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(54) **MANUFACTURING METHOD FOR HOT STAMPING COMPONENT HAVING ALUMINIUM-SILICON ALLOY COATING, AND HOT STAMPING COMPONENT**

(57) A manufacturing method for a hot stamping component having an aluminium-silicon alloy coating, and a hot stamping component, said method comprising the following steps: a steel plate coated with an aluminium-silicon alloy coating is machined into a blank having a shape required for a part, and the blank is subjected to heat treatment and hot stamping. The blank heat treatment is two-stage or three-stage heating, and the temperature of the heating increases in steps. The steel plate coated with the aluminium-silicon alloy coating comprises a substrate, and the aluminium-silicon alloy coating on at least one surface of the substrate. The present method fully takes into account the characteristics of the aluminium-silicon coating, effectively solves the problem of aluminium-silicon coating roller adhesion, reduces the probability of heat treatment furnace roller nodulation, increases roller service life, and also ensures the integrity of the hot stamping component coating, and the mechanical properties, welding performance, coating performance and corrosion resistance of the component.

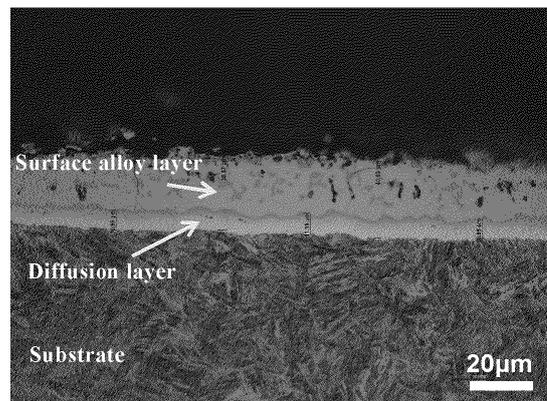


Figure 3

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Description**Technical Field**

5 [0001] The present invention relates to manufacturing technology of hot stamping components, in particular to a manufacturing method of a hot stamping component having an aluminum-silicon alloy coating and a hot stamping component.

Background Art

10 [0002] Lightweight and emission reduction are the main development trends of the automotive industry. High strength of automotive parts is finally achieved by heat treatment for changing the microstructure of the materials when using relatively low-strength materials. This hot forming technique realizes the improvement of forming level of automotive parts and guarantees the high strength properties. Compared with uncoated hot stamping products, the one that has an aluminum-silicon coating has a good thickness and dimensional accuracy, good corrosion resistance and welding performance. The proportion of hot stamping steels with an aluminum-silicon coating accounts for 70% of the hot stamping steels currently in use, and it will get higher and higher for the foreseeable future.

15 [0003] Chinese patent CN101583486B discloses a method of coated stamping products, including the temperature and time of stamping, wherein the heating rate from room temperature to 700 °C is 4-12 °C/s, which aims at ensuring the spot welding performance of stamping components.

20 [0004] Chinese patent CN102300707B further discloses a heating method of coated hot stamping components, specifically discloses the heating rate under melting temperature, the holding time under austenitizing temperature, etc. However, considering the efficiency and production cycle time of the heat treatment furnace during use, users find that this heating method still could not solve the problem of adhesion to the roller and nodulation by aluminum-silicon coating, which causes problems such as the decrease in service life of heat treatment furnace roller and peeling of coating of hot stamping components.

Summary of the Invention

30 [0005] The purpose of the present invention is to provide a manufacturing method of a hot stamping component having an aluminum-silicon alloy coating and a hot stamping component, which can not only effectively solve the problem of adhesion to the roller by aluminum-silicon coating, reduce the nodulation probability of the heat treatment furnace roller and improve the service life of the roller, but can also ensure the integrity of the coating of the hot stamping component and the mechanical properties, welding performance, coating performance and corrosion resistance of the component.

35 [0006] To achieve the above purpose, the technical solutions of the present invention are as follows.

[0007] A manufacturing method of a hot stamping component having an aluminum-silicon alloy coating, comprising the following steps: machining a steel plate coated with an aluminum-silicon alloy coating into a blank having a shape required for a part; conducting heat treatment and hot stamping of the blank; wherein, in the heat treatment of the blank, the blank is put into a heat treatment furnace for austenitizing heat treatment, and the heat treatment process of the blank comprises a first heating and holding stage, a second heating and holding stage, and a third heating and holding stage; and wherein:

45 when the thickness of the steel plate coated with an aluminum-silicon alloy coating is less than 1.5 mm, in the first heating and holding stage, the temperature and time of heating and holding lie within a graph ABCD, the graph ABCD represents the ranges of temperature and time defined by coordinates of A (750 °C, 30 s), B (750 °C, 90 s), C (870 °C, 90 s) and D (870 °C, 30 s); and

50 in the second heating and holding stage, the temperature and time of heating and holding lie within a graph EFGH, the graph EFGH represents the ranges of temperature and time defined by coordinates of E (875 °C, 60 s), F (875 °C, 240 s), G (930 °C, 150 s) and H (930 °C, 30 s); and

in the third heating and holding stage, the temperature and time of heating and holding lie within a graph IJKL, the graph IJKL represents the ranges of temperature and time defined by coordinates of I (935 °C, 60 s), J (935 °C, 240 s), K (955 °C, 180 s) and L (955 °C, 30 s);

55 when the thickness of steel plate coated with an aluminum-silicon alloy coating is 1.5 mm or more, in the first heating and holding stage, the temperature and time of heating and holding lie within a graph A'B'C'D', the graph A'B'C'D' represents the ranges of temperature and time defined by coordinates of A' (750 °C, 30 s), B' (750 °C, 90 s), C' (890 °C, 90 s) and D' (890 °C, 30 s); and

in the second heating and holding stage, the temperature and time of heating and holding lie within a graph E'F'G'H',

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the graph E'F'G'H' represents the ranges of temperature and time defined by coordinates of E' (895 °C, 90 s), F' (895 °C, 270 s), G' (940 °C, 210 s) and H' (940 °C, 60 s); and
in the third heating and holding stage, the temperature and time of heating and holding lie within a graph I'J'K'L',
the graph I'J'K'L' represents the ranges of temperature and time defined by coordinates of I' (945 °C, 60 s), J' (945 °C, 240 s), K' (955 °C, 180 s) and L' (955 °C, 30 s).

[0008] Further, the heating and holding time of the second heating and holding stage is zero so that the heat treatment process of the blank comprises two-stages of heating and temperature-holding, consisting of the first heating and holding stage and the third heating and holding stage; compared with the aforementioned three-stage heating and holding, the two-stage heating and holding has the following characteristics: the heating and holding time in the furnace is shortened and the production efficiency is improved, but as the heating temperature is higher, the energy consumption is increased and the requirement for equipment heating capacity is higher; and wherein:

when the thickness of the steel plate coated with an aluminum-silicon alloy coating is less than 1.5 mm, in the first heating and holding stage, the temperature and time of heating and holding lie within a graph abcd, the graph abcd represents the ranges of temperature and time defined by coordinates of a (750 °C, 30 s), b (750 °C, 90 s), c (870 °C, 90 s) and d (870 °C, 30 s); and

in the third heating and holding stage, the temperature and time of heating and holding lie within a graph ijkl, the graph ijkl represents the ranges of temperature and time defined by coordinates of i (935 °C, 180 s), j (935 °C, 300 s), k (955 °C, 270 s) and l (955 °C, 150 s);

when the thickness of steel plate coated with an aluminum-silicon alloy coating is 1.5 mm or more, in the first heating and holding stage, the temperature and time of heating and holding lie within a graph a'b'c'd', the graph a'b'c'd' represents the ranges of temperature and time defined by coordinates of a' (750 °C, 30 s), b' (750 °C, 90 s), c' (890 °C, 90 s) and d' (890 °C, 30 s); and

in the third heating and holding stage, the temperature and time of heating and holding lie within a graph i'j'k'l', the graph i'j'k'l' represents the ranges of temperature and time defined by coordinates of i' (945 °C, 180 s), j' (945 °C, 300 s), k' (955 °C, 270 s) and l' (955 °C, 150 s).

[0009] Furthermore, in the heat treatment process of the blank, the temperature increases stepwise in the order of the first, second, and third heating and holding stages or the temperatures in the first, second, and third heating and holding stages are set to be certain temperatures.

[0010] For example, for the steel plate having a thickness of 1.2 mm and an aluminum-silicon alloy coating, the heat treatment process can be as follows: the temperature and time of the first heating and holding stage are 800 °C and 60 s, respectively; and the temperature and time of the second heating and holding stage are 930 °C and 120 s, respectively; and the temperature and time of the third heating and holding stage are 940 °C and 60 s, respectively. The heat treatment process can also be as follows: multiple temperatures, for example 770 °C for 40 s, 820 °C for 30 s and 770 °C for 50 s are set in the first heating and holding stage; and multiple temperatures, for example 900 °C for 60 s and 930 °C for 60 s are set in the second heating and holding stage; and multiple temperatures, for example 935 °C for 60 s and 940 °C for 60 s are set in the third heating and holding stage.

[0011] Preferably, the time of the heat treatment process of the blank is not less than 150 s and not more than 600 s. Within this time range, the blank after heat treatment has high surface quality, good coating performance, and good welding performance.

[0012] Preferably, a heat treatment furnace is used in the heat treatment process of the blank. The oxygen content in the furnace's atmosphere is not less than 15% and the dew point in the furnace is not higher than -5 °C. The final hot stamping component has a low hydrogen content and an excellent resistance to delayed cracking.

[0013] Preferably, in the hot stamping process, the heat-treated blank is quickly transferred to a mold for stamping, the transfer time is 4-12 seconds, and the blank is in a temperature of not lower than 600 °C before being fed into the mold; the mold is cooled before stamping to ensure that the surface temperature of the mold before stamping is lower than 100 °C, and the cooling rate of the blank is greater than 30 °C/s. The microstructure of the hot stamping component obtained through the above process is mainly martensite or bainite, and the hot stamping component has excellent mechanical properties and meets the requirements for use.

[0014] Additionally, the steel plate coated with an aluminum-silicon alloy coating comprises a substrate and an aluminum-silicon alloy coating on at least one surface of the substrate, and the substrate comprises the following composition in percentage by weight: C: 0.04-0.8%, Si<1.2%, Mn: 0.1-5%, P<0.3%, S<0.1%, Al<0.3%, Ti<0.5%, B<0.1%, Cr<3% and the rest being Fe and inevitable impurities.

[0015] Preferably, the aluminum-silicon alloy coating comprises the following composition in percentage by weight: Si: 4-14%, Fe: 0-4%, and the balance being Al and inevitable impurities. By adopting the above-mentioned silicon alloy

coating composition, the obtained alloy coating has a uniform and thin thickness, the coating has good adhesion and good machinability.

[0016] Preferably, the average weight of the aluminum-silicon alloy coating is 58-105 g/m² on one side; more preferably, the average weight of the aluminum-silicon alloy coating is 72-88 g/m² on one side. By controlling the average weight of the aluminum-silicon alloy coating within the range, the final hot stamping component has a uniform appearance and color (no color difference), good coating performance, and good welding performance.

[0017] In addition, the aluminum-silicon alloy coating of the hot stamping component obtained by the manufacturing method of the present invention comprises a surface alloy layer and a diffusion layer, and the ratio of the thickness of the diffusion layer to the thickness of the aluminum-silicon alloy coating is 0.08-0.5. The final hot stamping component has uniform appearance and color, good coating performance and good welding performance.

[0018] Specifically, the aluminum-silicon alloy coating comprises two layers, the one that is in contact with the substrate is a diffusion layer. During the heat treatment process, Al in the aluminum-silicon alloy coating and Fe of the substrate further diffuse to form the diffusion layer. Al in the aluminum-silicon alloy coating and Fe of the substrate are alloyed to form a surface alloy layer. In the component after hot stamping, the ratio of the thickness of the diffusion layer to the total thickness of the aluminum-silicon alloy coating (including the diffusion layer and the surface alloy layer) is 0.08-0.5.

[0019] The hot stamping component according to the present invention has a yield strength of 400-1300 MPa, a tensile strength of 500-2000 MPa, and an elongation of 4% or more.

[0020] Preferably, the elongation of the hot stamping component according to the present invention is 4 to 20%.

[0021] During the heat treatment process of the hot stamping component according to the present invention, no coating melts and adheres to the roller, the coating is complete and has a good adhesion, and there is no significant peeling off the surface.

[0022] For the hot stamping component according to the present invention, no coating peels off, the surface roughness meets the requirements, and the ratio of the thickness of the diffusion layer to the thickness of the coating is between 0.08 and 0.5. After electrophoretic coating, the coating film is complete and the coating film adhesion is evaluated as grade 0 or higher.

[0023] For the hot stamping component according to the present invention, the thickness of the diffusion layer and the thickness of the coating meet the requirements, the ratio of the thickness of the diffusion layer to the thickness of the coating is between 0.08 and 0.5, and the spot welding performance is excellent with all the spot welding range being 2KA or above.

[0024] During the heat treatment process, the coating on the hot stamping component according to the present invention can well meet the diffusion of the coating and the austenitization of the substrate, and the melting and adhesion to the roller of the coating can be avoided, thereby obtaining the hot stamping component with good coating performance and substrate performance.

[0025] Specifically, the melting point of Al-Si alloy of the aluminum-silicon alloy coating is between 580 and 600 °C, the austenitizing temperature of the steel plate is 840 °C or above, the aluminum-silicon alloy coating will melt during the heat treatment process, and adhere to the furnace roller. Meanwhile, Al in the coating and Fe of the substrate will diffuse to form an Fe-Al alloy which has a strong heat resistance and a high melting temperature, and will not cause adhesion to the furnace roller. In the present invention, by controlling dwell time of the aluminum-silicon coating in the heating process and in the heating and holding stages, the melting of the aluminum-silicon alloy coating, the adhesion of the coating to the heat treatment furnace roller and the nodulation of the furnace roller are avoided as much as possible. And according to the production cycle time, by ensuring the coating to reach an appropriate alloying degree, obtaining a suitable thickness of the coating and of the diffusion layer, and the surface quality of the coating, the welding performance and coating performance of the component are guaranteed.

[0026] The beneficial effects of the present invention are as follows:

By designing the heat treatment process of the blank, the adhesion of the aluminum-silicon alloy coating to the heat treatment furnace roller is reduced, the occurrence rate of nodulation of the heat treatment furnace roller is reduced, and the maintenance cycle and service life of the roller are extended.

[0027] Moreover, the heat treatment process of the blank according to the present invention can improve the surface quality of the stamping component and prevent the coating from peeling off during the heat treatment process.

[0028] In addition, the heat treatment process of the blank according to present invention adopts a stepwise heating mode, fully considers the characteristics of the aluminum-silicon alloy coating, and appropriately adjusts the temperature and time according to the thickness of the blank, so that the energy can be effectively used and a good energy saving effect is achieved.

Brief Description of the Drawings

[0029]

Figure 1 shows a surface of the hot stamping component with an aluminum-silicon alloy coating prepared in Comparative Example 1.

Figure 2 shows a surface of the hot stamping component with an aluminum-silicon alloy coating prepared in Example 1 of the present invention.

5 Figure 3 is a cross-sectional view of the hot stamping component with an aluminum-silicon alloy coating prepared in Example 1 of the present invention.

Figure 4 is a schematic diagram of the temperature and time ranges of heating and temperature in the first to the third heating and holding stages of the heat treatment process (three-stage heating and holding) of the blank according to the present invention (in the case of the steel plate thickness < 1.5 mm).

10 Figure 5 is a schematic diagram of the temperature and time ranges of heating and holding in the first to the third heating and holding stages of the heat treatment process (three-stage heating and holding) of the blank according to the present invention (in the case of the steel plate thickness ≥ 1.5 mm).

Figure 6 is a schematic diagram of the temperature and time ranges of heating and holding in the first and the third heating and holding stages of the heat treatment process (two-stage heating and holding) of the blank according to the present invention.

Detailed Description

[0030] The present invention is further described below with reference to Examples and Figures.

20 [0031] Table 1 shows the compositions of the substrates of the steel plates in Examples of the present invention; Table 2 shows the manufacturing processes and properties of the hot stamping components in Examples of the present invention.

Example 1

25 [0032] A substrate with a thickness of 1.2 mm was subjected to hot dip aluminum plating at 650 °C, the composition of the plating bath is 8% of Si and 2.3% of Fe, with the rest being Al and inevitable impurities. The steel plate coated with the aluminum-silicon alloy coating was continuously blanked into a blank with a certain shape. The blank was subjected to a heat treatment, and the specific parameters of the heat treatment are shown in Table 2. The appearance of the obtained hot stamping component is shown in Figure 2. The cross-sectional microstructure of the aluminum-silicon alloy coating is shown in Figure 3. The aluminum-silicon alloy coating comprises a surface alloy layer and a diffusion layer, and the ratio of the thickness of the diffusion layer to the thickness of the aluminum-silicon alloy coating is 0.25.

Example 2

35 [0033] A substrate with a thickness of 0.9 mm was subjected to hot dip aluminum plating at 660 °C, the composition of the plating bath is 9% of Si and 2.5% of Fe, with the rest being Al and inevitable impurities. The steel plate coated with the aluminum-silicon alloy coating was continuously blanked into a blank with a certain shape. The blank was subjected to a heat treatment, and the specific parameters of the heat treatment are shown in Table 2. The ratio of the thickness of the diffusion layer to the thickness of the aluminum-silicon alloy coating is 0.3.

Example 3

45 [0034] A substrate with a thickness of 1.0 mm was subjected to hot dip aluminum plating at 660 °C, the composition of the plating bath is 8.5% of Si and 2.5% of Fe, with the rest being Al and inevitable impurities. The steel plate coated with the aluminum-silicon alloy coating was continuously blanked into a blank with a certain shape. The blank was subjected to a heat treatment. The ratio of the thickness of the diffusion layer to the thickness of the aluminum-silicon alloy coating is 0.15.

Example 4

50 [0035] A substrate with a thickness of 1.1 mm was subjected to hot dip aluminum plating at 680 °C, the composition of the plating bath is 9.5% of Si and 2.5% of Fe, with the rest being Al and inevitable impurities. The steel plate coated with the aluminum-silicon alloy coating was continuously blanked into a blank with a certain shape. The blank was subjected to a heat treatment. The ratio of the thickness of the diffusion layer to the thickness of the aluminum-silicon alloy coating is 0.28.

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Example 5

[0036] A substrate with a thickness of 1.2 mm was subjected to hot dip aluminum plating at 680 °C, the composition of the plating bath is 8.8% of Si and 2.4% of Fe, with the rest being Al and inevitable impurities. The steel plate coated with the aluminum-silicon alloy coating was continuously blanked into a blank with a certain shape. The blank was subjected to a heat treatment. The ratio of the thickness of the diffusion layer to the thickness of the aluminum-silicon alloy coating is 0.35.

Example 6

[0037] A substrate with a thickness of 1.5 mm was subjected to hot dip aluminum plating at 680 °C, the composition of the plating bath is 8.8% of Si and 2.4% of Fe, with the rest being Al and inevitable impurities. The steel plate coated with the aluminum-silicon alloy coating was continuously blanked into a blank with a certain shape. The blank was subjected to a heat treatment. The ratio of the thickness of the diffusion layer to the thickness of the aluminum-silicon alloy coating is 0.35.

Example 7

[0038] A substrate with a thickness of 1.6 mm was subjected to hot dip aluminum plating at 680 °C, the composition of the plating bath is 8.8% of Si and 2.4% of Fe, with the rest being Al and inevitable impurities. The steel plate coated with the aluminum-silicon alloy coating was continuously blanked into a blank with a certain shape. The blank was subjected to a heat treatment. The ratio of the thickness of the diffusion layer to the thickness of the aluminum-silicon alloy coating is 0.3.

Example 8

[0039] A substrate with a thickness of 1.8 mm was subjected to hot dip aluminum plating at 680 °C, the composition of the plating bath is 8.8% of Si and 2.4% of Fe, with the rest being Al and inevitable impurities. The steel plate coated with the aluminum-silicon alloy coating was continuously blanked into a blank with a certain shape. The blank was subjected to a heat treatment. The ratio of the thickness of the diffusion layer to the thickness of the aluminum-silicon alloy coating is 0.35.

Example 9

[0040] A substrate with a thickness of 2.0 mm was subjected to hot dip aluminum plating at 680 °C, the composition of the plating bath is 8.8% of Si and 2.4% of Fe, with the rest being Al and inevitable impurities. The steel plate coated with the aluminum-silicon alloy coating was continuously blanked into a blank with a certain shape. The blank was subjected to a heat treatment. The ratio of the thickness of the diffusion layer to the thickness of the aluminum-silicon alloy coating is 0.4.

Table 1 Composition of the substrate of the steel in percentage by weight (wt %)

Examples	C	Si	Mn	P	S	Al	Ti	B	Cr
1	0.22	0.10	2.90	0.059	0.038	0.09	0.090	0.031	0.150
2	0.10	0.02	0.8	0.018	0.007	0.08	0.001	0.001	0.003
3	0.20	0.23	1.19	0.015	0.040	0.08	0.027	0.005	0.200
4	0.39	0.36	3.00	0.044	0.030	0.07	0.050	0.006	0.300
5	0.08	0.05	0.70	0.02	0.010	0.05	0.002	0.002	0.220
6	0.25	0.40	2.30	0.059	0.038	0.09	0.090	0.031	0.150
7	0.12	0.20	0.90	0.018	0.007	0.08	0.001	0.001	0.003
8	0.30	0.30	1.70	0.015	0.040	0.08	0.027	0.005	0.200
9	0.50	0.36	3.00	0.044	0.030	0.07	0.050	0.006	0.300
Comparative Example	0.22	0.10	2.90	0.059	0.038	0.09	0.090	0.031	0.150

Table 2

Examples	thickness of the steel plate with coating (mm)	the first heating and holding stage		the second heating and holding stage		the third heating and holding stage		the ratio of thickness of alloy layer to thickness of the surface layer
		temperature (°C)	time of heating and holding (s)	temperature (°C)	time of heating and holding (s)	temperature (°C)	time of heating and holding (s)	
1	1.2	750	85	880	100	935	100	0.25
2	0.9	770	90	890	60	935	60	0.30
3	1.0	790	60	900	130	940	180	0.15
4	1.1	800	70	-	-	950	250	0.28
5	1.2	850	55	920	150	950	100	0.35
6	1.5	760	90	900	100	945	100	0.35
7	1.6	790	80	910	170	945	150	0.30
8	1.8	830	70	-	-	950	230	0.35
9	2.0	880	60	930	200	950	80	0.40
Comparative Example	1.2	-	-	-	-	945	150	0.05

[0041] Figure 1 shows the surface of the hot stamping component in Comparative Example. The aluminum-silicon coating surface melts, which causes the coating to adhere to the roller.

[0042] Figure 2 shows the surface of the hot stamping component in Example 1 of the present invention. The aluminum-silicon alloy coating surface shows no sign of melting, and the alloying is sufficient.

[0043] Figure 3 is a cross-sectional view of the coating of the hot stamping component in Example 1 of the present invention. It can be seen from the Figure that the aluminum-silicon alloy coating comprises two layers, i.e. a surface alloy layer and a diffusion layer. The ratio of the thickness of the diffusion layer to the thickness of the aluminum-silicon alloy coating is about 0.25. The substrate mainly consists of martensite.

[0044] Figure 4 shows the ranges of the first, the second and the third heating and holding stages when the thickness of the steel plate coated with an aluminum-silicon alloy coating according to the present invention is less than 1.5 mm. The temperature and time of heating and holding in the first heating and holding stage lie within a graph ABCD, the temperature and time of heating and holding in the second heating and holding stage lie within a graph EFGH, and the temperature and time of heating and holding in the third heating and holding stage lie within a graph IJKL.

[0045] Figure 5 shows the ranges of the first, the second and the third heating and holding stages when the thickness of the steel plate coated with an aluminum-silicon alloy coating according to the present invention is 1.5 mm or more. The temperature and time of heating and holding in the first heating and holding stage lie within a graph A'B'C'D', the temperature and time of heating and holding in the second heating and holding stage lie within a graph E'F'G'H', and the temperature and time of heating and holding in the third heating and holding stage lie within a graph I'J'K'L'.

[0046] Figure 6 is a schematic diagram of the temperature and time ranges of heating and holding in the first and the third heating and holding stages of the heat treatment process (two-stage heating and holding) of the blank according to the present invention, the heating and holding time in the second heating and holding stage is zero, which forms a two-stage heating and holding.

[0047] When the thickness of the steel plate coated with an aluminum-silicon alloy coating is less than 1.5 mm, the temperature and time of heating and holding in the first heating and holding stage lie within a graph abcd, and the temperature and time of heating and holding in the third heating and holding stage lie within a graph ijkl.

[0048] When the thickness of the steel plate coated with an aluminum-silicon alloy coating is 1.5 mm or more, the temperature and time of heating and holding in the first heating and holding section lie within a graph a'b'c'd', and the temperature and time of heating and holding in the third heating and holding stage lie within a graph i'j'k'l'.

Claims

1. A manufacturing method of a hot stamping component having an aluminum-silicon alloy coating, comprising the following steps: machining a steel plate coated with an aluminum-silicon alloy coating into a blank having a shape required for a part; conducting heat treatment and hot stamping of the blank; wherein, in the heat treatment of the blank, the blank is put into a heat treatment furnace for austenitizing heat treatment, and the heat treatment process of the blank comprises a first heating and holding stage, a second heating and holding stage, and a third heating and holding stage; and wherein:

when the thickness of the steel plate coated with an aluminum-silicon alloy coating is less than 1.5 mm, in the first heating and holding stage, the temperature and time of heating and holding lie within a graph ABCD, the graph ABCD represents the ranges of temperature and time defined by coordinates of A (750 °C, 30 s), B (750 °C, 90 s), C (870 °C, 90 s) and D (870 °C, 30 s); and

in the second heating and holding stage, the temperature and time of heating and holding lie within a graph EFGH, the graph EFGH represents the ranges of temperature and time defined by coordinates of E (875 °C, 60 s), F (875 °C, 240 s), G (930 °C, 150 s) and H (930 °C, 30 s); and

in the third heating and holding stage, the temperature and time of heating and holding lie within a graph IJKL, the graph IJKL represents the ranges of temperature and time defined by coordinates of I (935 °C, 60 s), J (935 °C, 240 s), K (955 °C, 180 s) and L (955 °C, 30 s);

when the thickness of the steel plate coated with an aluminum-silicon alloy coating is 1.5 mm or more, in the first heating and holding stage, the temperature and time of heating and holding lie within a graph A'B'C'D', the graph A'B'C'D' represents the ranges of temperature and time defined by coordinates of A' (750 °C, 30 s), B' (750 °C, 90 s), C' (890 °C, 90 s) and D' (890 °C, 30 s); and

in the second heating and holding stage, the temperature and time of heating and holding lie within a graph E'F'G'H', the graph E'F'G'H' represents the ranges of temperature and time defined by coordinates of E' (895 °C, 90 s), F' (895 °C, 270 s), G' (940 °C, 210 s) and H' (940 °C, 60 s); and

in the third heating and holding stage, the temperature and time of heating and holding lie within a graph I'J'K'L',

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the graph I'J'K'L' represents the ranges of temperature and time defined by coordinates of I' (945 °C, 60 s), J' (945 °C, 240 s), K' (955 °C, 180 s) and L' (955 °C, 30 s).

2. The manufacturing method of a hot stamping component having an aluminum-silicon alloy coating as claimed in claim 1, wherein the heating and holding time of the second heating and holding stage is zero so that the heat treatment process of the blank comprises two-stages of heating and temperature-holding, consisting of the first heating and holding stage and the third heating and holding stage, and wherein, when the thickness of the steel plate coated with an aluminum-silicon alloy coating is less than 1.5 mm, in the first heating and holding stage, the temperature and time of heating and holding lie within a graph abcd, the graph abcd represents the ranges of temperature and time defined by coordinates of a (750 °C, 30 s), b (750 °C, 90 s), c (870 °C, 90 s) and d (870 °C, 30 s); and in the third heating and holding stage, the temperature and time of heating and holding lie within a graph ijkl, the graph ijkl represents the ranges of temperature and time defined by coordinates of i (935 °C, 180 s), j (935 °C, 300 s), k (955 °C, 270 s) and l (955 °C, 150 s); when the thickness of the steel plate coated with an aluminum-silicon alloy coating is 1.5 mm or more, in the first heating and holding stage, the temperature and time of heating and holding lie within a graph a'b'c'd', the graph a'b'c'd' represents the ranges of temperature and time defined by coordinates of a' (750 °C, 30 s), b' (750 °C, 90 s), c' (890 °C, 90 s) and d' (890 °C, 30 s); and in the third heating and holding stage, the temperature and time of heating and holding lie within a graph i'j'k'l', the graph i'j'k'l' represents the ranges of temperature and time defined by coordinates of i' (945 °C, 180 s), j' (945 °C, 300 s), k' (955 °C, 270 s) and l' (955 °C, 150 s).
3. The manufacturing method of a hot stamping component having an aluminum-silicon alloy coating as claimed in claim 1, wherein in the heat treatment process of the blank, the temperature increases stepwise in the order of the first, second, and third heating and holding stages or the temperatures in the first, second, and third heating and holding stages are set to be certain temperatures.
4. The manufacturing method of a hot stamping component having an aluminum-silicon alloy coating as claimed in claim 1, wherein the time of the heat treatment process of the blank is not less than 150 s and not more than 600 s.
5. The manufacturing method of a hot stamping component having an aluminum-silicon alloy coating as claimed in claim 1, wherein a heat treatment furnace is used in the heat treatment process of the blank, the oxygen content in the furnace's atmosphere is not less than 15%, and the dew point in the furnace is not higher than -5 °C.
6. The manufacturing method of a hot stamping component having an aluminum-silicon alloy coating as claimed in claim 1, wherein in the hot stamping process, the heat-treated blank is quickly transferred to a mold for stamping, the transfer time is 4-12 seconds, and the blank is in a temperature of not lower than 600 °C before being fed into the mold; the mold is cooled before stamping to ensure that the surface temperature of the mold before stamping is lower than 100 °C, and the cooling rate of the blank is greater than 30 °C/s.
7. The manufacturing method of a hot stamping component having an aluminum-silicon alloy coating as claimed in claim 1, wherein the steel plate coated with an aluminum-silicon alloy coating comprises a substrate and an aluminum-silicon alloy coating on at least one surface of the substrate, and the substrate comprises the following composition in percentage by weight: C: 0.04-0.8%, Si<1.2%, Mn: 0.1-5%, P<0.3%, S<0.1%, Al<0.3%, Ti<0.5%, B<0.1%, Cr<3%, and the rest being Fe and inevitable impurities.
8. The manufacturing method of a hot stamping component having an aluminum-silicon alloy coating as claimed in claim 7, wherein the aluminum-silicon alloy coating comprises the following composition in percentage by weight: Si: 4-14%, Fe: 0-4%, and the balance being Al and inevitable impurities.
9. The manufacturing method of a hot stamping component having an aluminum-silicon alloy coating as claimed in claim 7 or 8, wherein the average weight of the aluminum-silicon alloy coating is 58-105 g/m² on one side.
10. The manufacturing method of a hot stamping component having an aluminum-silicon alloy coating as claimed in claim 7 or 8, wherein the average weight of the aluminum-silicon alloy coating is 72-88 g/m² on one side.
11. A hot stamping component obtained by the manufacturing method of a hot stamping component having an aluminum-

silicon alloy coating as claimed in any one of claims 1 to 10, wherein the aluminum-silicon alloy coating of the hot stamping component comprises a surface alloy layer and a diffusion layer, and the ratio of the thickness of the diffusion layer to the thickness of the aluminum-silicon alloy coating is 0.08-0.5.

- 5 **12.** The hot stamping component obtained by the manufacturing method of a hot stamping component having an aluminum-silicon alloy coating as claimed in claim 11, wherein the hot stamping component has a yield strength of 400-1300 MPa, a tensile strength of 500-2000 MPa, and an elongation of 4% or more.

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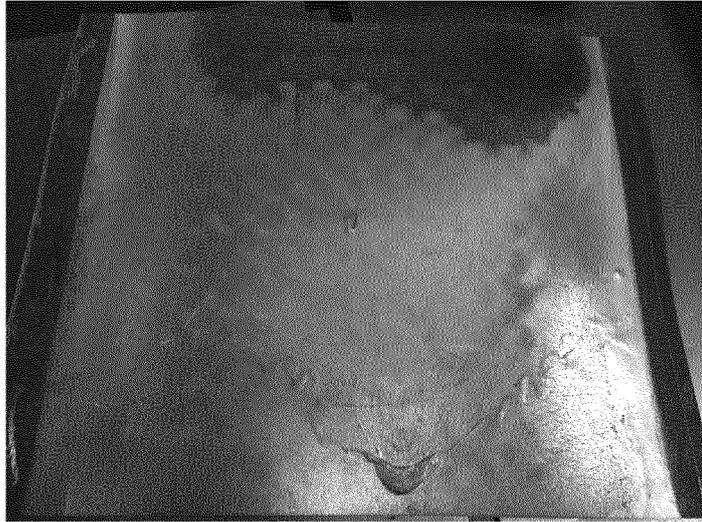


Figure 1

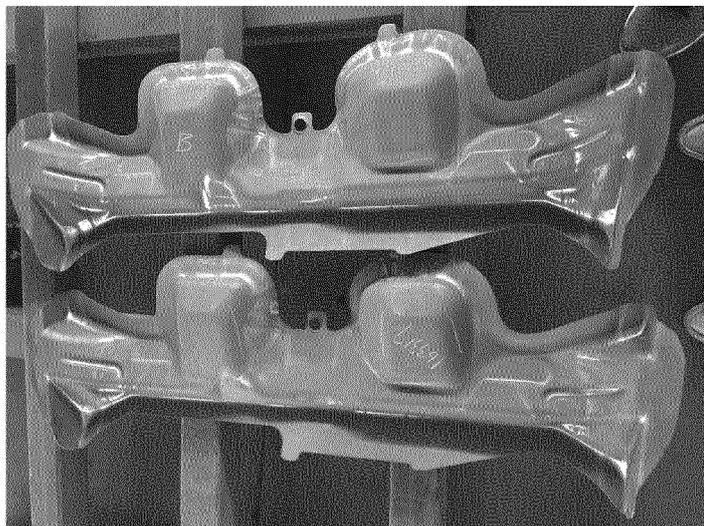


Figure 2

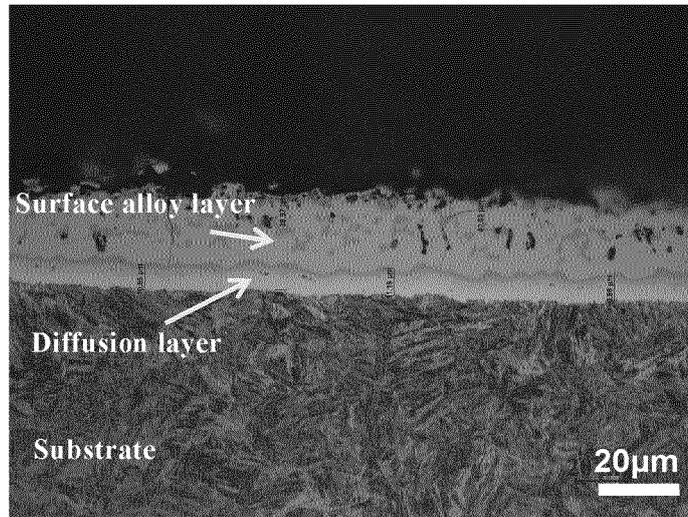


Figure 3

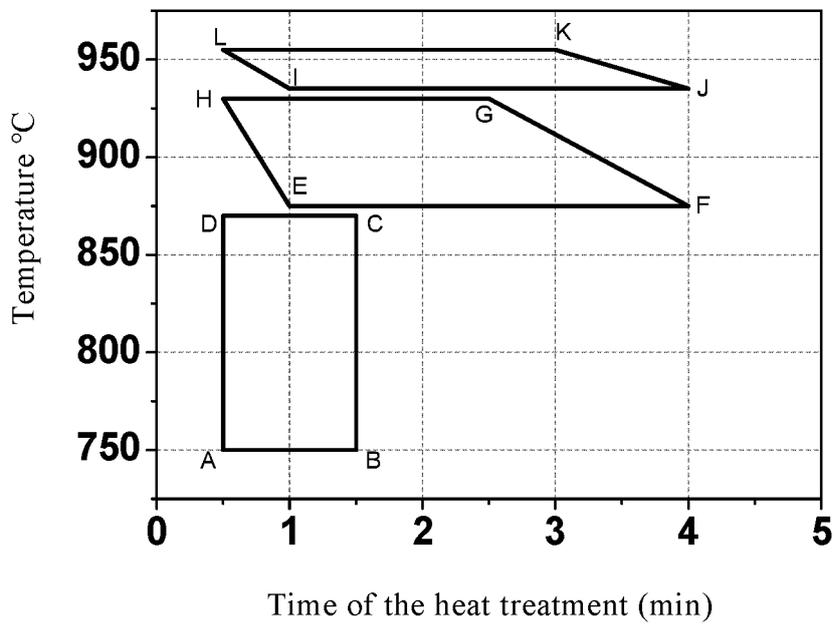


Figure 4

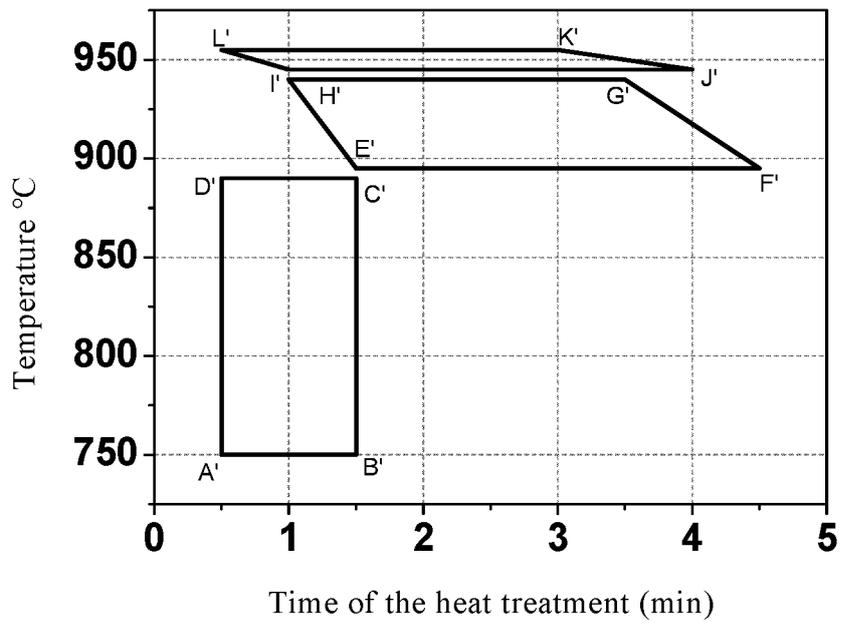


Figure 5

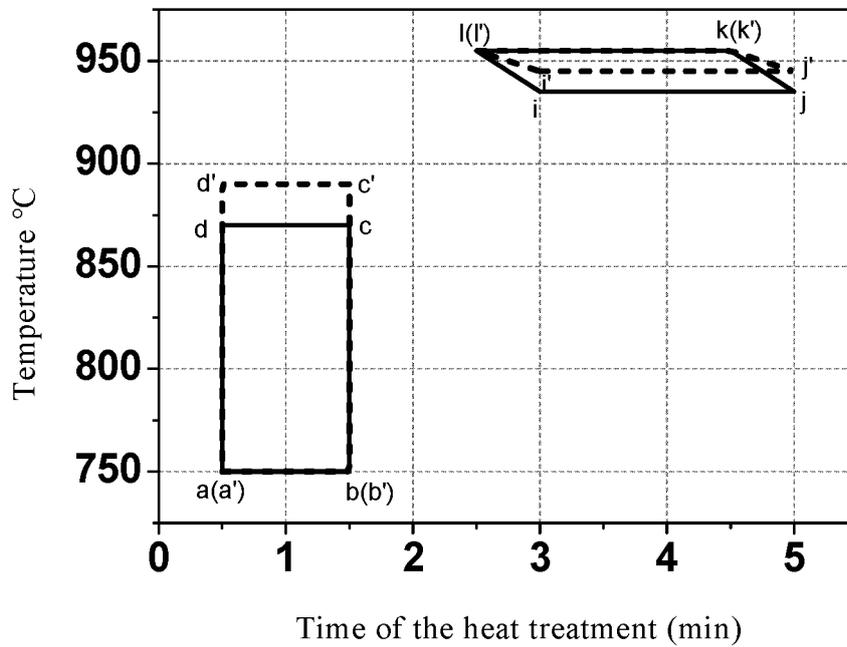


Figure 6

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2019/104708

5	A. CLASSIFICATION OF SUBJECT MATTER	
	C23C 2/12(2006.01)i; C23C 2/40(2006.01)i; C22C 38/02(2006.01)i; C22C 38/04(2006.01)i; C22C 38/06(2006.01)i; C22C 38/28(2006.01)i; C22C 38/32(2006.01)i	
	According to International Patent Classification (IPC) or to both national classification and IPC	
10	B. FIELDS SEARCHED	
	Minimum documentation searched (classification system followed by classification symbols) C22C;C23C	
	Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched	
15	Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) CNABS; CNTXT; CNKI; VEN; USTXT: 宝山钢铁, 奥氏体化, 奥氏体, 三段, 镀膜, 镀层, 硅铝合金, 铝硅合金, 硅铝, 铝硅, 时间, 温度, 阶梯温度, 粘辊, 钢板, 坯料, 热处理, 金属, 保温温度, 保温时间, 保温段, 保温, 阶梯, 加热, 温度段, 厚度, 冲压, thickness, Al, Si, metal, hot stamp+, coat+, austenitization, temperature, time, austenit+, austenitiz+, steel+	
20	C. DOCUMENTS CONSIDERED TO BE RELEVANT	
	Category*	Citation of document, with indication, where appropriate, of the relevant passages
		Relevant to claim No.
	PX	CN 109518114 A (BAOSHAN IRON & STEEL CO., LTD.) 26 March 2019 (2019-03-26) claims 1-12
25	A	CN 102300707 A (ARCELORMITTAL INVENSTIGACION Y DESARROLLO S.L. et al.) 28 December 2011 (2011-12-28) claim 1, and description, paragraphs 15-116
	A	CN 105886750 A (HEBEI IRON & STEEL CO., LTD.) 24 August 2016 (2016-08-24) entire document
30	A	CN 106734470 A (GUANGDONG POLYTECHNIC OF SCIENCE AND TECHNOLOGY) 31 May 2017 (2017-05-31) entire document
	A	CN 102605308 A (NANJING INSTITUTE OF TECHNOLOGY) 25 July 2012 (2012-07-25) entire document
35	<input checked="" type="checkbox"/> Further documents are listed in the continuation of Box C. <input checked="" type="checkbox"/> See patent family annex.	
40	* Special categories of cited documents: "A" document defining the general state of the art which is not considered to be of particular relevance "D" document cited by the applicant in the international application "E" earlier application or patent but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family
45	Date of the actual completion of the international search 12 November 2019	Date of mailing of the international search report 02 December 2019
50	Name and mailing address of the ISA/CN China National Intellectual Property Administration (ISA/CN) No. 6, Xitucheng Road, Jimenqiao Haidian District, Beijing 100088 China	Authorized officer
55	Facsimile No. (86-10)62019451	Telephone No.

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2019/104708

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C. DOCUMENTS CONSIDERED TO BE RELEVANT

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A	CN 101117697 A (CHENGDU GALAXIE DYNAMIC CO., LTD.) 06 February 2008 (2008-02-06) entire document	1-12
A	US 4714500 A (KRUPP STAHL AG) 22 December 1987 (1987-12-22) entire document	1-12

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.

PCT/CN2019/104708

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		JP 5551184 B2	16 July 2014
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		EP 0187904 A2	23 July 1986

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- CN 102300707 B [0004]