb is added by 0.05 to 0.20 wt%.

4. The aluminum alloy for die casting according to any one of claims 1 to 4, wherein B is added by 1 to 50 ppm.

5. An aluminum alloy die cast obtained through die-casting the aluminum alloy for die casting according to any one of claims 1 to 4.

Fig. 1

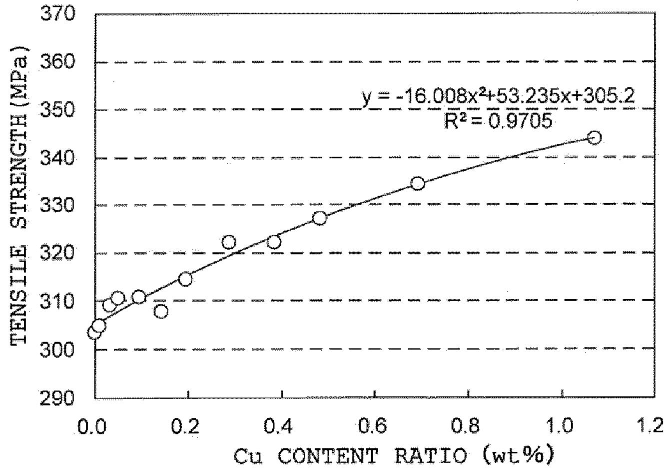

Fig.1-1 RELATIONSHIP BETWEEN Cu CONTENT RATIO AND TENSILE STRENGTH OF ALLOY

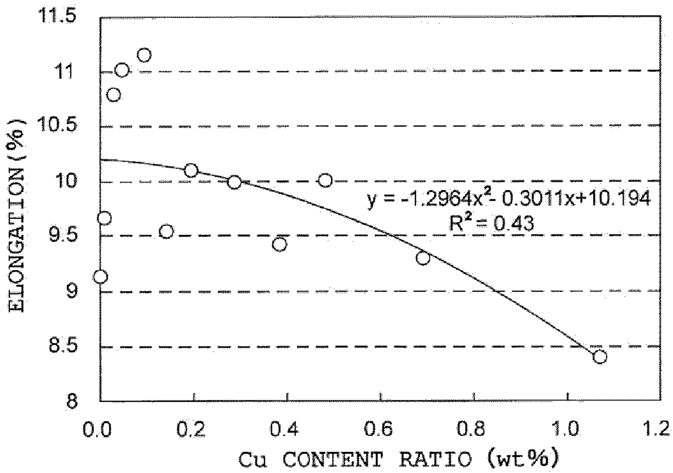

Fig.1-2 RELATIONSHIP BETWEEN Cu CONTENT RATIO AND ELONGATION OF ALLOY

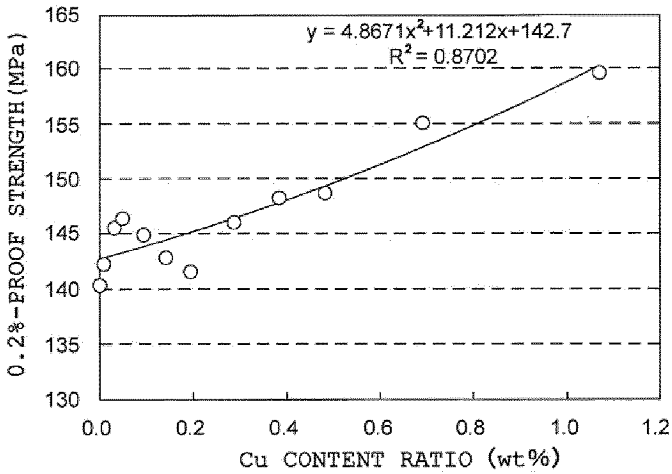

Fig.1-3 RELATIONSHIP BETWEEN Cu CONTENT RATIO AND 0.2%-PROOF STRENGTH OF ALLOY

Fig. 2

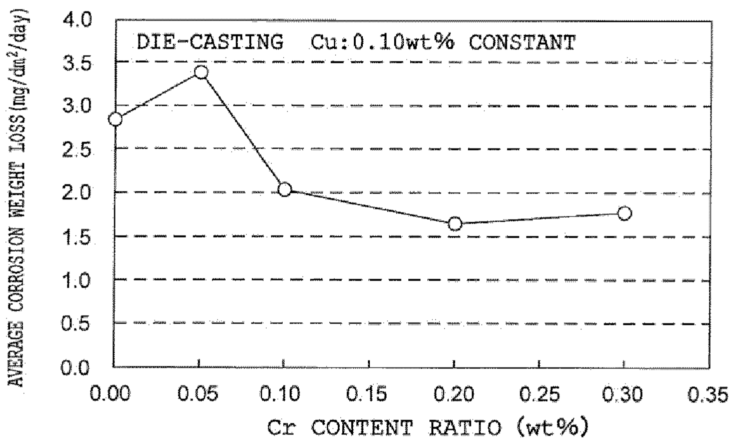

Fig.2-1 RELATIONSHIP BETWEEN CORROSION RESISTANCE AND Cr CONTENT RATIO AFTER DIE-CASTING

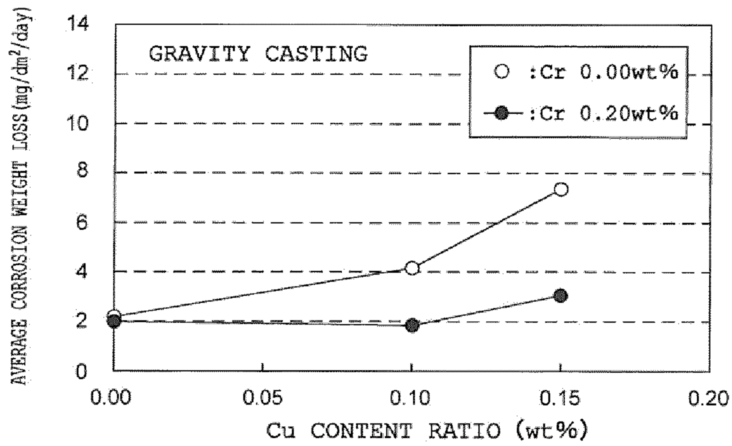

Fig.2-2 RELATIONSHIP BETWEEN CORROSION RESISTANCE AND Cu,Cr CONTENT RATIO AFTER GRAVITY CASTING

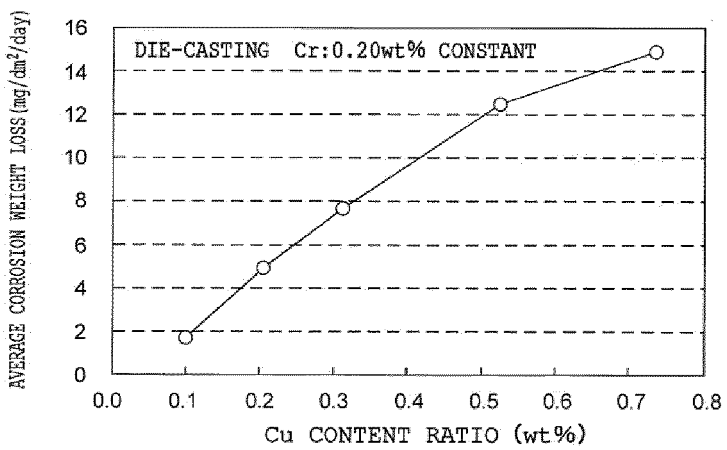

Fig.2-3 RELATIONSHIP BETWEEN CORROSION RESISTANCE AND Cu CONTENT RATIO AFTER DIE-CASTING

Fig. 3

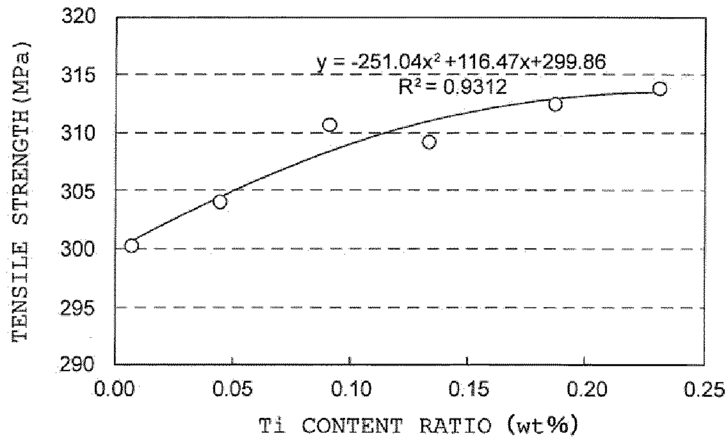

Fig.3-1 RELATIONSHIP BETWEEN Ti CONTENT RATIO AND TENSILE STRENGTH OF ALLOY

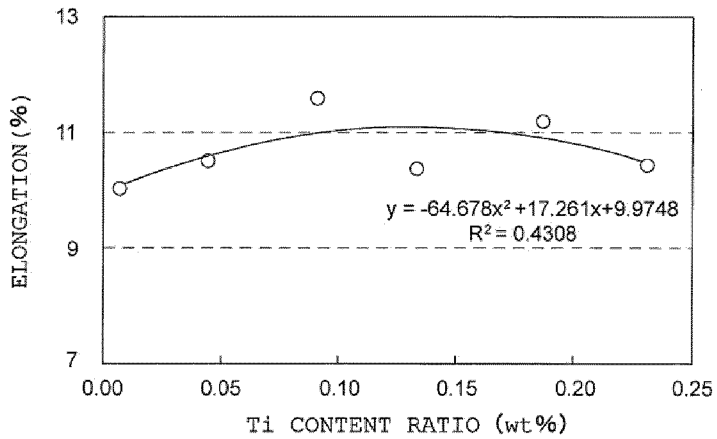

Fig.3-2 RELATIONSHIP BETWEEN Ti CONTENT RATIO AND ELONGATION OF ALLOY

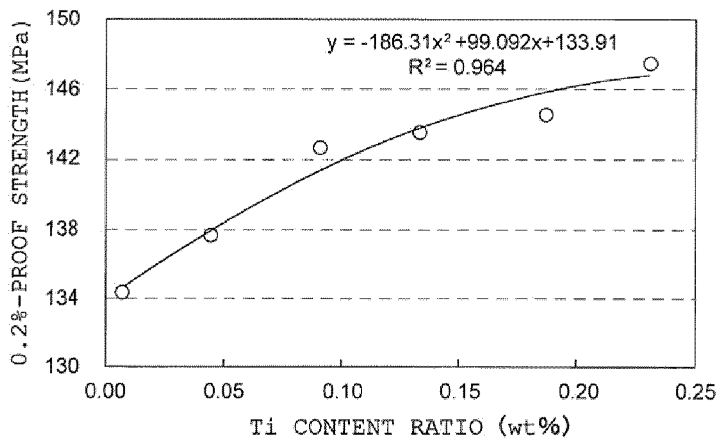

Fig.3-3 RELATIONSHIP BETWEEN Ti CONTENT RATIO AND 0.2%-PROOF STRENGTH OF ALLOY

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2015/002086

A. CLASSIFICATION OF SUBJECT MATTER
C22C21/02(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)
C22C21/00-21/18

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

Jitsuyo Shinan Koho	1922-1996	Jitsuyo Shinan Toroku Koho	1996-2015
Kokai Jitsuyo Shinan Koho	1971-2015	Toroku Jitsuyo Shinan Koho	1994-2015

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
JSTPlus/JST7580(JDreamIII)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 2006-16693 A (Aluminium Rheinfelden GmbH), 19 January 2006 (19.01.2006), entire text & US 2006/0011321 A1 & EP 1612286 A2 & CA 2510545 A1 & KR 10-2006-0046361 A & CN 1737176 A	1-5
A	JP 2002-105611 A (Ahresty Corp., Honda Motor Co., Ltd.), 10 April 2002 (10.04.2002), entire text; all drawings (Family: none)	1-5
A	JP 2002-339030 A (Yamaha Motor Co., Ltd.), 27 November 2002 (27.11.2002), entire text; all drawings (Family: none)	1-5

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

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
13 May 2015 (13.05.15)	26 May 2015 (26.05.15)

Name and mailing address of the ISA/	Authorized officer
Japan Patent Office 3-4-3,Kasumigaseki,Chiyoda-ku, Tokyo 100-8915,Japan	Telephone No.

Form PCT/ISA/210 (second sheet) (July 2009)

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 3255560 B **[0006]**