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(54) **DIE-CAST ALUMINUM ALLOY, PREPARATION METHOD THEREFOR, AND STRUCTURAL MEMBER FOR COMMUNICATION PRODUCT**

(57) Disclosed are a die-cast aluminum alloy, a method for preparing the die-cast aluminum alloy, and a structural member for a communications product prepared by using the die-cast aluminum alloy. The die-cast aluminum alloy includes the following components in mass percentages: 0.1-7% of magnesium, 7-35% of zinc,

0.2-0.8% of manganese, 0.1-0.7% of iron, 0.07-0.2% of titanium and/or zirconium, with the inevitable impurities being $\leq 0.3\%$, and the balance being aluminum. The die-cast aluminum alloy features high strength, high toughness, and excellent fluidity, and is applicable to molding complex thin-walled products.

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Description

[0001] This application claims priority to Chinese Patent Application No. 201910372923.2, filed with the China National Intellectual Property Administration on May 06, 2019 and entitled "DIE-CAST ALUMINUM ALLOY, METHOD FOR PREPARING DIE-CAST ALUMINUM ALLOY, AND STRUCTURAL MEMBER FOR communications product", which is incorporated herein by reference in its entirety.

TECHNICAL FIELD

[0002] The present invention relates to the technical field of aluminum alloy materials, and in particular, to a die-cast aluminum alloy, a method for preparing the die-cast aluminum alloy, and a structural member for a communications product.

BACKGROUND

[0003] While maintaining the advantages of conventional aluminum alloys such as high strength, high heat dissipation, and high corrosion resistance, die-cast aluminum alloys feature high fluidity and meet the industrialized die-cast production process, and therefore are widely used in household appliances, automobiles, electronic products and other fields. However, with the development of multi-functional, light and thin products, the structural space is further compressed, especially the fast-paced electronics industry, which puts forward higher requirements for the strength and toughness of die-cast materials.

[0004] Compared with commonly used aluminum-silicon die-cast aluminum alloys, aluminum-magnesium die-cast aluminum alloys have higher strength and excellent flexural toughness. However, because their fluidity is poor and die-cast friendliness is insufficient, aluminum-magnesium die-cast aluminum alloys are limited for use in scenarios such as die-cast parts of thin-walled electronic products (such as medium plates of mobile phones). Therefore, it is necessary to develop a die-cast aluminum alloy with high strength, high toughness, and excellent fluidity.

SUMMARY

[0005] In view of this, embodiments of the present invention provide a die-cast aluminum alloy and a method for preparing the die-cast aluminum alloy, where the die-cast aluminum alloy features high strength, high toughness, and excellent fluidity, so as to resolve the problem to a certain extent that the existing aluminum-magnesium die-cast aluminum alloy has poor fluidity and is limited for use in scenarios such as die-cast parts of thin-walled electronic products.

[0006] Specifically, a first aspect of the embodiments of the present invention provides a die-cast aluminum alloy, which includes the following components in mass percentages:

magnesium: 0.1%-7%,
 zinc: 7%-35%,
 manganese: 0.2%-0.8%,
 iron: 0.1%-0.7%,
 titanium and/or zirconium: 0.07%-0.2%,
 inevitable impurities $\leq$ 0.3%, and aluminum.

[0007] According to the die-cast aluminum alloy in the embodiments of the present invention, the fluidity of the alloy is improved by increasing content of zinc; in addition, content of elements such as magnesium, iron, and manganese is comprehensively controlled, so that the aluminum alloy can achieve good comprehensive mechanics performance such as high strength and high toughness while obtaining excellent fluidity.

[0008] In an implementation of the present invention, the mass percentage of zinc is 12%-33%.

[0009] In an implementation of the present invention, the mass percentage of zinc is 17%-23%.

[0010] In an implementation of the present invention, the mass percentage of magnesium is 2%-6%.

[0011] In an implementation of the present invention, the mass percentage of magnesium is 3.3%-5.1 %.

[0012] In an implementation of the present invention, the mass percentage of iron is 0.12%-0.35%.

[0013] In an implementation of the present invention, the mass percentage of iron is 0.2%-0.3%.

[0014] In an embodiment of the invention, the mass percentage of manganese is 0.25%-0.7%.

[0015] In an implementation of the present invention, the mass percentage of manganese is 0.35%-0.6%.

[0016] In an implementation of the present invention, the mass percentage of titanium and/or zirconium is 0.08%-0.12%.

[0017] In an implementation of the present invention, the components of the die-cast aluminum alloy further include silicon, and the mass percentage of silicon is greater than 0 and less than or equal to 2.3%.

[0018] In an implementation of the present invention, the mass percentage of silicon is 0.5%-1.9%.

[0019] In an implementation of the present invention, the mass percentage of silicon is 0.7%-1.6%.

[0020] In an implementation of the present invention, the components of the die-cast aluminum alloy further include copper, and the mass percentage of copper is greater than 0 and less than or equal to 2.6%.

[0021] In an implementation of the present invention, the mass percentage of copper is 0.3%-2.3%.

[0022] In an implementation of the present invention, the mass percentage of copper is 0.7%-1.6%.

[0023] In an implementation of the present invention, internal phases of the structure of the die-cast aluminum alloy include an α -Al phase and intermetallic compounds. The intermetallic compounds are distributed at grain boundary positions or precipitated in the α -Al phase. Intermetallic compounds include an $MgZn_2$ phase and an iron-rich phase.

[0024] In an implementation of the present invention, under the same conditions, the fluidity of the die-cast aluminum alloy is more than 91% of that of the ADC12 die-cast aluminum alloy.

[0025] In an implementation of the present invention, yield strength of the die-cast aluminum alloy is ≥ 240 MPa, and elongation is $\geq 3\%$.

[0026] The die-cast aluminum alloy provided in the first aspect of the embodiments of the present invention features high strength, high toughness, and excellent fluidity, and can greatly alleviate problems about the existing aluminum-magnesium die-cast aluminum alloy, such as low fluidity, poor mold filling, easy to pull molds, and easy to erode molds. Therefore, the die-cast aluminum alloy provided in the first aspect of the embodiments of the present invention can meet molding of a communications product with a complex structure, and is especially applicable to molding of thin-walled products such as medium plates of mobile phones that require high fluidity.

[0027] According to a second aspect, an embodiment of the present invention further provides a method for preparing a die-cast aluminum alloy, including the following steps:

[0028] According to component configuration of the die-cast aluminum alloy, a pure aluminum ingot is first added to a smelting furnace; after the aluminum ingot is melted, a metal element source that can provide element components other than aluminum is added for smelting; and then after the refining and degassing treatment, casting is performed to obtain the die-cast aluminum alloy. The die-cast aluminum alloy includes the following components in mass percentages: magnesium: 0.1%-7%, zinc: 7%-35%, manganese: 0.2%-0.8%, iron: 0.1%-0.7%, titanium and/or zirconium: 0.07%-0.2%, unavoidable impurities $\leq 0.3\%$, and aluminum.

[0029] In an implementation of the present invention, after a pure aluminum ingot is added to the melting furnace, heating is performed to reach 730°C-760°C to melt the aluminum ingot. After the aluminum ingot is completely melted, an aluminum-manganese alloy, a pure zinc ingot, iron powder, an aluminum-titanium alloy, and/or an aluminum-zirconium alloy are/is added. After cooling to 700°C-720°C, a pure magnesium ingot is added, and the compound is stirred and kept warm for 15-25 minutes.

[0030] In an implementation of the present invention, in the casting and molding process, the casting temperature is 650°C-720°C.

[0031] The preparation method provided in the second aspect of the present invention features a simple process, a high yield rate, and low production costs, and is applicable to complex thin-walled parts and similar scenarios, and has broad application prospects.

[0032] A third aspect of the embodiments of the present invention provides a structural member for a communications product. The structural member for a communications product is cast by using the die-cast aluminum alloy provided in the first aspect of the embodiments of the present invention. The structural member for a communications product includes a medium plate of a mobile phone.

[0033] The structural member for a communications product provided in the third aspect of the embodiments of the present invention features high strength, high toughness, and excellent forming performance, and can meet design requirements for complex thin-walled structural members.

DESCRIPTION OF EMBODIMENTS

[0034] The following describes the embodiments of the present invention with reference to some specific implementations of the present invention.

[0035] Existing aluminum-magnesium die-cast aluminum alloys feature high strength and high toughness, but their fluidity is poor. In the process of forming structural members for thin-walled electronic products (such as medium plates of mobile phones), the aluminum-magnesium die-cast aluminum alloys encounter problems such as poor die-cast molding, many cracks, and die erosion, seriously affecting the production effect and delivery capability. To effectively resolve these problems, an embodiment of the present invention provides a die-cast aluminum alloy with high strength, high toughness, and excellent fluidity.

[0036] Specifically, an embodiment of the present invention provides a die-cast aluminum alloy, which includes the following components in mass percentages:

magnesium: 0.1%-7%,
 zinc: 7%-35%,
 manganese: 0.2%-0.8%,
 iron: 0.1%-0.7%,
 titanium and/or zirconium: 0.07%-0.2%,
 inevitable impurities $\leq$ 0.3%, and aluminum.

[0037] In this embodiment of the present invention, the components of the die-cast aluminum alloy are determined by comprehensively considering the contribution of each chemical element to the comprehensive performance indicators (including fluidity, strength, toughness, hardness, and the like) of the alloy. Through the combined effect of the foregoing specific content of elements, various performance is balanced, a stable crystal structure is formed, and a die-cast aluminum alloy with excellent comprehensive performance is obtained.

[0038] In this embodiment of the present invention, internal phases of the structure of the die-cast aluminum alloy include an α -Al phase and intermetallic compounds. The intermetallic compounds are distributed at grain boundary positions or precipitated in the α -Al phase. The phase refers to a uniform continuous component with the same chemical composition, the same atomic aggregation state and properties, and there is an interface separation between different phases. The intermetallic compound refers to a compound formed by a metal and a metal, and a metal and a metalloid. Specifically, in the crystal structure of the die-cast aluminum alloy in the present invention, the intermetallic compound includes an $MgZn_2$ phase, an iron-rich phase, and the like. When the composition of the die-cast aluminum alloy further includes copper (Cu), the intermetallic compound further includes an Al_2Cu phase and the like. When the composition of the die-cast aluminum alloy further includes silicon (Si), the intermetallic compound further includes an Mg_2Si phase and the like. Zinc, magnesium, iron, copper, manganese, titanium, and zirconium are partially solid-dissolved in the α -Al phase in the form of atoms.

[0039] In some embodiments of the present invention, the components of the die-cast aluminum alloy may further include silicon (Si). The content of silicon (Si) is controlled at a lower level greater than 0 and less than or equal to 2.3%. Due to high brittleness of silicon, the lower content of silicon helps improve the toughness of the aluminum alloy. The addition of a small amount of silicon can reduce the tendency of hot cracking and improve the dimensional stability. In addition, Si can be combined with Mg to form Mg_2Si , ensuring certain strength of the aluminum alloy. In some embodiments, the mass percentage of silicon may be 0.5%-1.9%. In some other embodiments, the mass percentage of silicon may alternatively be 0.7%-1.6%. In some embodiments, the mass percentage of silicon may be specifically 0.8%, 1.2%, 1.5%, or 1.7%.

[0040] In an implementation of the present invention, magnesium (Mg) is combined with Zn and Si to form strengthening phases $MgZn_2$ and Mg_2Si , which significantly improve alloy strengthening. In addition, the increase in the magnesium content can improve alloy fluidity to a certain extent. However, magnesium is easy to burn and has a serious inclusion tendency. Excessive Mg content greatly affects the normal die-cast production and reduces the toughness of the alloy. In an implementation of the present invention, the content of magnesium is controlled within the range of 0.1%-7%. In some embodiments, the mass percentage of magnesium may be 2%-6%. In some other embodiments, the mass percentage of magnesium may alternatively be 3.3%-5.1%. In some embodiments, the mass percentage of magnesium may be specifically 1%, 3%, 4%, 5%, or 6%.

[0041] In an implementation of the present invention, an increase in the content of zinc (Zn) can lower a liquidus temperature and improve the fluidity of the alloy. When the content of Zn is $\geq$ 20%, it can significantly improve the fluidity of the alloy. In addition, Zn can be solid-dissolved in α -Al to achieve effects of solid dissolution and strengthening, but the strength improvement is limited. When the strength requirement is high, adding other elements such as Mg to be combined with Zn to form a second phase (such as an $MgZn_2$ phase) can significantly improve the strength of the alloy. Excessively high content of Zn leads to problems such as reduced corrosion resistance, poor thermal stability, and high thermal cracking tendency, and further increases the alloy density, causing a sharp increase in the product weight. Therefore, under the condition that the fluidity meets the requirements, controlling the Zn content and appropriately adding other strengthening elements can achieve the effects of high strength and high toughness, and further greatly reduce the product weight and raw material costs, especially for 3C products. In some embodiments, the mass percentage of zinc may alternatively be 12%-33%. In some other embodiments, the mass percentage of zinc may alternatively be 17%-23%. In some other embodiments, the mass percentage of zinc may alternatively be 7%-12%. In some embodiments, the mass percentage of zinc may be specifically 17%, 18%, 19%, 20%, or 22%.

[0042] In an implementation of the present invention, the addition of iron (Fe) can alleviate the mucosal tendency in the aluminum alloy die casting process, and ensure the smooth progress of die casting. However, when Fe is excessive, a thick needle-like iron-rich phase is formed, affecting the toughness of the alloy. Therefore, to ensure high toughness, in an embodiment of the present invention, the mass percentage of iron is controlled at 0.1%-0.7%. In some embodiments, the mass percentage of iron may alternatively be 0.12%-0.35%. In some other embodiments, the mass percentage of iron may alternatively be 0.2%-0.3%. In an embodiment of the present invention, the content of Fe is controlled at the

middle and lower limit (0.12%-0.35%), which can increase the toughness of the aluminum alloy.

[0043] In an implementation of the present invention, the addition of an appropriate amount of manganese (Mn) can transform the thick needle-like iron-rich phase to form a fine iron-rich phase, to reduce the adverse impact of Fe on the mechanics performance. In addition, the addition of manganese can alleviate the mucosal tendency of the aluminum alloy. In an implementation of the present invention, the mass percentage of manganese is controlled within the range of 0.2%-0.8%. In some embodiments, the mass percentage of manganese may be 0.25%-0.7%. In some other embodiments, the mass percentage of manganese may alternatively be 0.35%-0.6%. In some embodiments, the mass percentage of manganese may be specifically 0.3%, 0.4%, 0.5%, 0.55%, or 0.65%.

[0044] In some embodiments of the present invention, the components of the die-cast aluminum alloy may further include copper (Cu). Copper has significant effects of solid dissolution and strengthening, and can be combined with Al to form an intermetallic compound Al_2Cu , further enhancing the strength of the alloy. In an implementation of the present invention, the mass percentage of copper is $\leq 2.6\%$. In some embodiments, the mass percentage of copper may be 0.3%-2.3%. In some other embodiments, the mass percentage of copper may alternatively be 0.7%-1.6%. In some embodiments, the mass percentage of copper may be specifically 0.5%, 0.8%, 1.2%, 1.4%, 1.5%, or 2.0%.

[0045] In an implementation of the present invention, titanium (Ti) and zirconium (Zr) can be used as heterogeneous nucleation points to refine crystal grains and improve the strength and toughness of the aluminum alloy. In an embodiment of the present invention, titanium may be added separately, zirconium may be added separately, or titanium and zirconium may be added in combination. In some embodiments, the mass percentage of titanium and/or zirconium may be 0.07%-0.12%. In some other embodiments, the mass percentage of titanium and/or zirconium may alternatively be 0.08%-0.1%.

[0046] In an implementation of the present invention, to obtain better comprehensive performance, in some embodiments, the sum of the mass percentages of four elements of magnesium, copper, manganese, and titanium may be controlled to be greater than or equal to 4%. In some other embodiments, the sum of the mass percentages of four elements of magnesium, copper, manganese, and titanium may be controlled to be greater than or equal to 6%.

[0047] In an implementation of the present invention, the die-cast aluminum alloy includes the following components in mass percentages: silicon: 0.7%-1.6%, zinc: 17%-23%, magnesium: 3.3%-5.1%, copper: 0.7%-1.6%, iron: 0.12%-0.35%, manganese: 0.35%-0.6%, titanium and/or zirconium: 0.07%-0.12%. According to the die-cast aluminum alloy in this embodiment of the present invention, impact of various elements on the performance of the alloy is comprehensively considered. Under the condition that the fluidity meets the requirements, controlling the content of Zn to be 17%-23%, and appropriately adding strengthening elements such as Mg and Cu can achieve better effects of high strength and high toughness, and can further control the alloy weight, the raw material costs, the thermal stability, the corrosion resistance, and the like to be at a better level, thereby better meeting the application requirements of 3C products.

[0048] In an implementation of the present invention, because the addition of impurity elements reduces the performance of the material, in this embodiment of the present invention, the content of the inevitable impurity elements is controlled to be $\leq 0.3\%$.

[0049] In an implementation of the present invention, under the combined effect of the specific content of the specific elements, the fluidity of the die-cast aluminum alloy is more than 91% of the ADC12 under the same conditions. In an implementation of the present invention, the yield strength of the die-cast aluminum alloy is ≥ 240 MPa, and the elongation is $\geq 3\%$. The yield strength is a yield limit of a metal material when a yield phenomenon occurs, that is, a stress resisting slight plastic deformation. For metal materials without obvious yield phenomenon, a stress value that produces 0.2% residual deformation is specified as the yield limit, which is referred to as a conditional yield limit or yield strength. The elongation refers to an index describing the plastic performance of the material, and is a percentage of a ratio of the total deformation ΔL of the gauge length section after tensile fracture of a sample to the original gauge length L .

[0050] The die-cast aluminum alloy provided in the embodiments of the present invention features high strength, high toughness, and excellent fluidity, and can greatly alleviate problems about the existing aluminum-magnesium die-cast aluminum alloy, such as low fluidity, poor mold filling, easy to pull molds, and easy to erode molds. Therefore, the die-cast aluminum alloy provided in the first aspect of the embodiments of the present invention can meet molding of a communications product with a complex structure, and is especially applicable to scenarios of thin-walled parts that require high fluidity. Specifically, the die-cast aluminum alloy can be applied to fields such as mobile phones, notebook computers, communication equipment industries, automobiles, and civil hardware. Specifically, an embodiment of the present invention provides a structural member for a communications product. The structural member for a communications product is cast by using the die-cast aluminum alloy provided in this embodiment of the present invention. The structural member for a communications product includes a medium plate of a mobile phone. Certainly, in the communications product, other structural members that can be made of aluminum alloy may alternatively be cast by using the die-cast aluminum alloy in this embodiment of the present invention, such as a housing and a bracket. A wall thickness of the structural member for a communications product in this embodiment of the present invention is not particularly limited. The wall thickness may be as large as possible or as small as possible, for example, may be 0.25 mm to 2 mm, and further 0.4 mm to 1 mm. The wall thickness may be a partial wall thickness of the structural member, for example, a wall thickness of more than 50% of the area, or a wall thickness of more than 70% of the area.

[0051] Correspondingly, an embodiment of the present invention further provides a method for preparing a die-cast aluminum alloy, including the following steps:

[0052] S10. According to component configuration of the die-cast aluminum alloy, a pure aluminum ingot is first added to a smelting furnace; after the aluminum ingot is melted, a metal element source that can provide element components other than aluminum is added for smelting.

[0053] S20. After the refining and degassing treatment, casting is performed to obtain the die-cast aluminum alloy. The die-cast aluminum alloy includes the following components in mass percentages: magnesium: 0.1%-7%, zinc: 7%-35%, manganese: 0.2%-0.8%, iron: 0.1%-0.7%, titanium and/or zirconium: 0.07%-0.2%, unavoidable impurities $\leq 0.3\%$, and aluminum.

[0054] In some embodiments, the components of the die-cast aluminum alloy may further include copper. In some embodiments, the components of the die-cast aluminum alloy may further include silicon.

[0055] In an implementation of the present invention, the metal element source that can provide other element components other than aluminum may be a pure metal ingot, a master alloy, metal powder, and the like, specifically including a pure zinc ingot, a pure magnesium ingot, an aluminum-silicon alloy, iron powder, an aluminum-manganese alloy, an aluminum-copper alloy, an aluminum-titanium alloy, an aluminum-zirconium alloy, and the like. In an implementation of the present invention, various pure metal ingots and master alloys can be cleaned and dried to remove oxide layers and dirt from the surface.

[0056] In an implementation of the present invention, in step S10, after a pure aluminum ingot is added to the melting furnace, heating is performed to reach 730°C-760°C to melt the aluminum ingot. After the aluminum ingot is completely melted, an aluminum-manganese alloy, a pure zinc ingot, iron powder, an aluminum-titanium alloy, and/or an aluminum-zirconium alloy are/is added. After cooling to 700°C-720°C, a pure magnesium ingot is added, and the compound is stirred and kept warm for 15-25 minutes. More specifically, after a pure aluminum ingot is added to the melting furnace, heating is performed to reach 730°C-760°C for 30 minutes to melt the aluminum ingot. After the aluminum ingot is completely melted, an aluminum-manganese alloy, a pure zinc ingot, iron powder, an aluminum-titanium alloy, and/or an aluminum-zirconium alloy are/is added. Then a refining agent is added and slagging is performed, and the compound is kept still and warm for 15 minutes to 25 minutes. Then a pure magnesium ingot is added, and the compound is stirred and kept warm for 15 minutes to 25 minutes.

[0057] In an implementation of the present invention, in the casting process, the material temperature, that is, the casting temperature, is 650°C-720°C.

[0058] In an implementation of the present invention, in the refining process, a refining agent dedicated for aluminum alloy is added, argon gas is injected for rotating degassing, and then the compound is kept still and warm for 15 minutes to 20 minutes to fully separate impurities. Before the casting and molding, online hydrogen removal and two-stage filtration are performed. In an implementation of the present invention, the refining agent is a commercially available conventional refining agent dedicated for aluminum alloy, and the on-line hydrogen removal and two-stage filtration are conventional operations in the field. This is not particularly limited in the present invention.

[0059] In an implementation of the present invention, the mass percentage of silicon may be $\leq 2.3\%$. In some embodiments, the mass percentage of silicon may be 0.5%-1.9%. In some other embodiments, the mass percentage of silicon may alternatively be 0.7%-1.6%. In some embodiments, the mass percentage of silicon may be specifically 0.8%, 1.2%, 1.5%, or 1.7%.

[0060] In some embodiments, the mass percentage of magnesium may be 2%-6%. In some other embodiments, the mass percentage of magnesium may alternatively be 3.3%-5.1%. In some embodiments, the mass percentage of magnesium may be specifically 1%, 3%, 4%, 5%, or 6%.

[0061] In some embodiments, the mass percentage of zinc may alternatively be 12%-33%. In some other embodiments, the mass percentage of zinc may alternatively be 17%-23%. In some other embodiments, the mass percentage of zinc may alternatively be 7%-12%.

[0062] In some embodiments, the mass percentage of iron may alternatively be 0.12%-0.35%. In some other embodiments, the mass percentage of iron may alternatively be 0.2%-0.3%.

[0063] In some embodiments, the mass percentage of manganese may be 0.25%-0.7%. In some other embodiments, the mass percentage of manganese may alternatively be 0.35%-0.6%.

[0064] In an implementation of the present invention, the mass percentage of copper may be $\leq 2.6\%$. In some embodiments, the mass percentage of copper may be 0.3%-2.3%. In some other embodiments, the mass percentage of copper may alternatively be 0.7%-1.6%.

[0065] In an embodiment of the present invention, titanium may be added separately, zirconium may be added separately, or titanium and zirconium may be added in combination. In some embodiments, the mass percentage of titanium and/or zirconium may be 0.07%-0.12%. In some other embodiments, the mass percentage of titanium and/or zirconium may alternatively be 0.08%-0.1%.

[0066] In an implementation of the present invention, to obtain better comprehensive performance, in some embodiments, the sum of the mass percentages of four elements of magnesium, copper, manganese, and titanium may be

controlled to be greater than or equal to 4%. In some other embodiments, the sum of the mass percentages of four elements of magnesium, copper, manganese, and titanium may be controlled to be greater than or equal to 6%.

[0067] In an implementation of the present invention, because the addition of impurity elements reduces the performance of the material, in this embodiment of the present invention, the content of the inevitable impurity elements is controlled to be $\leq 0.3\%$.

[0068] The present invention can further combine existing casting processes (such as liquid die casting and gravity casting) to prepare various molded parts of aluminum alloy, including the structural member for a communications product described in the embodiments of the present invention.

[0069] The preparation method provided in the embodiments of the present invention features a simple process, a high yield rate, and low production costs. The prepared die-cast aluminum alloy features high strength, high toughness, and excellent fluidity, and is applicable to complex thin-walled parts and similar scenarios, and has broad application prospects.

[0070] The following further describes the embodiments of the present invention by using multiple examples.

Example 1

[0071] A die-cast aluminum alloy includes the following components in mass percentages: silicon: 1.69%, magnesium: 5.62%, zinc: 8.52%, copper: 2.38%, manganese: 0.538%, iron: 0.121%, titanium: 0.104%, zirconium: 0.0015%, content of inevitable impurities is $\leq 0.3\%$, and the rest is aluminum.

[0072] The method for preparing the die-cast aluminum alloy in this example includes the following steps:

[0073] According to component configuration of the die-cast aluminum alloy, a pure aluminum ingot is first added to a smelting furnace. Heating is performed to reach 730°C-760°C for 30 minutes to melt the aluminum ingot. After the aluminum ingot is completely melted, a pure zinc ingot, an aluminum-silicon alloy, iron powder, an aluminum-manganese alloy, an aluminum-copper alloy, an aluminum-titanium alloy, and an aluminum left-nickel alloy are first added and then a refining agent is added and slagging is performed, and the compound is kept still and warm for 15 minutes to 25 minutes. After cooling to 700°C-720°C, a pure magnesium ingot is added, and the compound is stirred evenly and kept warm for 15 minutes to 25 minutes. Then, a refining agent dedicated for aluminum alloy is added, argon gas is injected for rotating degassing, and then the compound is kept still for 20 minutes to fully separate impurities. Then, slagging and ashing are performed. Then, online hydrogen removal and two-stage filtration are performed, and casting is performed to form a die-cast aluminum alloy ingot. The casting temperature is 650°C-720°C.

Examples 2 and 3

[0074] The specific formula of the die-cast aluminum alloy is shown in Table 1.

[0075] The die-cast aluminum alloy in examples 1-3 in the present invention, the conventional Al-Mg-Si series aluminum alloy, and the ADC12 aluminum alloy were tested for mechanics performance and fluidity.

[0076] Mechanics performance test: The die-cast aluminum alloy ingot obtained by casting in examples 1-3 in the present invention is re-melted, heated to 700°C, and a 250T die-cast machine is used to prepare a tensile sample with a diameter of 6 mm in accordance with the provisions of the national standard GB/T228.1-2010. The yield strength and elongation are tested, and the tensile rate is 1.5 mm/min. The same method is used to test the mechanics performance of the conventional Al-Mg-Si series aluminum alloy and the ADC12 aluminum alloy. The test results are shown in Table 1.

[0077] Fluidity test: The metal spiral wire method is used to test the fluidity. Under the same conditions, the fluidity of the conventional Al-Mg-Si aluminum alloy and the ADC12 aluminum alloy is tested. The test results are shown in Table 1.

Table 1

SN	Si(%)	Mg(%)	Zn (%)	Cu (%)	Fe(%)	Mn (%)	Ti (%)	Zr (%)	Yield strength (Mpa)	Elongation (%)	Fluidity (mm)
Example 1	1.69	5.62	8.52	2.38	0.121	0.538	0.104	0.0015	249	3.84	983
Example 2	0.873	4.87	21.3	1.57	0.153	0.621	0.013	0.127	306	3.64	1081
Example 3	/	0.12	33.73	/	0.132	0.498	/	0.106	260	4.80	1103
Conventional Al-Mg-Si series	2.15	6.12	0.024	0.009	0.271	0.584	0.117	0.0027	238	4.60	917
ADC12	9.86	0.12	0.85	1.832	0.752	0.15	0.035	0.031	176	2.62	1068

[0078] It can be seen from the results in Table 1 that the fluidity of the die-cast aluminum alloy in the embodiments of the present invention is better than that of the conventional Al-Mg-Si series die-cast aluminum alloy, and is more than 91% of the fluidity of the conventional ADC12 (Al-Si-Cu series) die-cast aluminum alloy. It can be learned from examples 2 and 3 that while maintaining high toughness, the strength of the aluminum alloy in the multi-element (Zn, Mg, Cu) synergistic strengthening solution in example 2 is better than that of the ultra-high Zn content solution in example 3. Higher Zn content helps improve the fluidity, but leads to excessively high product weight, and reduced thermal stability and corrosion resistance. Therefore, under the conditions of meeting fluidity and toughness, controlling the content of Zn to be within a moderate range (such as 17%-23%), and the synergistic strengthening of magnesium, copper, and other elements are conducive to obtaining a die-cast aluminum alloy with better comprehensive performance, so as to better meet the requirements of 3C products.

Claims

1. A die-cast aluminum alloy, comprising the following components in mass percentages:
 - magnesium: 0.1%-7%,
 - zinc: 7%-35%,
 - manganese: 0.2%-0.8%,
 - iron: 0.1%-0.7%,
 - titanium and/or zirconium: 0.07%-0.2%,
 - inevitable impurities $\leq$ 0.3%, and aluminum.
2. The die-cast aluminum alloy according to claim 1, wherein the mass percentage of zinc is 12%-33%.
3. The die-cast aluminum alloy according to claim 1, wherein the mass percentage of zinc is 17%-23%.
4. The die-cast aluminum alloy according to claim 1, wherein the mass percentage of magnesium is 2%-6%.
5. The die-cast aluminum alloy according to claim 1, wherein the mass percentage of magnesium is 3.3%-5.1%.
6. The die-cast aluminum alloy according to claim 1, wherein the mass percentage of iron is 0.12%-0.35%.
7. The die-cast aluminum alloy according to claim 1, wherein the mass percentage of iron is 0.2%-0.3%.
8. The die-cast aluminum alloy according to claim 1, wherein the mass percentage of manganese is 0.25%-0.7%.
9. The die-cast aluminum alloy according to claim 1, wherein the mass percentage of manganese is 0.35%-0.6%.
10. The die-cast aluminum alloy according to claim 1, wherein the mass percentage of titanium and/or zirconium is 0.08%-0.12%.
11. The die-cast aluminum alloy according to claim 1, wherein the components of the die-cast aluminum alloy further comprise silicon, and the mass percentage of silicon is greater than 0 and less than or equal to 2.3%.
12. The die-cast aluminum alloy according to claim 11, wherein the mass percentage of silicon is 0.5%-1.9%.
13. The die-cast aluminum alloy according to claim 12, wherein the mass percentage of silicon is 0.7%-1.6%.
14. The die-cast aluminum alloy according to claim 1, wherein the components of the die-cast aluminum alloy further comprise copper, and the mass percentage of copper is greater than 0 and less than or equal to 2.6%.
15. The die-cast aluminum alloy according to claim 14, wherein the mass percentage of copper is 0.3%-2.3%.
16. The die-cast aluminum alloy according to claim 15, wherein the mass percentage of copper is 0.7%-1.6%.
17. The die-cast aluminum alloy according to claim 1, wherein internal phases of a structure of the die-cast aluminum alloy comprise an α -Al phase and intermetallic compounds; the intermetallic compounds are distributed at grain

boundary positions or precipitated in the α -Al phase; intermetallic compounds comprise an MgZn_2 phase and an iron-rich phase.

18. The die-cast aluminum alloy according to any one of claims 1 to 17, wherein under the same conditions, fluidity of the die-cast aluminum alloy is more than 91% of that of an ADC12 die-cast aluminum alloy.

19. The die-cast aluminum alloy according to any one of claims 1 to 18, wherein yield strength of the die-cast aluminum alloy is ≥ 240 MPa, and elongation is $\geq 3\%$.

20. A method for preparing a die-cast aluminum alloy, comprising the following steps:
according to component configuration of the die-cast aluminum alloy, a pure aluminum ingot is first added to a smelting furnace; after the aluminum ingot is melted, a metal element source that can provide element components other than aluminum is added for smelting; and then after the refining and degassing treatment, casting is performed to obtain the die-cast aluminum alloy; the die-cast aluminum alloy comprises the following components in mass percentages: magnesium: 0.1%-7%, zinc: 7%-35%, manganese: 0.2%-0.8%, iron: 0.1%-0.7%, titanium and/or zirconium: 0.07%-0.2%, unavoidable impurities $\leq 0.3\%$, and aluminum.

21. The preparation method according to claim 20, wherein after a pure aluminum ingot is added to the melting furnace, heating is performed to reach 730°C-760°C to melt the pure aluminum ingot; after the aluminum ingot is completely melted, an aluminum-manganese alloy, a pure zinc ingot, iron powder, an aluminum-titanium alloy, and/or an aluminum-zirconium alloy are/is added; after cooling to 700°C-720°C, a pure magnesium ingot is added, and the compound is stirred and kept warm for 15-25 minutes.

22. The preparation method according to claim 20, wherein in the casting process, a material temperature is 650°C-720°C.

23. A structural member for a communications product, wherein the structural member for a communications product is cast by using the die-cast aluminum alloy according to any one of claims 1 to 19.

24. The structural member for a communications product according to claim 23, wherein the structural member for a communications product comprises a medium plate of a mobile phone.

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2020/087148

A. CLASSIFICATION OF SUBJECT MATTER C22C 21/10(2006.01)i; C22C 1/03(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; C22C1 Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched																		
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) CNABS, DWPI, CNKI, VEN: 锰, 压铸, 铁, 钛, 锆, 镁, 铈, manganese, die casting, iron, titanium, zirconium, magnesium, zinc																		
C. DOCUMENTS CONSIDERED TO BE RELEVANT																		
<table border="1"> <thead> <tr> <th>Category*</th> <th>Citation of document, with indication, where appropriate, of the relevant passages</th> <th>Relevant to claim No.</th> </tr> </thead> <tbody> <tr> <td>PX</td> <td>CN 110129637 A (HUAWEI TECHNOLOGIES CO., LTD.) 16 August 2019 (2019-08-16) claims 1-24</td> <td>1-24</td> </tr> <tr> <td>X</td> <td>CN 107177761 A (GENESIS ALLOYS (NINGBO) LTD.) 19 September 2017 (2017-09-19) claim 1, and description, paragraph [0003]</td> <td>1-24</td> </tr> <tr> <td>X</td> <td>CN 104480353 A (LI, Shuqing) 01 April 2015 (2015-04-01) claims 1 and 2</td> <td>1-24</td> </tr> <tr> <td>X</td> <td>US 7060139 B2 (UES INC) 13 June 2006 (2006-06-13) table 1</td> <td>1-24</td> </tr> <tr> <td>X</td> <td>US 2007029016 A1 (UNIVERSAL ALLOY CORP) 08 February 2007 (2007-02-08) claim 1</td> <td>1-24</td> </tr> </tbody> </table>	Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.	PX	CN 110129637 A (HUAWEI TECHNOLOGIES CO., LTD.) 16 August 2019 (2019-08-16) claims 1-24	1-24	X	CN 107177761 A (GENESIS ALLOYS (NINGBO) LTD.) 19 September 2017 (2017-09-19) claim 1, and description, paragraph [0003]	1-24	X	CN 104480353 A (LI, Shuqing) 01 April 2015 (2015-04-01) claims 1 and 2	1-24	X	US 7060139 B2 (UES INC) 13 June 2006 (2006-06-13) table 1	1-24	X	US 2007029016 A1 (UNIVERSAL ALLOY CORP) 08 February 2007 (2007-02-08) claim 1	1-24
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Date of the actual completion of the international search 25 June 2020	Date of mailing of the international search report 03 July 2020																	
Name and mailing address of the ISA/CN China National Intellectual Property Administration (ISA/ CN) No. 6, Xitucheng Road, Jimenqiao Haidian District, Beijing 100088 China Facsimile No. (86-10)62019451	Authorized officer Telephone No.																	

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
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Patent document cited in search report			Publication date (day/month/year)	Patent family member(s)			Publication date (day/month/year)
CN	110129637	A	16 August 2019	None			
CN	107177761	A	19 September 2017	None			
CN	104480353	A	01 April 2015	None			
US	7060139	B2	13 June 2006	US	2004089378	A1	13 May 2004
US	2007029016	A1	08 February 2007	None			

REFERENCES CITED IN THE DESCRIPTION

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