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(54) **MICROCRACK-REDUCED, HOT PRESS-FORMED ARTICLE, AND METHOD FOR MANUFACTURING SAME**

HEISSPRESSFORMTEIL MIT REDUZIERTER MIKRORISSBILDUNG UND VERFAHREN ZUR HERSTELLUNG DAVON

ARTICLE À MICRO-FISSURATION RÉDUITE FORMÉ PAR COMPRESSION À CHAUD, ET SON PROCÉDÉ DE FABRICATION

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Description

[Technical Field]

[0001] The present disclosure relates to a microcrack reduced hot press-formed article and a method for manufacturing the same.

[Background Art]

[0002] In recent years, the use of high-strength steel has increased to reduce the weight of automobiles, but such high-strength steel is easily worn or fractured at room temperature. In addition, the occurrence of a spring back phenomenon during machining makes precise dimension work difficult, which makes it difficult to form complex products. Thus, hot press forming (HPF) has been used as a desirable method for machining high strength steel.

[0003] Hot press forming (HPF) is a method of machining a steel sheet to have a complicated shape at high temperatures by utilizing the properties of the steel sheet, soft-nitrides, having high ductility at high temperature. More specifically, in a state in which a steel sheet is heated to an austenite region or greater, the steel sheet is machined and rapidly quenched simultaneously to transform the structure of the steel sheet into martensite, thus producing a product having high strength and a precise shape.

[0004] However, when a steel material is heated to high temperatures, a phenomenon such as corrosion or decarbonization may occur on a surface of the steel material. To prevent this, plated steel materials having a zinc-based or aluminum-based plated layer formed on a surface thereof are commonly used as materials for hot press forming. In particular, a galvanized steel sheet having a zinc-based plated layer is a steel material having corrosion resistance improved using the self-sacrificial corrosion resistance of zinc.

[0005] However, when such a plated steel material is subjected to hot press forming, cracks are formed in the plated layer of a seam-processed part where surface friction is severe due to direct contact between a mold and the plated layer, and microcracks are formed even on a surface of the base steel sheet along the cracks formed in the plated layer.

[0006] In order to solve the problem, Patent document 1 (U.S. Patent Publication No. 6296805) proposes a technique of performing Al-based plating on a surface of a steel sheet. As proposed in Patent document 1, as Al-based plating is performed, an oxidation reaction on a surface of the steel sheet is suppressed, while the plated layer is maintained in a heating furnace, and formation of a passivation film of Al is used to increase corrosion resistance, but corrosion resistance of the Al plated steel sheet is drastically lowered.

[0007] WO 2012/139769 A1 discloses a hot-formable steel sheet (e.g. 22MnB5), comprising a Zn-based coating, preferably galvannealed.

[0008] WO 2014/166630 A1 discloses an article produced by hot-forming a metal-coated steel (e.g. a GA130 22MnB5), the Zn-based coating preferably comprising 1.0-2.5 wt.% Al, 1.0-2.5 wt.% Mg. The hot-formed article has improved bendability and good resistance against micro-cracks.

[0009] US 4 383 006 A discloses a hot-dip galvanized steel with zero-spangle and excellent resistance to age-flaking. The coating comprises 0.1-0.2 wt.% Al, 0.1-0.5 wt.% Sb and Zn as the balance.

[0010] In order to solve the problem, research into Zn-plated hot-pressed steel sheets has been conducted and reviewed, but there is a problem that microcracks are formed even in a surface of the base steel sheet, due to a high temperature working environment in which a temperature of the plated steel exceeds 900°C and stress caused by friction between a Zn-Fe alloyed layer alloyed during hot press forming and a die. Such microcracks may act as a starting point for the propagation of cracks in the base steel sheet or cause fatigue cracks, which may decrease durability of parts.

[Disclosure]

[Technical Problem]

[0011] An aspect of the present disclosure is to provide a microcrack reduced hot press-formed article and a method for manufacturing the same.

[Technical Solution]

[0012] According to an aspect of the present disclosure, there is provided a hot press-formed article according to claim 1. This is manufactured by hot press forming a galvanized steel sheet including a base steel sheet and a zinc-based plated layer formed on a surface of the base steel sheet, wherein the zinc-based plated layer includes at least one element selected from the group consisting of Sb, Sn, and Bi in a total amount of 0.05 to 2.0 wt%, and further includes 0.1 to 5.0 wt% of Mg and 0.1 to 5.0 wt% of Al, a balance of Zn, and inevitable impurities, and at least 70 wt% of the at least one element selected from the group consisting of Sb, Sn, Bi is concentrated in a region 3 μm or less away from a surface of an alloyed zinc-based plated layer, formed by alloying the zinc-based plated layer, of the hot press-formed article, wherein a degree of alloying of Fe of the alloyed zinc-based plated layer is 30 to 85%.

[0013] According to another aspect of the present disclosure, a method for manufacturing a hot press-formed article is provided according to claim 3. This method includes: preparing a zinc-based plated steel sheet; primarily heating the zinc-based plated steel sheet to a temperature of 640 to 680°C at a rate of 3.5 to 4.2°C/sec; secondarily heating the primarily-heated zinc-based plated steel sheet to a temperature of 900 to 930°C at a rate of 1.1 to 1.6°C/sec; maintaining the secondarily-heated zinc-based plated steel sheet at a constant temperature for 1 to 5 minutes; and molding the zinc-based plated steel sheet maintained at the constant temperature with a die and simultaneously quenching the steel sheet, wherein the zinc-based plated steel sheet includes a base steel sheet and a zinc-based plated layer formed on a surface of the base steel sheet and including at least one element selected from the group consisting of Sb, Sn, and Bi in a total amount of 0.05 to 2.0 wt%, and further includes 0.1 to 5.0 wt% of Mg and 0.1 to 5.0 wt% of Al.

[Advantageous Effects]

[0014] As set forth above, in the hot press-formed article according to an exemplary embodiment in the present disclosure, microcracks in a plated layer caused during hot press forming is effectively restrained from propagating to the base steel sheet, obtaining excellent durability.

[0015] Various and advantageous advantages and effects of the present inventive concept are not limited to those described above and may be more easily understood in the course of describing the specific example embodiment of the present inventive concept.

[Description of Drawings]

[0016]

FIG. 1 shows observed microcracks of Comparative Example 1, FIG. 2 shows observed microcracks of Inventive Example 1, FIG. 3 shows observed microcracks of Inventive Example 3, FIG. 4 shows observed microcracks of Comparative Example 4, and FIG. 5 shows observed microcracks of Inventive Example 5.

FIG. 6 (a) is GDS data obtained by analyzing contents of Al, Mg, and Sn according to depths of a plated layer in Inventive Example 1, FIG. 6 (b) is GDS data obtained by analyzing contents of Al, Mg, and Sn according to depths of a plated layer in Inventive Example 3, and FIG. 6 (c) is GDS data obtained by analyzing contents of Al, Mg, and Sn according to depths of a plated layer in Inventive Example 5.

[Best Mode for invention]

[0017] The inventors of the present application have conducted research in depth to provide a hot press formed article with suppressed microcracks and resultantly discovered that propagation of microcracks in a plated layer to a base steel sheet could be effectively blocked by using a galvanized steel sheet having a zinc-based plated layer containing a proper amount of grain, a boundary segregation element as a material for hot press forming and concentrating the boundary segregation element on a surface layer of a plated layer by appropriately controlling heating conditions during the hot press forming, thus completing the present disclosure.

[0018] Hereinafter, a hot press-formed article according to an aspect of the present disclosure will be described in detail.

[0019] The hot press formed article as one aspect of the present disclosure is manufactured by hot press forming a galvanized steel sheet including a base steel sheet and a zinc-based plated layer formed on a surface of the base steel sheet to hot press molding.

[0020] In the present disclosure, the kind of the base steel sheet is not limited and may be, for example, a hot-rolled steel sheet or a cold-rolled steel sheet used as a base of a general galvanized steel sheet. However, in the case of a hot-rolled steel sheet, a large amount of oxide scale is present on a surface thereof. Such an oxide scale lowers plating adhesion to deteriorate quality of plating, and thus, a hot-rolled steel sheet whose oxide scale has previously been removed by an acid solution may be used as a base.

[0021] Meanwhile, the zinc-based plated layer is formed on one side or both sides of the base steel sheet, and the zinc-based plated layer is alloyed at the time of heat treatment for hot press forming to change into an alloyed zinc-based plated layer.

[0022] The zinc-based plated layer may include at least one element selected from the group consisting of Sb, Sn, and Bi in a total amount of 0.05% to 2.0% by weight, 0.1 to 5.0 wt% of Mg and 0.1 to 5.0 wt% of Al, a balanced amount of Zn, and inevitable impurities.

[0023] Sb, Sn, and Bi are grain boundary segregation elements serving to inhibit formation of an internal oxide due to penetration of oxygen into the grain boundary in a high-temperature working environment. In order to exhibit such effects in the present disclosure, the sum of the contents of the above elements is 0.05 wt% or greater, and more preferably 0.3 wt% or greater. However, if the content is excessive, formation of an aluminum oxide film on the surface of the plated layer may be hindered to impair a barrier function of aluminum and an effect is low relative to the increase in the content, lowering economic efficiency. Therefore, the sum of the contents of the above elements is 2.0 wt% or less, more preferably 1.5 wt% or less.

[0024] According to the invention, the zinc-based plated layer further contains 0.1 to 5.0 wt% of Mg and 0.1 to 5.0 wt% of Al.

[0025] Mg is an element serving to improve corrosion resistance of a hot press-formed article. In order to exhibit such an effect in the present disclosure, the Mg content is 0.1 wt% or greater, and preferably 1 wt% or greater. However, if the Mg content is excessive, dross of a plating bath may be generated due to Mg oxidation in the plating bath. Therefore, an upper limit of the magnesium content is 5.0 wt%, preferably 4.0 wt%, and more preferably 3.0 wt%.

[0026] Al serves to suppress Mg oxide dross. If the Al content is too low, the effect of preventing Mg oxidation in the plating bath may be insignificant. Therefore, a lower limit of the aluminum content is 0.1 wt%, and preferably 1.5 wt%. However, if the Al content is too excessive, a temperature of the plating bath must be increased. If the temperature of the plating bath is high, the plating facility may be eroded. Therefore, an upper limit of the aluminum content is 5.0 wt%.

[0027] According to the invention, a degree of alloying of Fe of the alloyed zinc-based plated layer formed by alloying the zinc-based plated layer is 30 to 85%, preferably 45 to 78%, and more preferably 50 to 75%. When the degree of alloying of Fe satisfies the above range, surface cracking during hot pressing may be effectively prevented and corrosion resistance characteristics based on sacrificial corrosion prevention is excellent. If the degree of alloying of Fe is less than 30%, a region of the plated layer in which a part of Zn is concentrated may exist in a liquid phase, causing a liquid embrittlement cracks during processing. Meanwhile, if the degree of alloying of Fe degree exceeds 85%, corrosion resistance may be lowered.

[0028] The hot pressed-formed article of the present disclosure features that at least 70 wt% of at least one element selected from the group consisting of Sb, Sn, and Bi is concentrated in a region 3 μm or less away from a surface of the alloyed zinc-based plated layer.

[0029] When Sb, Sn and Bi are concentrated in a large amount on the surface of the alloyed zinc-based plated layer as described above, Sb, Sn and Bi may settle on the surface of the plated layer before oxygen penetrates from the surface of the plated layer to cause grain boundary segregation to restrain formation of internal oxide to prevent formation of boundary cracks in the plated layer, thus blocking propagation of microcracks to the base member. Furthermore, microcracks are mainly formed in a location where friction between the mold and the plated layer is severe. The oxide of Sb, Sn, and Bi concentrated on the surface may reduce a coefficient of friction between the mold and the plated layer to reduce formation of microcracks, thus improving durability of the hot press-formed article.

[0030] Meanwhile, in the present disclosure, a specific method of measuring the content of at least one element selected from the group consisting of Sb, Sn, and Bi concentrated in a region 3 μm or less away from the surface of the alloyed zinc-based plated layer is not particularly limited, but the following method may be used. That is, after the hot press-formed article may be cut vertically, a distribution of at least one element selected from the group consisting of Sb, Sn, and Bi in the cross-section of the plated layer may be measured using a glow discharge emission spectrometry (GDS), and an area thereof is integrated in a graph related to the content of at least one element selected from the group consisting of Sb, Sn, and Bi relative to the depth from the surface of the plated layer, whereby the content of at least one element selected from the group consisting of Sb, Sn, and Bi concentrated in the region 3 μm or less away from the surface of the alloyed zinc-based plated layer may be measured.

[0031] The hot press-formed article of the present disclosure described above may be manufactured by various methods, and the manufacturing method is not particularly limited. However, the hot press-formed article may be manufactured by the following method as one embodiment.

[0032] Hereinafter, a method for manufacturing a hot press-formed article having excellent durability, which is another aspect of the present disclosure, will be described in detail.

[0033] First, a galvanized steel sheet having the above-described alloy composition is prepared. In the present disclosure, a specific method for preparing a zinc-based plated steel sheet is not particularly limited. The galvanized steel sheet may be manufactured by a general method of manufacturing a hot dip galvanized steel sheet. For example, a base steel sheet may be dipped in a zinc-based plating bath having the above-described composition and subsequently cooled to prepare the galvanized steel sheet.

[0034] However, in order to further maximize the intended effect of the present disclosure, it is preferable to perform bubbling by supplying an inert gas in advance in the zinc-based plating bath before dipping the base steel sheet in the zinc-based plating bath. Here, the inert gas may be one or more selected from the group consisting of nitrogen (N_2), argon (Ar), and helium (He).

[0035] Performing bubbling in the zinc-based plating bath prior to performing the plating as described above may help uniformly distribute Sb, Sn, and Bi in the zinc-based plating bath, help evenly distribute Sb, Sn, and Bi in the zinc-based plated layer obtained by a plating operation (to be described hereinafter), and help concentrate Sb, Sn, and Bi on the surface of the alloyed zinc-based plated layer of the hot press-formed article which is resultantly obtained. This is because as the distribution of Sb, Sn, and Bi in the plated layer prior to heating for hot press forming is uniform, Sb, Si, and Bi may be easily concentrated on the surface.

[0036] Meanwhile, in order to obtain the above effect, supply of the inert gas is preferably maintained for 1 hour or greater, and more preferably for 3 hours or greater. Meanwhile, an increase in the supply time of the inert gas may be advantageous to evenly distribute the components in the plating bath, and thus, an upper limit is not particularly limited.

[0037] Next, the zinc-based plated steel sheet is primarily-heated to be processed into an article. This operation is performed in order to sufficiently impart the zinc content of the plated layer in a follow-up heating process by increasing a melting point by performing alloying with iron before zinc of the plated layer is oxidized in the atmosphere

[0038] During the primary heating, an average heating rate is 3.5 to 4.2°C/sec. If the average heating rate is lower than 3.5°C/sec, a rise time may be prolonged to delay the effect of the increase in the melting point due to alloying to cause excessive oxidation of zinc. Meanwhile, if the average heating rate exceeds 4.2°C/sec, zinc on the surface may be first melted earlier than alloying of the material to increase oxidation of the surface of the plated layer.

[0039] During the primary heating, a primary heating end temperature is 640 to 680°C. If the temperature is lower than 640 °C, a diffusion coefficient in the plated layer may be too low due to the low temperature so the plated layer may not be uniformly alloyed. Meanwhile, if the temperature exceeds 680°C, the plated layer may be liquefied beyond the melting point of zinc delta and zinc may be vaporized to cause loss of the plated layer.

[0040] Next, the primarily-heated zinc-based plated steel sheet is secondarily-heated. This operation is performed so that added internal oxidation inhibiting materials are first segregated to the grain boundary to prevent grain boundary oxidation due to oxygen to suppress microcracks, while stably changing the plated layer, sufficiently changed into delta phase, into Fe-alpha phase.

[0041] During the secondary heating, an average heating rate is 1.1 to 1.6°C/sec. If the average heating rate is less than 1.1°C/sec, an alloying time to the Fe-alpha phase may be prolonged to cause a possibility of grain boundary oxidation based on oxygen, rather than the grain boundary segregation element. Meanwhile, if the average heating rate exceeds 1.6°C/sec, partial plated layer liquefaction may occur on the surface of the plated layer at high temperatures to deteriorate quality due to a non-uniform surface.

[0042] During the secondary heating, a secondary heating end temperature is 900 to 930°C. If the temperature is lower than 900°C, sufficient austenite transformation of the material may not be achieved, making it difficult to secure strength of a final product. If the temperature exceeds 930°C, the plated layer may be entirely liquefied to degrade the microcrack suppressing effect based on the added grain boundary oxidation element.

[0043] Next, the secondarily-heated zinc-based plated steel sheet is kept at the secondary heating end temperature for 1 to 5 minutes. If the holding time is less than 1 minute, it may be difficult to secure a sufficient time for the austenite transformation of the material due to the shortage of the total heating time. Meanwhile, if the holding time exceeds 5 minutes, the plated layer may be excessively alloyed to lower the zinc content in the plated layer to degrade corrosion resistance.

[0044] Thereafter, the secondarily-heated zinc-based plated steel sheet is molded by a die and quenched at the same time. Here, the molding and quenching by the die may be sufficient by the general hot press forming method, and therefore, it is not limited in the present disclosure.

[Mode for invention]

[0045] Hereinafter, the present disclosure will be described more specifically by way of examples. It should be noted, however, that the following embodiments are intended to illustrate and specify the present disclosure and do not to limit the scope of the present disclosure. The scope of the present disclosure is determined by the matters described in the claims and the matters reasonably deduced therefrom.

[0046] A low carbon cold-rolled steel sheet having a thickness of 0.8 mm, a width of 100 mm, and a length of 200 mm, as a base steel sheet, was prepared as a test sample for plating, dipped in acetone, and ultrasonically cleaned to remove foreign substances such as rolling oil present on the surface thereof. Thereafter, the steel sheet was subjected to a heat treatment in a reducing atmosphere at 750°C to secure the mechanical properties of the steel sheet at the general hot-dip plating site and subsequently dipped in a zinc-based plating bath having the composition shown in Table 1 below to manufacture a plated steel sheet. Thereafter, each of the manufactured plated steel materials was gas-wiped to adjust the coating weight to 70g/m^2 per side and cooled at a rate of 12°C/sec.

[0047] Thereafter, each of the cooled plated steel materials was heated under the conditions shown in Table 2 below and hot press-formed to obtain a hot press-formed article.

[0048] Thereafter, each of the hot press-formed articles was cut vertically, and a distribution of grain boundary segregation elements in the plated layer was measured by a GDS analysis. The results are shown in Table 2 below. A specific measurement method is as described above.

[0049] Thereafter, a maximum depth of microcracks at a portion where tension and surface friction were most severe during molding, and the results are shown in Table 2 below.

[Table 1]

Bath type	Plating bath composition (wt%) (* balance is Zn)				
	Sb	Sn	Bi	Al	Mg
Bath 1	-	-	-	0.21	-
Bath 2	-	0.7	-	1.50	1.0
Bath 3	-	0.4	-	2.5	1.0
Bath 4	-	-	-	2.5	1.0
Bath 5	-	0.3	-	7.0	3.0
Bath 6	0.3	-	-	1.5	1.0
Bath 7	-	-	0.5	2.5	1.0

[Table 2]

No .	Bath type	Primary heating		Secondary heating		Main tain	①	Maximum depth of microcrack	Remark
		Rate (°C/s)	End temperature (°C)	Rate (°C/s)	End tempe rature (°C)	Time (min.)			
1	Bath 1	3.8	640	1.2	900	5	-	32.0	Comparative Example 1
2	Bath 1	4.2	670	1.6	910	5	-	29.0	Comparative Example 2
3	Bath 2	3.5	650	1.2	900	5	78	2.5	Inventive Example 1
4	Bath 2	3.9	670	1.4	910	5	85	3.8	Inventive Example 2
5	Bath 3	3.7	650	1.3	910	5	99	3.0	Inventive Example 3
6	Bath 3	4.0	660	1.1	900	5	92	3.7	Inventive Example 4
7	Bath 4	4.0	660	1.3	900	5	-	28.0	Comparative Example 3
8	Bath 4	3.9	660	1.5	915	5	-	26.0	Comparative Example 4
9	Bath 5	3.7	650	1.2	910	5	77	7.0	Inventive Example 5
10	Bath 5	3.8	640	1.4	910	5	79	7.3	Inventive Example 6
11	Bath 6	4.0	650	1.5	900	5	83	5.2	Inventive Example 7
12	Bath 6	4.1	640	1.3	920	5	82	6.0	Inventive Example 8

(continued)

No .	Bath type	Primary heating		Secondary heating		Main tain	①	Maximum depth of microcrack	Remark
		Rate (°C/s)	End temperature (°C)	Rate (°C/s)	End tempe rature (°C)	Time (min.)			
13	Bath 7	3.9	650	1.3	910	5	89	8 . 0	Inventive Example 9
14	Bath 7	3.5	640	1.2	930	5	91	7.8	Inventive Example 10
Here, ① indicates the content (wt%) of at least one element selected from the group consisting of Sb, Sn, and Bi concentrated a region 3μm or less away from the surface of the alloyed zinc-based plated layer									

[0050] Referring to Table 2, it can be seen that the maximum depth of microcracks in Inventive Examples 1 to 10 satisfying all the conditions of the present disclosure was suppressed to 10 μm or less.

[0051] FIG. 1 shows observed microcracks of Comparative Example 1, FIG. 2 shows observed microcracks of Inventive Example 1, FIG. 3 shows observed microcracks of Inventive Example 3, FIG. 4 shows observed microcracks of Comparative Example 4, and FIG. 5 shows observed microcracks of Inventive Example 5. Referring to FIGS. 1 to 5, it can be seen that in the case of Inventive Examples, propagation of microcracks in the plated layer to the base steel sheet was effectively blocked.

[0052] FIG. 6A is GDS data obtained by analyzing contents of Al, Mg, and Sn according to depths of a plated layer in Inventive Example 1, FIG. 6B is GDS data obtained by analyzing contents of Al, Mg, and Sn according to depths of a plated layer in Inventive Example 3, and FIG. 6C is GDS data obtained by analyzing contents of Al, Mg, and Sn according to depths of a plated layer in Inventive Example 5.

Claims

1. A hot press-formed article manufactured by hot press forming a galvanized steel sheet including a base steel sheet and a zinc-based plated layer formed on a surface of the base steel sheet,
wherein the zinc-based plated layer includes at least one element selected from the group consisting of Sb, Sn, and Bi in a total amount of 0.05 to 2.0 wt%, and further includes 0.1 to 5.0 wt% of Al and 0.1 to 5.0 wt% of Mg, a balance of Zn, and inevitable impurities, and
at least 70 wt% of the at least one element selected from the group consisting of Sb, Sn, Bi is concentrated in a region 3 μm or less away from a surface of an alloyed zinc-based plated layer, formed by alloying the zinc-based plated layer, of the hot press-formed article, and
wherein a degree of alloying of Fe of the alloyed zinc-based plated layer is 30 to 85%.

2. The hot press-formed article of claim 1,
wherein the zinc-based plated layer includes at least one element selected from the group consisting of Sb, Sn, and Bi in a total amount of 0.3 to 1.5 wt%.

3. A method for manufacturing a hot press-formed article, the method comprising:

preparing a zinc-based plated steel sheet;
primarily heating the zinc-based plated steel sheet to a temperature of 640 to 680°C at a rate of 3.5 to 4.2°C/sec;
secondarily heating the primarily-heated zinc-based plated steel sheet to a temperature of 900 to 930°C at a rate of 1.1 to 1.6°C/sec;
maintaining the secondarily-heated zinc-based plated steel sheet at a constant temperature for 1 to 5 minutes; and
molding the zinc-based plated steel sheet maintained at the constant temperature with a die and simultaneously quenching the steel sheet,
wherein the zinc-based plated steel sheet includes a base steel sheet and a zinc-based plated layer formed on a surface of the base steel sheet and,

wherein the zinc-based plated layer includes at least one element selected from the group consisting of Sb, Sn, and Bi in a total amount of 0.05 to 2.0 wt%, and further includes 0.1 to 5.0 wt% of Al and 0.1 to 5.0 wt% of Mg.

4. The method of claim 3,
wherein the zinc-based plated layer includes at least one element selected from the group consisting of Sb, Sn, and Bi in a total amount of 0.3 to 1.5 wt%.

Patentansprüche

1. Heißpressformteil, das durch Heißpressformen eines galvanisierten Stahlblechs hergestellt ist, das ein Basisstahlblech und eine Überzugsschicht auf Zinkbasis umfasst, die auf einer Oberfläche des Basisstahlblechs ausgebildet ist,
wobei die Überzugsschicht auf Zinkbasis mindestens ein Element, das aus der Gruppe ausgewählt ist, die aus Sb, Sn und Bi besteht, in einer Gesamtmenge von 0,05 bis 2,0 Gew.-% enthält, und darüber hinaus 0,1 bis 5,0 Gew.-% an Al und 0,1 bis 5,0 Gew.-% an Mg, einen Rest aus Zn und unvermeidbaren Verunreinigungen enthält, und mindestens 70 Gew.-% des mindestens einen Elements, das aus der Gruppe ausgewählt ist, die aus Sb, Sn und Bi besteht, in einem Bereich von 3 μm oder weniger von einer Oberfläche einer legierten Überzugsschicht auf Zinkbasis des Heißpressformteils weg konzentriert ist, die durch Legieren der Überzugsschicht auf Zinkbasis ausgebildet ist, und
wobei ein Fe-Legierungsgrad der legierten Überzugsschicht auf Zinkbasis 30 bis 85 % beträgt.

2. Heißpressformteil nach Anspruch 1,
wobei die Überzugsschicht auf Zinkbasis mindestens ein Element, das aus der Gruppe ausgewählt ist, die aus Sb, Sn und Bi besteht, in einer Gesamtmenge von 0,3 bis 1,5 Gew.-% enthält.

3. Verfahren zum Herstellen eines Heißpressformteils, wobei das Verfahren umfasst:

Vorbereiten eines auf Zinkbasis beschichteten Stahlblechs;
primäres Erwärmen des auf Zinkbasis beschichteten Stahlblechs auf eine Temperatur von 640 bis 680° C mit einer Rate von 3,5 bis 4,2° C/s;
sekundäres Erwärmen des primär erwärmten, auf Zinkbasis beschichteten Stahlblechs auf eine Temperatur von 900 bis 930° C mit einer Rate von 1,1 bis 1,6° C/s;
Halten des sekundär erwärmten, auf Zinkbasis beschichteten Stahlblechs auf einer konstanten Temperatur für 1 bis 5 Minuten; und
Formen des auf der konstanten Temperatur gehaltenen, auf Zinkbasis beschichteten Stahlblechs mit einem Gesenk und gleichzeitiges Abschrecken des Stahlblechs,
wobei das auf Zinkbasis beschichtete Stahlblech ein Basisstahlblech und eine Überzugsschicht auf Zinkbasis umfasst, die auf einer Oberfläche des Basisstahlblechs ausgebildet ist, und
wobei die Überzugsschicht auf Zinkbasis mindestens ein Element, das aus der Gruppe ausgewählt ist, die aus Sb, Sn und Bi besteht, in einer Gesamtmenge von 0,05 bis 2,0 Gew.-% enthält, und darüber hinaus 0,1 bis 5,0 Gew.-% an Al und 0,1 bis 5,0 Gew.-% an Mg enthält.

4. Verfahren nach Anspruch 3,
wobei die Überzugsschicht auf Zinkbasis mindestens ein Element, das aus der Gruppe ausgewählt ist, die aus Sb, Sn und Bi besteht, in einer Gesamtmenge von 0,3 bis 1,5 Gew.-% enthält.

Revendications

1. Article formé par compression à chaud fabriqué en formant par compression à chaud une tôle d'acier galvanisée incluant une tôle d'acier de base et une couche plaquée à base de zinc formée sur une surface de la tôle d'acier de base,
sachant que la couche plaquée à base de zinc inclut au moins un élément sélectionné dans le groupe constitué par Sb, Sn, et Bi dans une quantité totale de 0,05 à 2,0 % en poids, et inclut en outre 0,1 à 5,0 % en poids d'Al et 0,1 à 5,0 % en poids de Mg, un solde de Zn, et des impuretés inévitables, et
au moins 70 % en poids de l'au moins un élément sélectionné dans le groupe constitué par Sb, Sn, Bi sont concentrés dans une région située à 3 μm ou moins d'une surface d'une couche plaquée à base de zinc alliée, formée en alliant la couche plaquée à base de zinc, de l'article formé par compression à chaud, et

sachant qu'un degré d'alliage de Fe de la couche plaquée à base de zinc alliée est de 30 à 85 %.

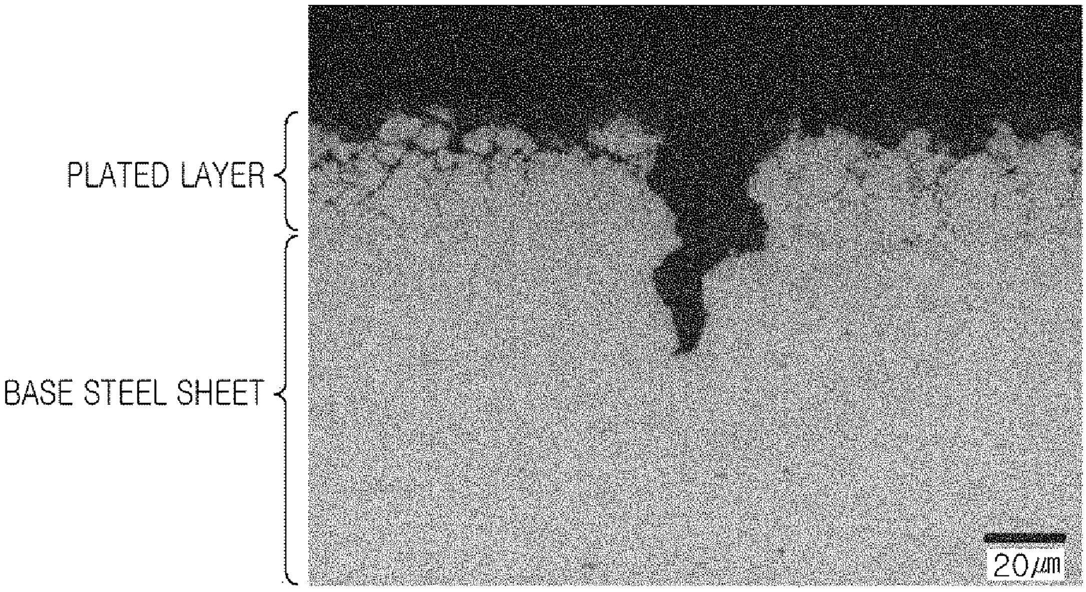
2. L'article formé par compression à chaud de la revendication 1,
sachant que la couche plaquée à base de zinc inclut au moins un élément sélectionné dans le groupe constitué par Sb, Sn, et Bi dans une quantité totale de 0,3 à 1,5 % en poids.

3. Procédé de fabrication d'un article formé par compression à chaud, le procédé comprenant :

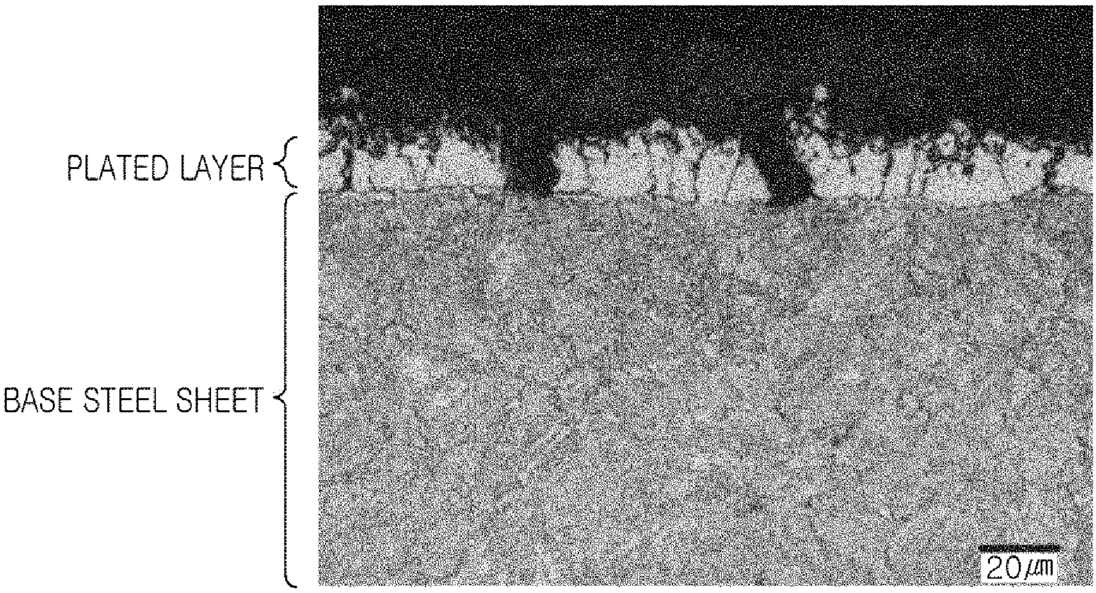
la préparation d'une tôle d'acier plaquée à base de zinc ;
le chauffage primaire de la tôle d'acier plaquée à base de zinc à une température de 640 à 680 °C à une cadence de 3,5 à 4,2 °C/s ;
le chauffage secondaire de la tôle d'acier plaquée à base de zinc chauffée par chauffage primaire à une température de 900 à 930 °C à une cadence de 1,1 à 1,6 °C/s ;
le maintien de la tôle d'acier plaquée à base de zinc chauffée par chauffage secondaire à une température constante pendant 1 à 5 minutes ; et
le moulage de la tôle d'acier plaquée à base de zinc maintenue à la température constante avec une matrice et la trempe simultanée de la tôle d'acier,
sachant que la tôle d'acier plaquée à base de zinc inclut une tôle d'acier de base et une couche plaquée à base de zinc formée sur une surface de la tôle d'acier de base, et
sachant que la couche plaquée à base de zinc inclut au moins un élément sélectionné dans le groupe constitué par Sb, Sn, et Bi dans une quantité totale de 0,05 à 2,0 % en poids, et inclut en outre 0,1 à 5,0 % en poids d'Al et 0,1 à 5,0 % en poids de Mg.

4. Le procédé de la revendication 3,
sachant que la couche plaquée à base de zinc inclut au moins un élément sélectionné dans le groupe constitué par Sb, Sn, et Bi dans une quantité totale de 0,3 à 1,5 % en poids.

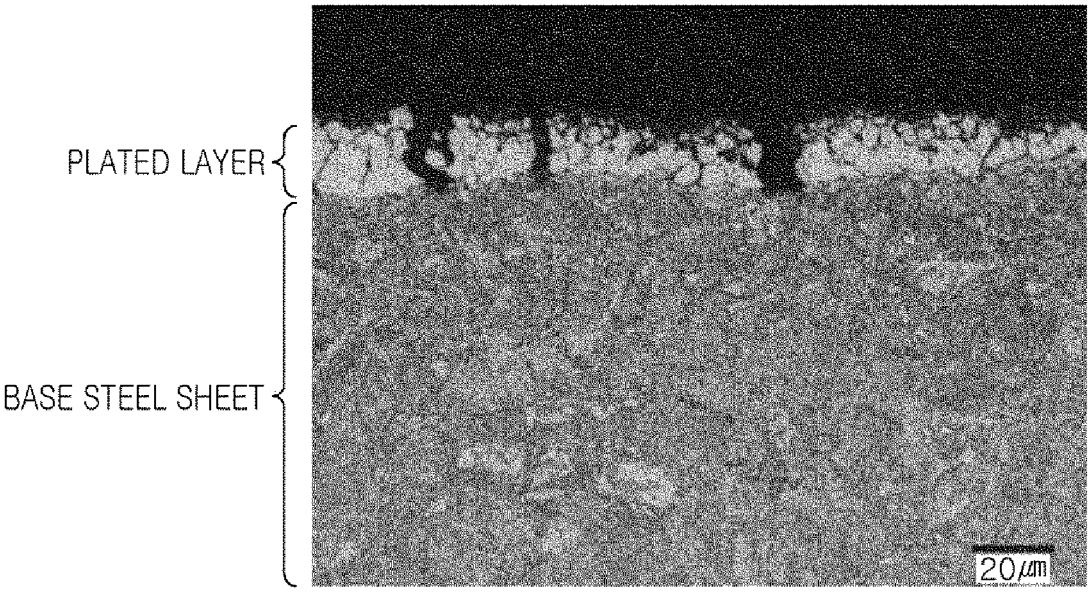
【FIG. 1】



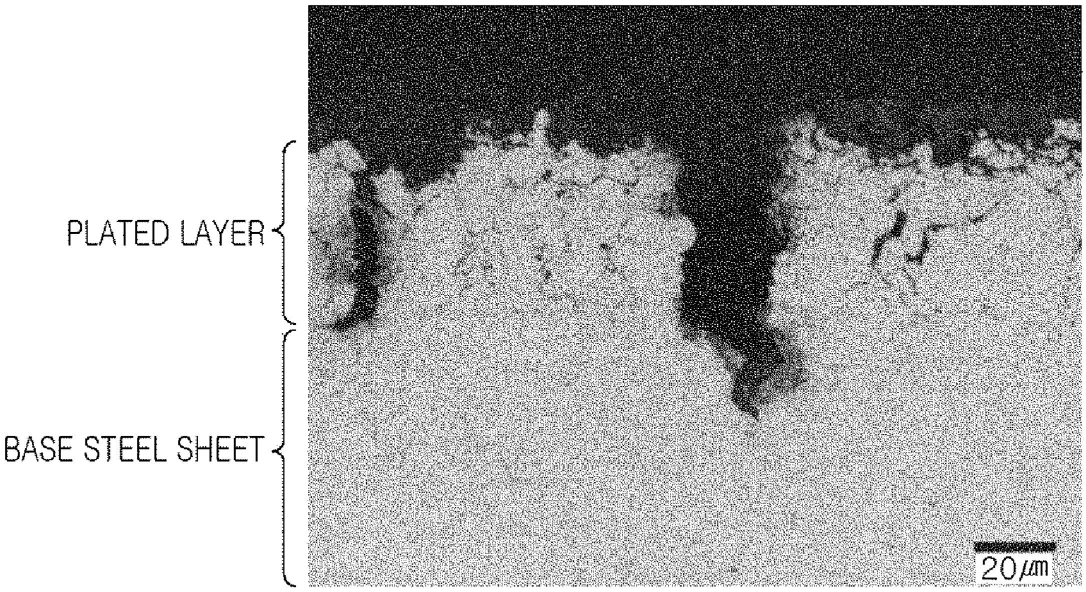
【FIG. 2】



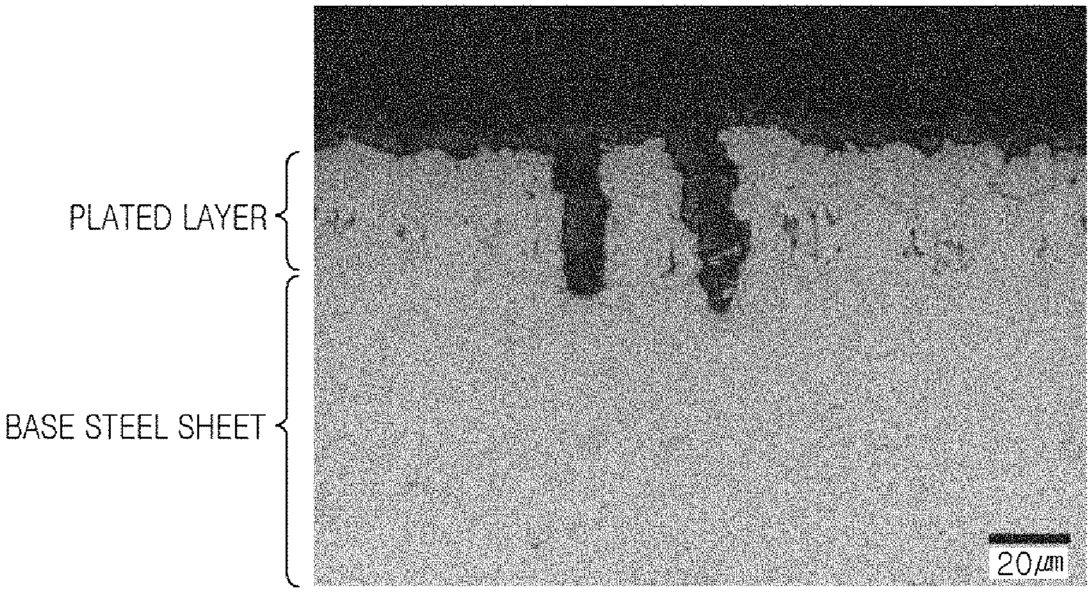
【FIG. 3】


PLATED LAYER
BASE STEEL SHEET
20㎛

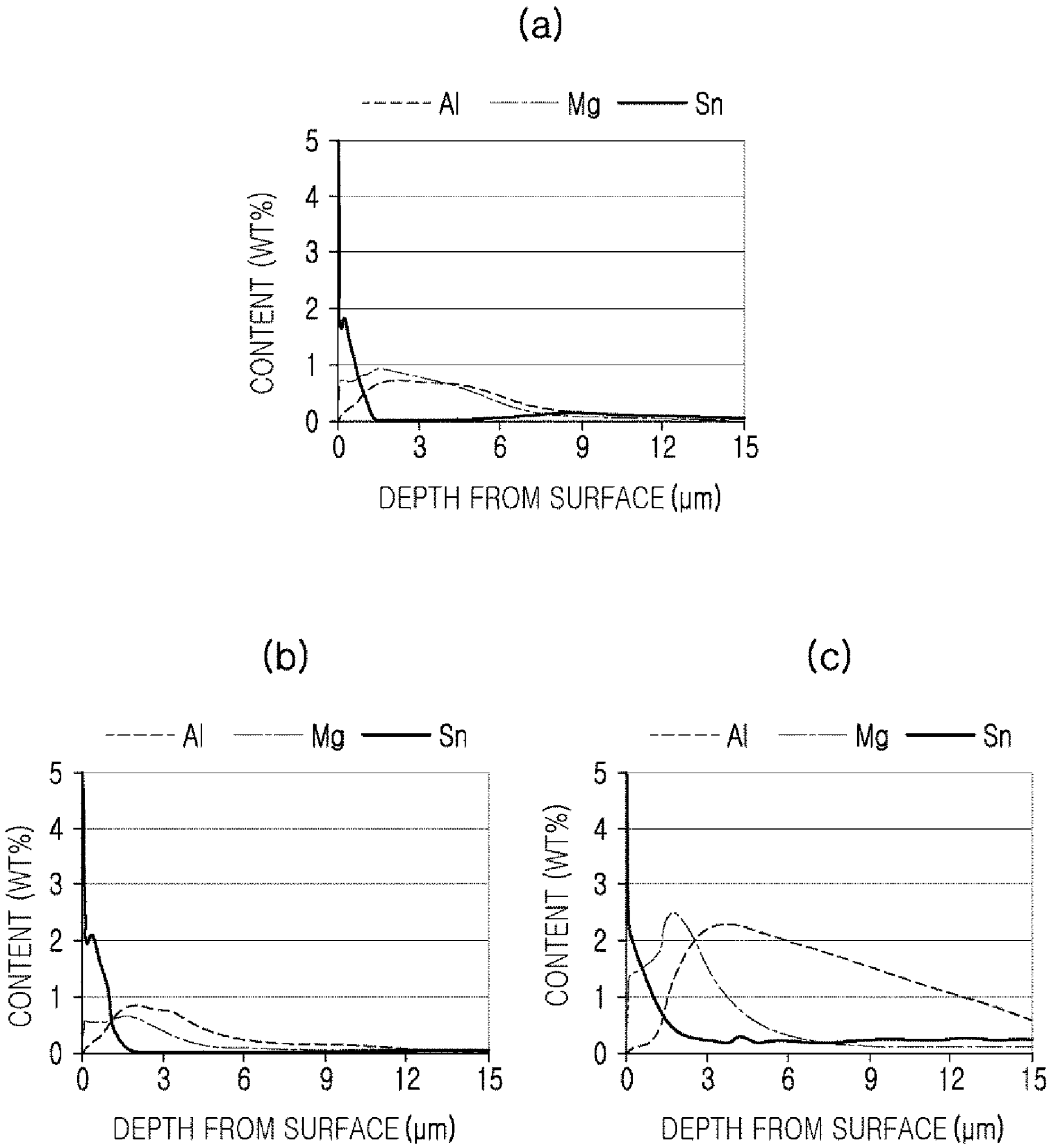
【FIG. 4】


PLATED LAYER
BASE STEEL SHEET
20㎛

【FIG. 5】



【FIG. 6】


(a)
Al
Mg
Sn
CONTENT (WT%)
DEPTH FROM SURFACE (μm)
0
1
2
3
4
5
0
3
6
9
12
15
(b)
Al
Mg
Sn
CONTENT (WT%)
DEPTH FROM SURFACE (μm)
(c)
Al
Mg
Sn
CONTENT (WT%)
DEPTH FROM SURFACE (μm)

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- US 6296805 B **[0006]**
- WO 2012139769 A1 **[0007]**
- WO 2014166630 A1 **[0008]**
- US 4383006 A **[0009]**