

(19)



(11)

EP 2 811 041 B1

(12)

EUROPEAN PATENT SPECIFICATION

(45) Date of publication and mention
of the grant of the patent:

06.07.2016 Bulletin 2016/27

(51) Int Cl.:

C22C 21/02 *(2006.01)*

C22F 1/043 *(2006.01)*

(86) International application number:

PCT/JP2012/052215

(21) Application number: **12867174.0**

(22) Date of filing: **01.02.2012**

(87) International publication number:

WO 2013/114582 (08.08.2013 Gazette 2013/32)

(54) **ALUMINUM ALLOY HAVING EXCELLENT WEAR RESISTANCE, EXTRUDABILITY, AND FORGING WORKABILITY**

ALUMINIUMLEGIERUNG MIT HERVORRAGENDER ABRIEBFESTIGKEIT, EXTRUDIERBARKEIT UND SCHMIEDEBEARBEITBARKEIT

ALLIAGE D'ALUMINIUM PRÉSENTANT UNE RÉSISTANCE À L'USURE, UNE APTITUDE À L'EXTRUSION ET UNE APTITUDE AU FAÇONNAGE PAR FORGEAGE D'EXCELLENTE QUALITÉ

(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**

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(43) Date of publication of application:

10.12.2014 Bulletin 2014/50

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EP 2 811 041 B1

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Description**Technical Field**

5 **[0001]** The present invention relates to aluminum alloy with superior abrasion resistance, extrusion property and forge processing property, such aluminum alloy being used for parts such as compressors in automobiles and home electric appliances.

Background Art

10 **[0002]** Properties such as abrasion resistance and the like are required with aluminum alloy used for compressors and the like in automobiles and home electric appliances. For example, regarding an aluminum alloy used for compressors, Si is added to the Al-Si by 10 mass% (herein after referred to as %) or more, in order to improve abrasion resistance and to decrease the rate of thermal expansion. Patent Literature 1 discloses an aluminum alloy for sliding use with
 15 superior fatigue resistance and seizure resistance. In order to obtain such fatigue resistance and seizure resistance, Si is added to the aluminum alloy as an essential element by 1 to 15%. However, the literature also discloses that the aluminum alloy becomes brittle when the amount of Si added exceeds 15%.

Citation List**Patent Literature**

[0003] [Patent Literature 1] JP H03-006345

SUMMARY OF INVENTION**Technical Problem**

30 **[0004]** As mentioned above, aluminum alloys used for compressors and the like are added with a quite amount of Si to obtain the required properties of superior abrasion resistance, rate of thermal expansion and the like. Although such aluminum alloys are improved in abrasion resistance, rate of thermal expansion and the like, they have problems in that processability such as extrusion processability may decrease and surface texture may deteriorate. This is observed since processability decreases by increasing the concentration of additives in the aluminum alloy. In particular, Si added to the aluminum alloy for improving abrasion resistance decreases the productivity in the processes of extrusion process
 35 and forge process. In practical use, abrasion resistance, rate of thermal expansion and the like of the aluminum alloy often exceed the degree required for its actual use. Therefore, when such an extremely superior abrasion resistance and the like are not necessary, it is desirable to optimize the required properties (such as abrasion resistance) of the aluminum alloy within the required degree, from the view of productivity.

[0005] Accordingly, by balancing the required property and the productivity as necessary, aluminum alloy with highly advantageous effect in cost can be obtained without losing productivity.

[0006] Thus, development of a balanced aluminum alloy with required property while suppressing the loss of productivity to its minimum is desired.

[0007] Taking the afore-mentioned circumstances into consideration, an object of the present invention is to provide an aluminum alloy of Al-Si series which possesses superior extrusion property and forge property, and also enables the
 45 production of forged products maintaining their abrasion resistance.

Solution to Problem

50 **[0008]** The present inventors have made a diligent investigation and found that an aluminum alloy with balanced required properties and productivity can be obtained, by adjusting the amount of each compositions and controlling the size of eutectic Si. That is, the present inventors have found that the object of the present invention can be achieved by the following means.

[0009] That is, according to the present invention, an aluminum alloy possessing superior abrasion resistance, extrusion property and forging property, comprising: 5.5 to 7.0 mass% (hereinafter referred to as %) of Si, 1.0 to 2.0% of Cu, 0.4 to 0.8% of Mg, 0.05 to 0.15% of Cr, 0.05 to 0.25% of Ni, with the rest consisting of Al and unavoidable impurities, wherein Sc (defined as the size of an eutectic Si in the central portion of the cross section which is vertical with respect to the longitudinal direction of the aluminum alloy extruded) and Ss (defined as the size of the eutectic Si at the surface side of the cross section which is vertical with respect to the longitudinal direction of the aluminum alloy extruded) satisfies

an equation of " $Sc-Ss \leq 15 \mu m^2$ ", and the number of the eutectic Si particles having the size of $20 \mu m^2$ or smaller is 1000 to 3000 /mm², is provided.

[0010] Preferably, an aluminum alloy with superior abrasion resistance, extrusion property and forge processing property further containing 0.01 to 0.05% of Sr is provided.

Advantageous Effects of Invention

[0011] According to the present invention, aluminum alloy material for manufacturing extrusion material and forged material with superior extrusion property and forge processing property, while also maintaining abrasion resistance, can be provided by controlling the content of each composition and the size of the eutectic Si in the aluminum alloy.

Brief Description of the Drawing

[0012] [FIG 1]

This is a figure showing the forge processing of the extruded product manufactured by extrusion.

Description of Embodiments

[0013] Hereinafter, the embodiments of the present invention will be described.

[0014] First, each of the elements added to the aluminum alloy will be explained.

[0015] Si contributes to the improvement in abrasion resistance by forming a Si compound. In addition, Si, together with Mg, forms Mg_2Si , and thereby contributes to the improvement in strength. When the amount of Si added is less than 5.5%, the effect observed for the improvement in strength and abrasion resistance is low. When the amount of Si added exceeds 7.0%, the surface texture deteriorates, and the extrusion property lowers.

[0016] Cu contributes to the improvement in strength. When the amount of Cu added is less than 1.0%, the effect observed for the improvement in strength is low. When the amount of Cu added exceeds 2.0%, the extrusion processability and corrosion resistance lowers.

[0017] Mg, together with Si, forms Mg_2Si and contributes to the improvement in strength. When the amount of Mg added is less than 0.4%, its effect is low. When the amount of Mg added exceeds 0.8%, the extrusion processability lowers. Preferably, Mg is added by 0.55 to 0.65%.

[0018] Cr is effective for refining the crystalline grain, and contributes to the improvement in strength. When the amount of Cr added is less than 0.05%, such effect is low. When the amount of Cr added exceeds 0.15%, further increase in such effect cannot be observed. Preferably, Cr is added by 0.07 to 0.10%.

[0019] Ni is effective for improving heat resistance and abrasion resistance, and also contributes to the improvement in strength. When the amount of Ni added is less than 0.05%, such effect is low. When the amount of Ni added exceeds 0.25%, further increase in such effect cannot be observed. In addition, extrusion property lowers. Preferably, Ni is added by 0.07 to 0.13%.

[0020] Sr, by being added, is an element which contributes to the improvement in mechanical properties. Sr is used for the modification treatment of the crystallized Si, and addition of Sr gives fine crystals of Si. The amount of Sr added is preferably 0.01 to 0.05%. When the amount of Sr added is less than 0.01%, such effect is low. When the amount of Sr added exceeds 0.05%, further increase in such effect cannot be observed.

[0021] Fe and Mn are contained by 0.5% or less, since these elements form compounds with other additive elements and thus leads to lowering of the effects obtained by the additive elements.

[0022] Here, the aluminum alloy according to the present invention consists of the afore-mentioned elements, unavoidable impurities and Al. For example, the aluminum alloy may contain a small amount of Ti, Zr or Zn in the range so long as it does not impair the effect of the present invention. Such range is 0.05% or less.

[0023] The uniformity of surface texture and abrasion resistance in extrusion material and forged material depend on the size and distribution of the eutectic Si in these materials, since eutectic Si have influence on such properties. That is, the aluminum alloy of the present invention attained the superior extrusion property and forge processing property by controlling the content of Si and other compositions. In addition, by controlling the size and distribution of the eutectic Si, variation in the surface texture and the properties among the portions of the material can be avoided. Therefore, the present invention can provide extrusion material and forged material having uniform properties with high productivity.

[0024] When Ss and Sc are controlled so as to satisfy the equation of " $Sc-Ss \leq 15 \mu m^2$ ", the surface texture of the extrusion material becomes superior, and the variation in abrasion resistance among the surface side and the central portion of the extrusion material can be suppressed. Here, regarding the size of eutectic Si, Ss is obtained as the size of eutectic Si as follows: A cross section obtained by cutting the extrusion material in the vertical direction with respect to the longitudinal direction thereof is used for the observation. The size of the eutectic Si existing slightly inward of $50 \mu m$ from the surface side of the cross section of the extrusion material is observed under an optical microscope with

magnification of 100 times. Within this visual field under the microscope, the size of the eutectic Si is observed for four sites, each site being placed with an interval of 90 degrees of central angle, with respect to the center of the visual field. S_s refers to the largest size of eutectic Si thus observed. S_c is defined as the size of eutectic Si observed at the central portion of the cross section of the extrusion material under an optical microscope with magnification of 100 times. The

size of eutectic Si in the present invention means the crystal area of the eutectic Si.

[0025] Further, the roughness of the surface of the extrusion material can be suppressed by keeping the size of the eutectic Si contained in the extrusion material 20 μ m² or smaller. In addition, the number of eutectic Si particles should be kept in the range of 1000 to 3000 /mm² in order to obtain the abrasion resistance. When the number of eutectic Si particles with the size of 20 μ m² or smaller is less than 1000 /mm², the effect on abrasion resistance after the material being forged is low. When the number of eutectic Si particles exceeds 3000 /mm², the extrusion property and the forge processing property are inhibited.

[0026] Here, it should be noticed that there is no particular limitation with respect to the production conditions and the thermal refining of the aluminum alloy of the present invention. The thermal refining should be selected depending on the intended application, within the usual production conditions.

[0027] When the extrusion material is used as the forged product, the processability during the forging process is influenced by the hardness of the material. Therefore, the type of thermal refining adopted for the extrusion material of the present invention is preferably F, T1 or O, and more preferably O.

[0028] In addition, the type of thermal refining after the forging process should be selected depending on the required properties. Here, in the present invention, T6 is preferable.

Examples

[0029] The present invention will be described in detail by referring to the Examples. However, the present invention shall not be limited to these Examples.

[0030] First, each of the alloy having the composition described in Table 1 was heated within the temperature range of 700°C to 740°C to give the molten aluminum alloy, and then molding was conducted using a metallic mold. The amount of cooling water was adjusted to 70 to 100 L/min.

[0031] After obtaining ingots with 220mm diameter, these ingots were subjected to surface finishing for four hours at 490°C. The ingots were then extruded through a single hole at 500°C to give a round bar with 30mm diameter.

[0032] The samples thus obtained as the extrusion materials were subjected to observation. Here, the cross section which is vertical with respect to the longitudinal direction of the extrusion material was used for such observation. The size of the eutectic Si existing slightly inward of 50 μ m from the surface side of the cross section of the extrusion material was observed under an optical microscope with magnification of 100 times. The largest size of the eutectic Si (S_s) was obtained by observing four sites within this visual field under the microscope, each site being placed with an interval of 90 degrees of central angle, with respect to the center of the visual field. Further, the size of eutectic Si at the central portion (S_c) was observed at the cross section of the extrusion material under an optical microscope with magnification of 100 times. Here, the size and the number of the eutectic Si particles were analyzed using the software "image analysis software A-ZO-KUN" available from Asahi Kasei Engineering Corporation. Surface texture was evaluated by stroking the surface with a pencil with hardness of HB, and the results were judged as passed "Good" when no scratch was observed, and the results were judged as failed "Not Good" when scratch was observed. The results are shown in Table 2. Samples which satisfied the predetermined criteria were judged as passed, and samples which did not meet the predetermined criteria were judged as failed.

[0033] Next, the round bars were subjected to annealing treatment for five hours at 400°C to give an O-material. Before evaluating the forged product, the samples were confirmed that the size and number of eutectic Si particles were in the range of the present invention.

[0034] The round bars were then cut by 100mm length in the longitudinal direction, and were subsequently subjected to upset forging with the processing rate of 80%. The forged products were then subjected to solution treatment for two hours at 520°C, followed by immediate heat treatment with 50°C water. The forged products further went through artificial aging treatments for ten hours at 180°C to give forged products with thermal refining of T6.

[0035] Here, the processing rate for the upset forging is a value obtained by calculation using the formula: $(r_1 - r_2) / r_1 \times 100$ with respect to Fig. 1.

[0036] Tensile strength test, observation of appearance after upset forging and abrasion test were conducted for the test samples of forged alloy products obtained as above. Results are given in Table 3.

(1) Appearance after upset forging

[0037] Appearance after upset forging with the processing rate of 80 % was observed. Samples with no cracks were judged as passed (shown as "Good"), and samples with cracks were judged as failed (shown as "Not Good").

(2) Tensile strength test

[0038] Test pieces for the tensile strength test were prepared so that the longitudinal direction of the extrusion bar is used for the longitudinal side of the test piece. The test pieces were prepared in accordance with the Japanese Industrial Standards (JIS) as test piece No. 4. The results of the test were evaluated as "passed" when the tensile strength (TS) was 300 MPa or higher, and were evaluated as "failed" when TS was lower than such value.

(3) Abrasion test

[0039] Comparative abrasion quantity was evaluated using the Ogoshi-type abrasion tester. Here, the conditions for the test were arranged as follows: gear oil (75W-90) was used as the lubricant, SCM415 was used as the opposite material, abrasion distance was set to 1200m, and the load was set to 19kgf. The results of the test were evaluated as "passed" when the comparative abrasion quantity was 5.0×10^{-9} or lower, and were evaluated as "failed" when the comparative abrasion quantity was higher than such value.

[Table 1]

		Composition									
		Si	Fe	Cu	Mn	Mg	Cr	Ni	Zn	Ti	Sr
Example	1	6.5	—	1.7	—	0.7	0.15	0.25	—	—	0.03
	2	5.5	—	1.3	—	0.5	0.05	0.05	—	—	—
	3	6.0	0.4	1.5	—	0.6	0.10	0.15	—	0.02	0.04
	4	7.0	—	1.3	0.4	0.5	0.08	0.18	—	—	0.02
	5	6.4	—	1.0	—	0.7	0.08	0.25	—	—	0.02
	6	6.5	0.2	1.5	—	0.5	0.08	0.09	—	—	0.02
	7	6.2	—	1.5	—	0.7	0.07	0.17	—	—	0.02
	8	6.1	—	1.7	—	0.4	0.08	0.17	0.03	—	—
	9	6.3	—	1.7	0.3	0.5	0.08	0.24	—	—	0.05
	10	6.1	—	2.0	—	0.8	0.08	0.09	—	—	0.01
Comparison Example	11	7.5	—	1.7	—	0.7	0.15	0.25	—	—	0.03
	12	4.5	—	1.3	0.2	0.5	0.05	0.05	—	—	—
	13	4.5	—	0.9	—	0.5	0.05	0.05	—	0.03	0.02
	14	7.5	—	2.2	—	0.9	0.20	0.15	—	—	0.03
	15	5.7	—	1.3	—	0.5	0.07	0.06	—	—	—
	16	11.0	0.4	3.8	—	0.6	0.10	0.25	—	—	0.06
	17	10.0	—	1.5	—	0.3	0.10	0.15	0.02	—	—

[Table 2]

		Size of Eutectic Si Particle at Surface Side (Ss) [μm^2]	Size of Eutectic Si Particle at Central Portion (Sc) [μm^2]	Sc-Ss [μm^2]	Number of Eutectic Si Particles Having the Size of 20 μm^2 or Smaller [particles/mm ²]	Surface Texture
Example	1	9	20	11	3000	Good
	2	8	10	2	1000	Good
	3	11	17	6	1500	Good
	4	15	20	5	2000	Good
	5	14	16	2	1300	Good
	6	10	18	8	1200	Good
	7	11	12	1	1100	Good
	8	8	12	4	2000	Good
	9	19	20	1	1100	Good
	10	5	20	15	1500	Good
Comparison Example	11	11	27	16	1000	Not Good
	12	7	23	16	900	Not Good
	13	9	21	12	1500	Not Good
	14	14	25	11	1200	Not Good
	15	11	28	17	1200	Not Good
	16	14	22	8	3100	Not Good
	17	11	27	16	2500	Not Good

[Table 3]

		Appearance After Forging	Tensile Test TS(MPa)	Comparative Abrasion Quantity (mm ² /kgf)
Example	1	Good	372	3.0×10^{-9}
	2	Good	345	3.8×10^{-9}
	3	Good	350	3.6×10^{-9}
	4	Good	387	3.0×10^{-9}
	5	Good	379	3.0×10^{-9}
	6	Good	382	3.0×10^{-9}
	7	Good	388	3.0×10^{-9}
	8	Good	356	3.0×10^{-9}
	9	Good	379	3.0×10^{-9}
	10	Good	392	3.6×10^{-9}
Comparison Example	11	Not Good	397	1.7×10^{-9}
	12	Good	290	5.1×10^{-9}
	13	Good	280	5.1×10^{-9}
	14	Not Good	398	1.7×10^{-9}
	15	Good	340	3.5×10^{-9}
	16	Not Good	430	1.2×10^{-9}
	17	Not Good	360	1.4×10^{-9}

[0040] As shown in Table 1 and Table 2, the extrusion materials 1 to 10 according to the present invention showed superior surface texture, while the extrusion materials of comparative Examples 11 to 17 showed inferior surface texture.

[0041] Surface texture of Examples 1 to 10 of the present invention are superior since the composition is within the preferred range. That is, their smooth surface provides superior extrusion property and thus productivity is high.

[0042] The composition of the extrusion materials of Comparison Examples 11 to 14, 16 and 17 were out of the preferred range, and thus their surface texture caused the extrusion material to get caught during extrusion, leading to poor extrusion processability.

[0043] The extrusion material of Comparison Example 11 contains a large amount of Si, and the value of Sc-Ss is large. Therefore, the surface texture of the extrusion material caused the extrusion material to get caught during the extrusion, leading to poor extrusion processability.

[0044] The extrusion material of Comparison Example 12 contains a small amount of Si, and the value of Sc-Ss is large. Therefore, the surface texture of the extrusion material caused the extrusion material to get caught during the extrusion, leading to poor extrusion processability.

[0045] The extrusion material of Comparison Example 13 contains a small amount of Si and Cu. Therefore, the surface texture of the extrusion material caused the extrusion material to get caught during the extrusion, leading to poor extrusion processability.

[0046] The extrusion material of Comparison Example 14 contains a large amount of Si, Cu, Mg and Cr. Therefore, the surface texture of the extrusion material caused the extrusion material to get caught during the extrusion, leading to poor extrusion processability.

[0047] Sr contained in the extrusion material of Comparison Example 16 is out of the preferred range, and the number of eutectic Si particles having the size of $20\mu\text{m}^2$ or smaller is large. Therefore, the surface texture of the extrusion material caused the extrusion material to get caught during the extrusion, leading to poor extrusion processability.

[0048] The extrusion material of Comparison Example 17 contains a large amount of Si, contains a small amount of Mg, and the value of Sc-Ss is large. Therefore, the surface texture of the extrusion material caused the extrusion material to get caught during the extrusion, leading to poor extrusion processability.

[0049] The composition of the extrusion material of Comparison Example 15 is within the preferred range, however, the value of Sc-Ss is large. Therefore, the surface texture of the extrusion material caused the extrusion material to get caught during the extrusion, leading to poor extrusion processability.

[0050] As shown in Table 3, Examples 1 to 10 according to the present invention showed superior appearance after forging, tensile strength and comparative abrasion quantity, while the Comparison Examples 11 to 17 showed inferior results.

[0051] The forged materials of Examples 1 to 10 according to the present invention showed good results in tensile strength test and possessed good comparative abrasion quantity. In addition, since the forged materials have good forge processing property, the appearance after upset forging was superior.

[0052] The forged material of Comparison Example 11 contains a large amount of Si in its composition. Therefore, crack is observed in the appearance of the material after upset forging. That is, the forge processing property of Comparison Example 11 is low, and thus such material is not suitable as a forge material.

[0053] The forged material of Comparison Example 12 contains a small amount of Si in its composition. Therefore, the tensile strength is low, and the abrasion resistance is inferior. Further, as shown in Table 2, abrasion resistance is inferior since the number of eutectic Si particles having the size of $20\mu\text{m}^2$ or smaller is large.

[0054] The forged material of Comparison Example 13 contains a small amount of Si and Cu in its composition. Therefore, the tensile strength is low, and the abrasion resistance is inferior.

[0055] The forged material of comparative Example 14 contains a large amount of Si, Cu, Mg and Cr. Therefore, crack is observed in the appearance of the material after upset forging. That is, the forge processing property of Comparison Example 14 is low, and thus such material is not suitable as a forge material.

[0056] The forged material of Comparison Example 15 has its composition within the preferred range, and thus all of the appearance after upset forging, results of the tensile strength test and the comparative abrasion quantity were satisfactory. However, as shown in Table 2, the productivity of the extrusion material of comparative Example 15 is poor due to its poor extrusion processability. Therefore, productivity of the forged material of comparison 15 is poor.

[0057] The forged material of Comparison Example 16 contains a large amount of Si, Cu and Sr in its composition. In addition, as shown in Table 2, crack is observed in the appearance of the material after upset forging since the number of eutectic Si particles having the size of $20\mu\text{m}^2$ or smaller is large. That is, the forge processing property of this material is poor, and is not suitable as a forged material.

[0058] The forged material of Comparison Example 17 contains a large amount of Si and a small amount of Mg in its composition. Accordingly, crack is observed in the appearance of the material after upset forging. That is, the forge processing property of this material is poor, and is not suitable as a forged material.

Explanation of Symbols

[0059]

- 1 extruded bar after cutout (before forging)
- 2 forging machine
- r1 height of material before upset forging
- r2 height of material after upset forging

Claims

1. An extruded product of an aluminum alloy possessing superior abrasion resistance, extrusion property and forging property, comprising:

5.5 to 7.0 mass% (hereinafter referred to as %) of Si, 1.0 to 2.0% of Cu, 0.4 to 0.8% of Mg, 0.05 to 0.15% of Cr, 0.05 to 0.25% of Ni, with the rest consisting of Al, 0.5% or less of Fe and Mn, and unavoidable impurities, wherein

Sc (defined as the size of an eutectic Si in the central portion of the cross section of the extruded product which is vertical with respect to the longitudinal direction of the extruded product) and Ss (defined as the size of the eutectic Si at the surface side of the cross section which is vertical with respect to the longitudinal direction of the extruded product) satisfies an equation of " $\text{Sc-Ss} \leq 15 \mu\text{m}^2$ ", and the number of the eutectic Si particles having the size of $20\mu\text{m}^2$ or smaller is 1000 to 3000 per mm^2 .

2. The extruded product of Claim 1, further comprising 0.01 to 0.05% of Sr.

Patentansprüche

1. Extrudiertes Produkt aus einer Aluminiumlegierung mit ausgezeichneter Abriebfestigkeit, Extrudiereigenschaft und Schmiedeeigenschaft, umfassend:

5,5 bis 7,0 Masse% (nachstehend als % bezeichnet) Si, 1,0 bis 2,0 % Cu, 0,4 bis 0,8 % Mg, 0,05 bis 0,15 % Cr, 0,05 bis 0,25 % Ni, wobei der Rest aus Al, 0,5 % oder weniger Fe und Mn und unvermeidbaren Verunreinigungen besteht, wobei

Sc (definiert als die Größe von eutektischem Si im mittleren Teil des Querschnitts des extrudierten Produkts, der senkrecht in Bezug auf die Längsrichtung des extrudierten Produkts ist) und Ss (definiert als die Größe des eutektischen Si an der Oberflächenseite des Querschnitts, der senkrecht in Bezug auf die Längsrichtung des extrudierten Produkts ist) eine Gleichung " $Sc-Ss \leq 15 \mu m^2$ " erfüllen, und die Anzahl der eutektischen Si-Partikel mit der Größe von $20 \mu m^2$ oder kleiner 1000 bis 3000 pro mm^2 beträgt.

2. Extrudiertes Produkt nach Anspruch 1, das weiterhin 0,01 bis 0,05 % Sr umfasst.

Revendications

1. Produit extrudé en alliage d'aluminium présentant des qualités supérieures de résistance à l'abrasion, d'extrusion et de forgeage, comprenant :

de 5,5 à 7,0 % en masse (ci-après abrégé en : %) de Si, de 1,0 à 2,0 % de Cu, de 0,4 à 0,8 % de Mg, de 0,05 à 0,15 % de Cr, de 0,05 à 0,25 % de Ni, le reste consistant en Al, 0,5 % ou moins de Fe et de Mn, et en impuretés inévitables, où

Sc (définie comme la dimension de Si eutectique dans la partie centrale de la section transversale du produit extrudé, perpendiculaire au sens de la longueur du produit extrudé) et Ss (définie comme la dimension de Si eutectique sur le côté de surface de la section transversale, perpendiculaire au sens de la longueur du produit extrudé) satisfont à l'équation :

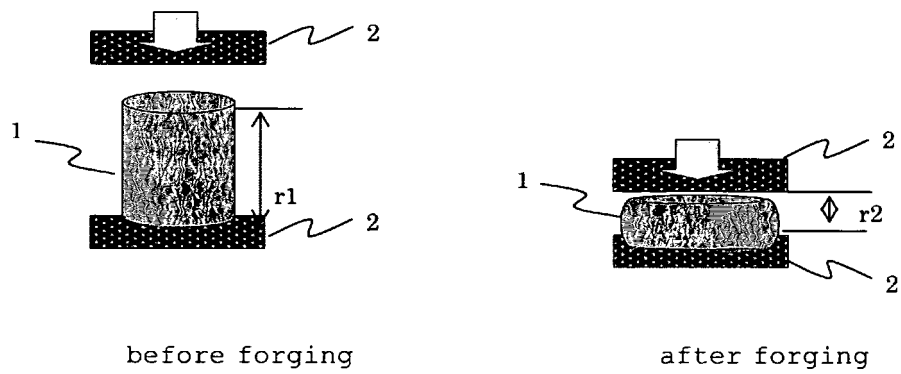
$$Sc-Ss \leq 15 \mu m^2, \text{ et où}$$

et où

le nombre de particules de Si eutectique présentant une dimension égale ou inférieure à $20 \mu m^2$ est compris de 1000 à 3000 par mm^2 .

2. Produit extrudé selon la revendication 1, comprenant en outre de 0,01 à 0,05 % de Sr.

FIG. 1



outline of forging process

REFERENCES CITED IN THE DESCRIPTION

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