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(54) AUTOMOTIVE OUTER PANEL MADE FROM A 6XXX-SERIES ALUMINIUM ALLOY SHEET PRODUCT

AUS BLECHPRODUKT AUS 6XXX-SERIE-ALUMINIUMLEGIERUNG-GEFERTIGTES AUTOMOBILKAROSSERIETEIL

PANNEAU EXTÉRIEUR D'AUTOMOBILE FABRIQUÉ À PARTIR D'UN PRODUIT EN TÔLE D'ALLIAGE D'ALUMINIUM SÉRIE 6XXX

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Description

FIELD OF THE INVENTION

[0001] The invention relates to an automotive outer panel made from a 6xxx-series aluminium alloy sheet product and to a method of manufacturing such a panel.

BACKGROUND OF THE INVENTION

[0002] Generally, outer body panels of a vehicle require excellent physical properties in formability, dent-resistance, corrosion resistance and surface quality. However, the conventional AA5xxx-series alloy sheets have not been favoured because they have low mechanical strength even after press forming and may also exhibit poor surface quality. Therefore, 6xxx-series sheet alloys have been increasingly used. In general, the 6xxx-series alloys provide excellent bake hardenability after painting and high mechanical strength as a result, thus making it possible to manufacture more thin-gauged and more lightweight sheets in combination with a good corrosion resistance and class-A surface finish.

[0003] EP 1 433 866 A2 discloses a heat treated and slow quenched aluminum alloy sheet comprising from about 0.5 to about 0.7 wt.% Si, from about 0.5 to about 0.7 wt.% Mg, from about 0.1 to about 0.3 wt.% Mn, and the balance Al and incidental impurities. US2017/121801A1 also discloses a similar aluminum alloy.

[0004] There is a need for aluminium alloy rolled sheet products for use in automotive panels, in particular automotive outer panels, having in a T4P temper a combination of a relative low yield strength and a high formability, and a high yield strength and tensile strength and a good corrosion resistance after a paint bake cycle.

DESCRIPTION OF THE INVENTION

[0005] As will be appreciated herein below, except as otherwise indicated, aluminium alloy designations and temper designations refer to the Aluminium Association designations in Aluminium Standards and Data and the Registration Records, as published by the Aluminium Association in 2016 and well known to the persons skilled in the art. The temper designations are laid down in European standard EN515.

[0006] For any description of alloy compositions or preferred alloy compositions, all references to percentages are by weight percent unless otherwise indicated.

[0007] The term "up to" and "up to about", as employed herein, explicitly includes, but is not limited to, the possibility of zero weight-percent of the particular alloying component to which it refers. For example, up to 0.15% Zn may include an alloy having no Zn.

[0008] The invention is defined in the appended claims.

[0009] This and other objects and further advantages are met or exceeded by the present invention providing an automotive outer panel made from a 6xxx-series aluminium alloy sheet product consisting of, in wt.%: Si 0.54% to 0.75%, Mg 0.57% to 0.65%, Cu 0.03% to 0.08%, Mn 0.06% to 0.20%, Fe 0.10% to 0.25%, wherein the ratio of Fe to Mn is in a range of 1.0 to 2.30 (Fe:Mn), and wherein the aluminium alloy sheet product has a ratio of Si to Mg of less than 1.20 (Si:Mg) and at least 0.90 (Si:Mg), Cr up to 0.09%, Zn up to 0.15%, V up to 0.04%, Ti up to 0.15%, other elements and unavoidable impurities each up to 0.05%, total up to 0.2%, balance aluminium.

[0010] In accordance with the invention, it has been found that the automotive outer panel made of the defined aluminium alloy sheet product by carefully controlling the compositional ranges of the aluminium alloy (with preferred ranges herein set forth and claimed) and its manufacturing route provides a good balance of low strength and good formability, in particular also a good hemming performance, in a T4P temper (relates to material in a T4 temper and that has undergone a pre-ageing treatment to a pre-age temperature in a range of 90 °C to 105 °C), and a high paint bake response and high strength in a T64 temper (after 2% prestrain and a simulated paint bake cycle of 185°C/20 min). While maintaining this balance, it has been found that the aluminium sheet product has a very good resistance to corrosion. In particular, it has a very good resistance to intergranular corrosion (IGC) when tested in a naturally aged condition after being subjected to a paint bake cycle, as well as after being exposed for 1,000 hours at 150°C. The requirement of a good IGC resistance after 1,000 hours at 150°C is to reflect the extreme situation that the aluminium sheet product when applied in a vehicle body is long term exposed to elevated temperature near heat sources such as an engine, exhaust system or sun rays.

[0011] The aluminium alloy sheet product applied has in a T4P temper a tensile strength (R_m or UTS) of 180 MPa or more, preferably at least 195 MPa, a yield point ($R_{p0.2}$ or YS) of 115 MPa or less when measured within 3-10 days after solution heat treatment and quench, but the yield point ($R_{p0.2}$ or YS) is less than 130 MPa after 6 months storage at ambient (room) temperature, an elongation at break (A_{80mm}) of at least 24%, an uniform elongation (A_g) of at least 20%, a strain hardening exponent ($n_{5\%}$) of at least 0.26. In this temper, it also has an excellent hemming performance, which is preserved for up to 6 months or even more when stored at ambient (room) temperature. The aluminium alloy sheet product has in a T64 temper a tensile strength (R_m) of 260 MPa or more, a yield point ($R_{p0.2}$) of 195 MPa or more, and an elongation

at break (A_{80mm}) of at least 14%.

[0012] In an embodiment, the aluminium alloy sheet product contains at least 0.58% Si, and more preferably at least 0.60%. At Si levels below 0.54%, the yield strength is reduced to a level making the sheet product less suitable for vehicle outer panels. A preferred upper-limit for the Si-content is 0.75%, more preferably 0.70%, and most preferably 0.68%.

[0013] The Mg-content in the aluminium alloy sheet product is at most 0.65%.

[0014] The ratio of wt.% Si to wt.% Mg is less than 1.20 (Si:Mg), and preferably at most 1.10 (Si:Mg) to provide sufficient strength and a high formability in the T4P temper. The ratio of Si to Mg is at least 0.90 (Si:Mg). In an embodiment, the ratio of Si to Mg is at least 0.95 (Si:Mg). This narrow range of Si:Mg ratio is to improve the formability in the T4P temper and to increase the strength in the T64 temper of the aluminium alloy sheet product.

[0015] Copper (Cu) is present in the aluminium alloy sheet product for at least 0.03%. The upper-limit for the Cu-content is 0.08%, and preferably 0.07%.

[0016] In a preferred embodiment of the aluminium alloy sheet product, the manganese (Mn)-content is at least 0.10%. A preferred upper-limit for the Mn-content is 0.18%, and more preferably 0.15%. The purposive addition of Mn in this range in combination with maintaining the Fe/Mn-ratio within the defined ranges provides for a good formability in the T4P condition and provides a very good resistance to intergranular corrosion after artificial ageing. A too high Mn-content has an adverse effect on the elongation.

[0017] A preferred lower-limit for the Fe-content is 0.12%, and preferably 0.15%.

[0018] In a preferred embodiment of the aluminium alloy sheet product, the ratio of wt.% Fe to wt.% Mn is less than 2.0, more preferably less than 1.8 (Fe:Mn). A lower-limit for the Fe to Mn ratio is 1.0, and preferably 1.15.

[0019] Chromium (Cr) can be present in the aluminium alloy sheet product in a range of up to 0.09%. A more preferred upper-limit for the Cr-content is 0.07%, and more preferably 0.04%. A preferred lower limit for the Cr-content is 0.01%.

[0020] Zinc (Zn) is an impurity element that can be tolerated up to about 0.15%, and is preferably as low as possible, e.g. 0.06% or less.

[0021] Zirconium (Zr) is preferentially avoided in the aluminium alloy, and an upper-limit for Zr is 0.02%, preferably 0.01%, and more preferably 0.008%.

[0022] Vanadium (V) can be present in the aluminium alloy sheet product up to about 0.04%. Preferably, the aluminium alloy includes not greater than 0.03% V, and more preferably not greater than 0.02% V, as it may have an adverse effect on the r-value of the aluminium sheet in the T4P temper.

[0023] Titanium (Ti) can be added to the aluminium alloy sheet product amongst others for grain refiner purposes during casting of the aluminium alloy rolling ingots. The addition of Ti should not exceed about 0.15%, and preferably it should not exceed 0.10%. A preferred lower limit for the Ti addition is 0.01%, and typically a preferred upper-limit for Ti is 0.05%, and can be added as a sole element or with either boron or carbon serving as a casting aid, for grain size control.

[0024] Unavoidable impurities can be present each up to 0.05% and the total is up to 0.15%, the balance is made with aluminium.

[0025] The resistance to intergranular corrosion (IGC) after 1,000 hours at 150°C has been tested in accordance with European standard ISO-11846, April 2008, section 6.2.2 Method B. The aluminium sheet product according to this invention has typically a corrosion depth of less than 200μm.

[0026] A preferred thickness of the aluminium alloy sheet product when used as an automotive outer panel is in the range of 0.7 mm to 4.0 mm, and preferably in a range of 0.7 mm to 2.0 mm, for example, a thickness of about 1.0 mm or about 1.3 mm.

[0027] In a preferred embodiment, the aluminium alloy sheet product is formed by a monolithic rolled product and is devoid of any cladding (for example, applied by means of roll bonding or casting technology) made of another aluminium alloy, for example, a dilute Al-Mg alloy or another 6xxx-series alloy or a 3xxx-series alloy. Some of these aluminium alloy clad combinations for automotive sheet products are disclosed in, for example, patent documents WO 2006/053701 A1, WO 2007/129391 A1, WO 2007/128389 A1, and EP 2 156 945 A1.

[0028] The 6xxx-series aluminium alloy sheet product used in accordance with this invention has been manufactured via a method comprising the steps of casting (e.g. direct chill (DC) casting) an ingot of the 6xxx aluminium alloy of defined composition, homogenizing the ingot at a temperature in a range for 520°C to 570°C for at least 5 hours, hot rolling, cold rolling to intermediate gauge, to improve the surface quality of the final sheet product an intermediate annealing (e.g. batch annealing at a temperature of about 345°C to 410°C), cold rolling to a final gauge in a range of 0.7 mm to 4.0 mm (e.g. 0.7 to 2.0 mm), solution heat treating the rolled sheet product, wherein the solution heat treating comprises heating the rolled sheet product to a temperature in the range of 530°C to 570°C and for a time such that substantially all of Mg_2Si, and excess Si, if any, in the rolled sheet product are dissolved into solid solution, and after the solution heat treating, quenching the rolled product.

[0029] Following the solution heat treatment and quenching of the sheet product, the sheet product is subjected to pre-ageing treatment and then natural aged to provide a T4P temper; the natural ageing occurs as a result of storing at ambient (room) temperature, typically for about 72 hours up to 6 months, until forming into an automotive body member, in particular into a three-dimensional automotive outer panel.

[0030] It has been found that the pre-age treatment temperature is a key processing parameter to arrive at the desired balance of mechanical and physical properties in the T4P and T64 temper. A pre-age temperature of about 60°C-75°C does not provide the required level of paint bake response, which is only achieved after pre-ageing at a temperature in a range of 90°C-105°C. The desired pre-age heat treatment comprises of heating the aluminium alloy sheet product to a temperature in a range of 90°C to 105°C followed by immediate coiling the sheet material (coiling temperature is the pre-age temperature) and cooling of the coiled sheet material in an ambient environment to ambient temperature and storing of the cooled coiled material.

[0031] Following the forming operation (e.g. by deep-drawing, pressing, or stamping), the three-dimensional formed part is made part of an assembly of other metal components as is regular in the art for manufacturing vehicle components, and subjected to a paint bake operation to cure any paint or lacquer layer applied. The paint bake operation or cycle comprises one or more sequential short heat treatment in the range of 140°C to 210°C for a period of 10 to less than 40 minutes. A typical paint bake cycle would comprise a first heat treatment of 185°C@20 minutes, cooling to ambient temperature, then 160°C@20 minutes and cooling to ambient temperature. In dependence of the OEM, such a paint bake cycle may comprise of 2 to 5 sequential steps and includes drying steps. For testing purposes, sheet products are commonly subjected to a so-called simulated paint bake cycle 2% prestrain followed by a heat treatment of 185°C@20 minutes only; this would bring the product to a T64 temper. The difference in strength between T64 and T4P is often referred to as the paint-bake response.

[0032] In an aspect of the invention, it relates to the use of an aluminium alloy sheet product as herein described and claimed for an automotive outer panel formed from said aluminium alloy sheet product in T4P temper. The invention also relates to an automotive vehicle door comprising an outer panel made from such an aluminium alloy sheet product.

EXAMPLE 1.

[0033] On an industrial scale of processing DC-cast ingots of three different alloys have been processed into 1.0 mm sheet material and tested for its mechanical properties yield strength (YS), ultimate tensile strength (UTS), elongation at break (A80), uniform elongation Ag, and the n- and r-value (mean over three measurements) and the corrosion resistance in the T4P condition and for its mechanical properties in the T64 condition.

[0034] The IGC corrosion resistance has been tested in accordance with ISO11846 on T4P samples after 1000 hours at 150°C. The deepest penetration in microns is measured, and the mean of three measurements is given here.

[0035] The aluminium alloys have been DC-cast into rolling ingots, then homogenised and hot rolled to a gauge of 8mm. The are first cold rolled to an intermediate gauge of 3mm and batch annealed at about 380°C, then are cold rolled to a final gauge of 1.0 mm. They are then subsequently subject to a continuous solution heat treatment at about 550°C and pre-aging at about 100°C and immediately coiled at this temperature and cooled to room temperature in an ambient environment.

[0036] The composition of the alloys are listed in Table 1, and the mechanical properties are listed in Table 2. Alloys no. 1 and 2 are according to the invention, and Alloy no. 3 is a comparative alloy.

[0037] The deepest IGC penetration for alloys no. 1, 2, and 3 was respectively 63 micron, 86 micron, and 76 micron.

Table 1. Alloy compositions, the Cr, V and Zn are at impurity level, balance is made by other impurities and aluminium.

Alloy	Element										
	Si	Fe	Cu	Mn	Mg	Cr	Ti	V	Zn	Fe/Mn	Si/Mg
1	0.67	0.21	0.04	0.127	0.63	0.01	0.02	0.01	0.006	1.6	1.0
2	0.65	0.21	0.04	0.127	0.63	0.01	0.02	0.01	0.006	1.6	1.0
3	0.70	0.21	0.04	0.129	0.53	0.01	0.02	0.01	0.06	1.6	1.3

Table 2. Properties of the sheet material.

Alloy	T4P						T64		
	YS (MPa)	UTS (MPa)	A80 (%)	Ag (%)	n	r	YS (MPa)	UTS (MPa)	A80 (%)
1	96.0	200.2	24.2	20.2	0.30	0.62	203.7	262.5	18.2
2	94.1	200.2	24.2	21.9	0.31	0.65	206.2	264.8	17.9
3			23.0						

[0038] From the results of Table 2, it can be seen that the alloy according to the invention meets the requirements that in a

T4P temper it has a tensile strength of 180 MPa or more, preferably at least 195 MPa, a yield point of 115 MPa or less when measured within 3-10 days after solution heat treatment and quench, and an elongation at break of at least 24%, an uniform elongation of at least 20%, a strain hardening exponent (n-value) of at least 0.26. Although not listed in Table 2 above, the yield point was less than 130 MPa after 6 months storage at room temperature. The sheet product has an IGC corrosion resistance well below the required threshold of less than 200 micron. This makes the sheet product an ideal candidate for manufacturing automotive body panels therefrom requiring a very good formability and good corrosion resistance. The aluminium alloy sheet product has in a T64 temper a tensile strength of 260 MPa or more, a yield point of 195 MPa or more, and an elongation at break of at least 14%.

[0039] From the comparison with alloy 3, it can be seen that although the IGC corrosion resistance remains at a favourable level, the formability by a reducing of the elongation at break is adversely affected when the aluminium alloy composition is outside the claimed range.

EXAMPLE 2.

[0040] On an industrial scale of processing, DC-cast ingots of an aluminium alloy according to this invention has been processed in accordance with the invention into 1.0mm sheet material except for a difference in the pre-age temperature. The composition of the aluminium alloy is listed in Table 2. One alloy has been pre-aged at about 100°C (4A) and one at about 70°C (4B) and immediately coiled at this temperature and cooled to room temperature in an ambient environment.

[0041] For both sheet materials 4A and 4B, the YS and UTS in T4P and T64 condition have been measured (mean over three samples) and are listed in Table 4.

Table 3. Alloy composition, the Cr, V and Zn are at impurity level, balance is made by other impurities and aluminium.

Alloy	Element										
	Si	Fe	Cu	Mn	Mg	Cr	Ti	V	Zn	Fe/Mn	Si/Mg
4	0.58	0.20	0.03	0.13	0.63	0.01	0.02	0.01	0.01	1.53	0.92

Table 4. Properties of the sheet material.

Alloy	T4P		T64		
	YS (MPa)	UTS (MPa)	YS (MPa)	UTS (MPa)	A80 (%)
4A	100	199	203	263	17.0
4B	104	199	193	254	18.5

[0042] From the results of Table 4, it can be seen that an aluminium alloy having otherwise been processed in the same manner except for a difference in the pre-age temperature, that the pre-age temperature plays an important role in achieving in the T64 condition a tensile strength of 260 MPa or more, a yield point of 195 MPa or more, and an elongation at break of at least 14%. A low pre-age temperature (here about 70°C) does not provide sufficient paint-bake response.

EXAMPLE 3.

[0043] An aluminium alloy having a composition (see Table 5) outside the current invention has been processed on an industrial scale to 1.0 mm sheet material and similar as in Example 1 is tested for its yield strength, ultimate tensile strength, elongation at break, uniform elongation Ag, and the n- and r-value (mean over three measurements) and the corrosion resistance in the T4P condition and for its mechanical properties in the T64 condition. The results are listed in Table 6. The deepest IGC penetration in T4P after 1000 hours at 150°C was 239 micron.

Table 5. Alloy composition, the Cr, V and Zn are at impurity level, balance is made by other impurities and aluminium.

Alloy	Element										
	Si	Fe	Cu	Mn	Mg	Cr	Ti	V	Zn	Fe/Mn	Si/Mg
4	1.22	0.26	0.06	0.12	0.39	0.02	0.02	0.001	0.02	2.1	3.1

Table 6. Properties of the sheet material.

Alloy	T4P						T64		
	YS (MPa)	UTS (MPa)	A80 (%)	Ag (%)	n	r	YS (MPa)	UTS (MPa)	A80 (%)
1	109	226	26.9	22.8	0.31	0.68	331	286	20.4

[0044] From the results of Table 6, it can be seen that the aluminium alloy meets the requirements that in a T4P temper it has a tensile strength of 180 MPa, a yield point of 115 MPa or less when measured within 3-10 days after solution heat treatment and quench, and an elongation at break of at least 24%, an uniform elongation of at least 20%, together with a strain hardening exponent (n-value) of at least 0.26. However, due to the difference in Mg- and Si-content compared to the aluminium alloy according to this invention the IGC corrosion resistance measured in accordance with ISO11846 on T4P samples after 1000 hours at 150°C was significantly worse.

Claims

1. An automotive outer panel made from a 6xxx-series aluminium alloy sheet product, obtained by a method comprising the steps of:
casting an ingot having a composition consisting of, in wt.%:

Si	0.54% to 0.75%,
Mg	0.57% to 0.65%,
Cu	0.03% to 0.08%,
Mn	0.06% to 0.20%,
Fe	0.10% to 0.25%,

wherein the ratio of Fe to Mn is in a range of 1.0 (Fe:Mn) to 2.30 (Fe:Mn),

Cr	up to 0.09%,
Zn	up to 0.15%,
V	up to 0.04%,
Ti	up to 0.15%,

other elements and unavoidable impurities each up to 0.05%, total up to 0.2%, balance aluminium, and wherein the aluminium alloy sheet product has a ratio of Si to Mg of less than 1.20 (Si:Mg) and at least 0.90 (Si:Mg);

- homogenising the ingot;
- hot rolling;
- cold rolling into sheet having a final gauge of 0.7 mm to 4.0 mm;
- solution heat treating the cold rolled sheet material, followed by quenching;
- heating of the solution heat-treated and quenched cold rolled sheet material to a pre-age temperature in a range of 90°C to 105°C, coiling of the sheet material at a temperature in said temperature range of 90°C to 105°C, and cooling of the coil to ambient temperature in an ambient environment;
- natural ageing and storing.

2. An automotive outer panel according the claim 1, wherein the aluminium alloy sheet product has the ratio of Fe to Mn less than 2.0, and preferably less than 1.8.

3. An automotive outer panel according to claim 1 or 2, wherein the aluminium alloy sheet product has a ratio of Si to Mg of at most 1.10.

4. An automotive outer panel according to any one of claims 1 to 3, wherein the aluminium alloy sheet product has a Mn-content of at least 0.10%, and preferably of at most 0.18%.

5. An automotive outer panel according to any one of claims 1 to 4, wherein the aluminium alloy sheet product has a Si-content of at least 0.58%, and preferably of at least 0.60%.

6. An automotive outer panel according to any one of claims 1 to 5, wherein the aluminium alloy sheet product has a Si-content of at most 0.70%, and preferably of at most 0.68%.

7. An automotive outer panel according to any one of claims 1 to 6, wherein the aluminium alloy sheet product has an Fe-content of at least 0.12%, and preferably of at least 0.15%.

8. Use of an aluminium alloy sheet product as defined in any one of claims 1 to 7 in an automotive outer panel, and preferably wherein the aluminium alloy sheet product has been formed in the T4P condition.

9. A motor vehicle door comprising an automotive outer panel made from an aluminium sheet product as defined in any one of claims 1 to 7.

10. Method of producing an automotive outer panel, comprising the steps of:

- casting an ingot having a composition according to any one of claims 1 to 7;
- homogenising the ingot;
- hot rolling;
- cold rolling into sheet having a final gauge of 0.7 mm to 4.0 mm;
- solution heat treating the cold rolled sheet material, followed by quenching;
- heating of the solution heat-treated and quenched cold rolled sheet material to a pre-age temperature in a range of 90°C to 105°C, coiling of the sheet material at a temperature in said temperature range of 90°C to 105°C, and cooling of the coil to ambient temperature in an ambient environment;
- natural ageing and storing.

11. Method according to claim 10, wherein further the aluminium sheet in a forming operation is formed into an automotive body member or panel, preferably into a three-dimensional automotive outer panel.

12. Method according to any one of claims 10 or 11, wherein solution heat treating the cold rolled sheet material is at a temperature in the range of 530°C to 570°C.

13. Method according to any one of claims 10 to 12, wherein following the hot rolling, the aluminium is cold rolled to intermediate gauge, intermediate annealed, preferably by batch annealing at a temperature in a range of 345°C to 410°C, and cold rolled to a sheet having a final gauge of 0.7 mm to 4.0 mm.

Patentansprüche

1. Außenpaneel für Kraftfahrzeuge, hergestellt aus einem Blechprodukt aus einer Aluminiumlegierung der 6xxx-Serie, erhalten durch ein Verfahren, das die folgenden Schritte umfasst:
Gießen eines Barrens mit einer Zusammensetzung bestehend aus, in Gew.-%:

Si	0,54% bis 0,75%,
Mg	0,57% bis 0,65%,
Cu	0,03% bis 0,08%,
Mn	0,06% bis 0,20%,
Fe	0,10% bis 0,25%,

wobei das Verhältnis von Fe zu Mn in einem Bereich von 1,0 (Fe:Mn) bis 2,30 (Fe:Mn) liegt,

Cr	bis zu 0,09%,
Zn	bis zu 0,15%,
V	bis zu 0,04%,

(continued)

Ti	bis zu 0,15%,

andere Elemente und unvermeidbare Verunreinigungen jeweils bis zu 0,05 %, insgesamt bis zu 0,2 %, Rest Aluminium, und wobei das Blechprodukt aus Aluminiumlegierung ein Verhältnis von Si zu Mg von weniger als 1,20 (Si:Mg) und mindestens 0,90 (Si:Mg) aufweist;

- Homogenisieren des Barrens;
- Warmwalzen;
- Kaltwalzen zu Blechen mit einer Enddicke von 0,7 mm bis 4,0 mm;
- Lösungsglühen des kaltgewalzten Blechmaterials und anschließendes Abschrecken;
- Erwärmen des lösungsgeglühten und abgeschreckten kaltgewalzten Blechmaterials auf eine Voralterungstemperatur im Bereich von 90 °C bis 105 °C, Aufwickeln des Blechmaterials bei einer Temperatur in dem genannten Temperaturbereich von 90 °C bis 105 °C und Abkühlen der Rolle auf Umgebungstemperatur in einer umgebenden Umgebung;
- natürliche Alterung und Lagerung.

2. Außenpaneel für Kraftfahrzeuge nach Anspruch 1, wobei die das Blechprodukt aus Aluminiumlegierung ein Verhältnis von Fe zu Mn von weniger als 2,0 und vorzugsweise weniger als 1.8 aufweist.

3. Außenpaneel für Kraftfahrzeuge nach Anspruch 1 oder 2, wobei das Blechprodukt aus Aluminiumlegierung ein Verhältnis von Si zu Mg von höchstens 1,10 aufweist.

4. Außenpaneel für Kraftfahrzeuge nach einem der Ansprüche 1 bis 3, wobei das Blechprodukt aus Aluminiumlegierung einen Mn-Gehalt von mindestens 0,10 %, und vorzugsweise von höchstens 0,18 % aufweist.

5. Außenpaneel für Kraftfahrzeuge nach einem der Ansprüche 1 bis 4, wobei das Blechprodukt aus Aluminiumlegierung einen Si-Gehalt von mindestens 0,58 %, und vorzugsweise von mindestens 0,60 % aufweist.

6. Außenpaneel für Kraftfahrzeuge nach einem der Ansprüche 1 bis 5, wobei das Blechprodukt aus Aluminiumlegierung einen Si-Gehalt von höchstens 0,70 % aufweist, und vorzugsweise von höchstens 0,68 %.

7. Außenpaneel für Kraftfahrzeuge nach einem der Ansprüche 1 bis 6, wobei das Blechprodukt aus Aluminiumlegierung einen Fe-Gehalt von mindestens 0,12 %, vorzugsweise von mindestens 0,15 % aufweist

8. Verwendung eines Blechproduktes aus Aluminiumlegierung nach einem der Ansprüche 1 bis 7 in einem Außenpaneel eines Kraftfahrzeugs, wobei das Blechprodukt aus Aluminiumlegierung vorzugsweise im T4P-Zustand geformt worden ist.

9. Kraftfahrzeugtür mit einem Außenpaneel, das aus einem Aluminiumblechprodukt nach einem der Ansprüche 1 bis 7 hergestellt ist.

10. Verfahren zur Herstellung eines Außenpaneels für Kraftfahrzeuge, das die folgenden Schritte umfasst:

- Gießen eines Barrens mit einer Zusammensetzung nach einem der Ansprüche 1 bis 7;
- Homogenisieren des Barrens;
- Warmwalzen;
- Kaltwalzen zu Blechen mit einer Enddicke von 0,7 mm bis 4,0 mm;
- Lösungsglühen des kaltgewalzten Blechmaterials und anschließendes Abschrecken;
- Erwärmen des lösungsgeglühten und abgeschreckten kaltgewalzten Blechmaterials auf eine Voralterungstemperatur im Bereich von 90 °C bis 105 °C, Aufwickeln des Blechmaterials bei einer Temperatur in dem genannten Temperaturbereich von 90 °C bis 105 °C und Abkühlen der Rolle auf Umgebungstemperatur in einer umgebenden Umgebung;
- natürliche Alterung und Lagerung.

11. Verfahren nach Anspruch 10, wobei ferner das Aluminiumblech in einer Umformung in ein Kraftfahrzeug-Karosserieteil oder -paneel geformt wird, vorzugsweise in ein dreidimensionales Außenpaneel für Kraftfahrzeuge.

12. Verfahren nach einem der Ansprüche 10 oder 11, wobei das Lösungsglühen des kaltgewalzten Blechmaterials bei einer Temperatur im Bereich von 530°C bis 570°C erfolgt.

13. Verfahren nach einem der Ansprüche 10 bis 12, wobei das Aluminium nach dem Warmwalzen auf eine mittlere Dicke kaltgewalzt, zwischengeglüht, vorzugsweise durch Chargenglühen bei einer Temperatur im Bereich von 345°C bis 410°C, und zu einem Blech mit einer Enddicke von 0,7 mm bis 4,0 mm kaltgewalzt wird.

Revendications

1. Panneau extérieur automobile fait à partir d'un produit en tôle d'alliage d'aluminium de série 6xxx, obtenu par un procédé comprenant les étapes suivantes :
coulage d'un lingot ayant une composition comprenant, en %m :

Si	0,54 % à 0,75 %,
Mg	0,57 % à 0,65 %,
Cu	0,03 % à 0,08 %,
Mn	0,06 % à 0,20 %,
Fe	0,10 % à 0,25 %,

dans lequel le ratio de Fe sur Mn est dans une plage allant de 1,0 (Fe:Mn) à 2,30 (Fe:Mn),

Cr	jusqu'à 0,09 %,
Zn	jusqu'à 0,15 %,
V	jusqu'à 0,04 %,
Ti	jusqu'à 0,15 %,

d'autres éléments et impuretés inévitables allant chacun jusqu'à 0,05 %, au total jusqu'à 0,2 %, le reste étant de l'aluminium, et le produit en tôle d'alliage d'aluminium ayant un ratio de Si sur Mg inférieur à 1,20 (Si:Mg) et d'au moins 0,90 (Si:Mg) ;

- homogénéisation du lingot ;
- laminage à chaud ;
- laminage à froid pour obtenir une tôle ayant un calibre final de 0,7 mm à 4,0 mm ;
- traitement thermique par solution du matériau en tôle laminé à froid, puis trempe ;
- chauffe du matériau en tôle laminé à froid soumis au traitement thermique par solution et à la trempe à une température de pré-vieillissement dans une plage de 90 °C à 105 °C, enroulement du matériau en tôle à une température dans ladite plage de température de 90 °C à 105 °C, et refroidissement du rouleau à température ambiante dans un environnement ambiant ;
- vieillissement naturel et stockage

2. Panneau extérieur automobile selon la revendication 1, dans lequel le produit en tôle d'alliage d'aluminium a le ratio de Fe sur Mn inférieur à 2,0, et de préférence inférieur à 1,8.

3. Panneau extérieur automobile selon la revendication 1 ou 2, dans lequel le produit en tôle d'alliage d'aluminium a un ratio de Si sur Mg d'au plus 1,10.

4. Panneau extérieur automobile selon l'une quelconque des revendications 1 à 3, dans lequel le produit en tôle d'alliage d'aluminium a une teneur en Mn d'au moins 0,10 %, et de préférence d'au plus 0,18 %.

5. Panneau extérieur automobile selon l'une quelconque des revendications 1 à 4, dans lequel le produit en tôle d'alliage d'aluminium a une teneur en Si d'au moins 0,58 %, et de préférence d'au moins 0,60 %.

6. Panneau extérieur automobile selon l'une quelconque des revendications 1 à 5, dans lequel le produit en tôle d'alliage d'aluminium a une teneur en Si d'au plus 0,70 %, et de préférence d'au plus 0,68 %.

7. Panneau extérieur automobile selon l'une quelconque des revendications 1 à 6, dans lequel le produit en tôle d'alliage d'aluminium a une teneur en Fe d'au moins 0,12 %, et de préférence d'au moins 0,15 %.

8. Utilisation d'un produit en tôle d'alliage d'aluminium tel que défini dans l'une quelconque des revendications 1 à 7 dans un panneau extérieur automobile, et de préférence dans laquelle le produit en tôle d'alliage d'aluminium a été formé dans la condition T4P.

9. Porte de véhicule motorisé comprenant un panneau extérieur automobile fait à partir d'un produit en tôle d'aluminium tel que défini dans l'une quelconque des revendications 1 à 7.

10. Procédé de production d'un panneau extérieur automobile, comprenant les étapes suivantes :

- coulage d'un lingot ayant une composition selon l'une quelconque des revendications 1 à 7 ;
- homogénéisation du lingot ;
- laminage à chaud ;
- laminage à froid pour obtenir une tôle ayant un calibre final de 0,7 mm à 4,0 mm ;
- traitement thermique par solution du matériau en tôle laminé à froid, puis trempe ;
- chauffe du matériau en tôle laminé à froid soumis au traitement thermique par solution et à la trempe, à une température de pré-vieillissement dans une plage de 90 °C à 105 °C, enroulement du matériau en tôle à une température dans ladite plage de température de 90 °C à 105 °C, et refroidissement du rouleau à température ambiante dans un environnement ambiant ;
- vieillissement naturel et stockage

11. Procédé selon la revendication 10, dans lequel la tôle d'aluminium, dans une opération de formage, est en outre formée pour obtenir un élément ou un panneau de corps automobile, de préférence un panneau extérieur automobile tridimensionnel.

12. Procédé selon l'une quelconque des revendications 10 ou 11, dans lequel la chauffe thermique par solution du matériau en tôle laminé à froid est à une température dans la plage de 530 °C à 570 °C.

13. Procédé selon l'une quelconque des revendications 10 à 12, dans lequel à la suite du laminage à chaud, l'aluminium est laminé à froid à un calibre intermédiaire, recuit de manière intermédiaire, de préférence par recuit par lots à une température dans une plage de 345 °C à 410° C, et laminé à froid pour obtenir une tôle ayant un calibre final de 0,7 mm à 4,0 mm.

REFERENCES CITED IN THE DESCRIPTION

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