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(54) **STEEL USED FOR HOT STAMPING, HOT STAMPING PROCESS AND FORMED COMPONENT**

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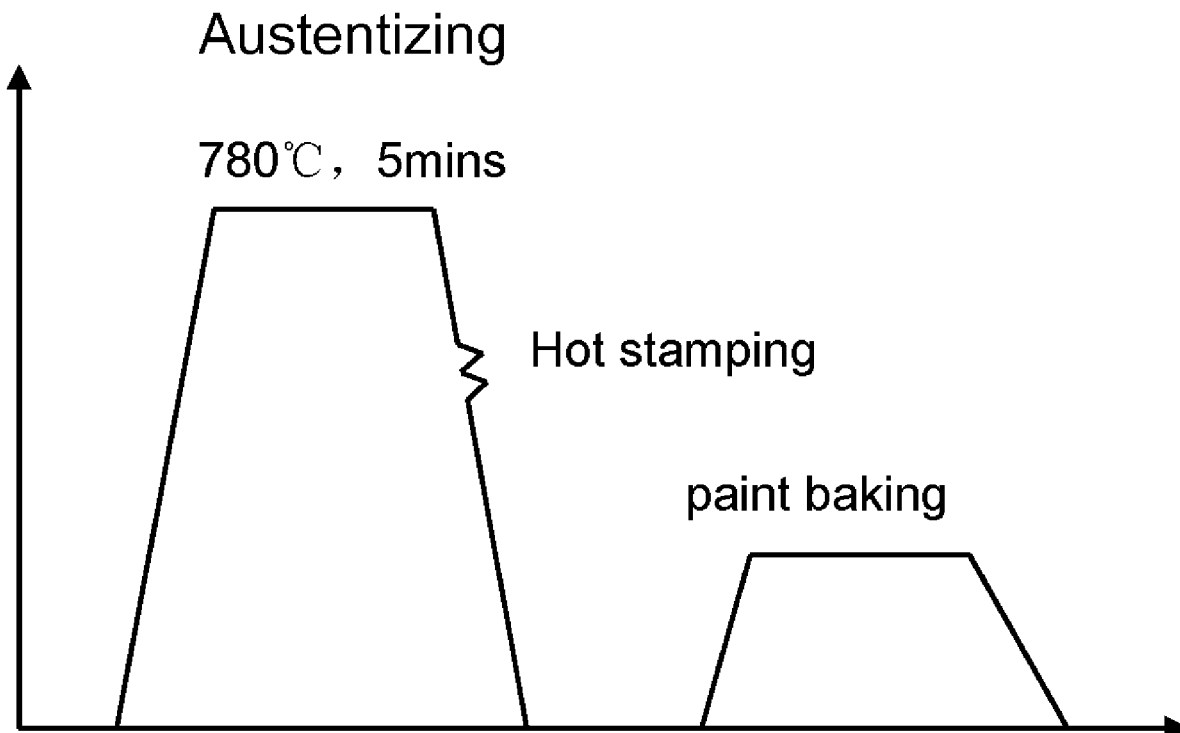
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ABSTRACT

A kind of steel is able to achieve a high elongation with the steel used for hot stamping by means of simple hot stamping process. The formed component has excellent yield strength, tensile strength and elongation. The steel used for hot stamping comprises by weight percent 0.1-0.19% of C, 5.09-9.5% of Mn, 0.11-0.4% of V, and 0-2% Si+Al, wherein the combination of C and V meets one of the following two requirements: 1) 0.1-0.17% of C and 0.11-0.4% of V; and 2) 0.171-0.19% of C and 0.209-0.4% of V.



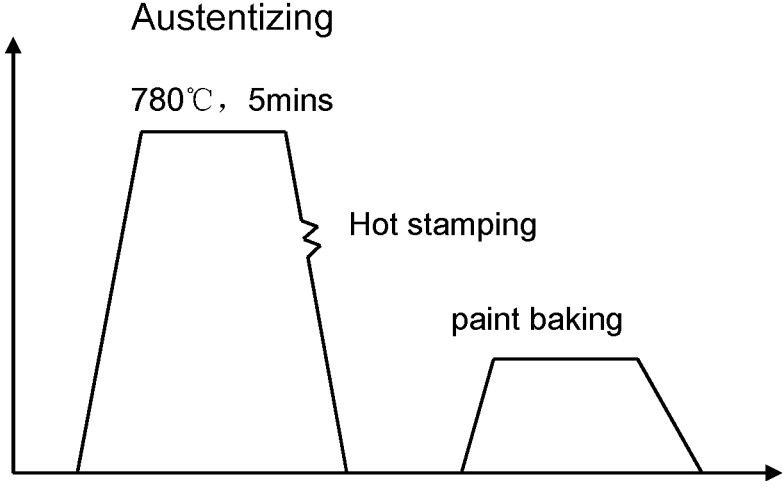


Fig. 1

STEEL USED FOR HOT STAMPING, HOT STAMPING PROCESS AND FORMED COMPONENT

TECHNICAL FIELD

[0001] The present invention relates to a steel for hot stamping, a hot stamping process and a formed component.

BACKGROUND ART

[0002] Rapid development of the automobile industry results in safety and environmental pollution issues. On the premise of ensuring safety, lightweighting of vehicles can effectively reduce energy consumption and emission, and enhance vehicle performance. Utilization of high-strength steel may decrease the thickness of parts and satisfy the requirements for safety performance, and is therefore a key route for lightweighting and better safety of vehicles.

[0003] Generally speaking, the forming properties of steel decrease as the strength thereof increases. Hot stamping is a process for producing an ultrahigh strength vehicle part by means of forming the vehicle part before strengthening, wherein the strengthening mechanism is based on interstitial solid solution strengthening of martensite. A hot stamped part has the advantages of ultrahigh strength and shape precision, and can effectively avoid the springback of high-strength steel during cold formation. Among the current high-strength steels for automobiles, only the hot-stamped steel or press hardening steel (PHS) can have a strength equal to or greater than 1500 MPa.

[0004] In order to achieve further weight reduction, vehicle safety structural components require that the material used shall have a higher strength and a better ductility compared with the current PHS, 22MnB5. In particular, the current hot stamped components can be improved in terms of elongation.

[0005] Moreover, current coated PHS are all Al—Si coated sheets, which are less competent than galvanized sheets in terms of anti-corrosion performance and are difficult to be welded. Galvanized sheets when heated to 900° C. in the hot stamping process may be severely liquefied, gasified and oxidized, which imposes a limitation to the application of galvanized sheets to hot stamping.

[0006] The Chinese Patent No. CN102127675A provides a steel sheet, a warm formed part and a manufacturing method thereof. With the components of steel disclosed, in order to obtain desired mechanical properties, the method comprises, under the condition of decreased hot stamping temperature, heating a material to a temperature ranging from 730° C. to 780° C., and stamping and cooling the material to a temperature that is 30° C. to 150° C. below Ms point (namely, normally cooled to 150° C. to 280° C.), then further heating the material to a temperature ranging from 150° C. to 450° C. and maintaining the temperature for 1 to 5 minutes to stabilize it to a final state by partitioning carbon from martensite to retained austenite. The elongation of the material can be increased on the basis of the Transformation Induced Plasticity (TRIP) effect of retained austenite.

[0007] However, in this method, the component must be cooled to a particular temperature ranging from 150° C. to 280° C. before being heated to a temperature ranging from 150° C. to 450° C. and maintaining the temperature, in such a way that the temperature accuracy and uniformity of the component can be hardly controlled, and a complicated

production process is required to control the quenching temperature thereof, which is disadvantageous to the actual production of the hot stamped component.

SUMMARY OF THE INVENTION

[0008] An object of the present invention is to provide steel used for hot stamping, a hot stamping process and a formed component made therefrom. It is able to achieve a high elongation with the steel used for hot stamping by means of simple hot stamping process. The formed component has excellent yield strength, tensile strength and elongation.

[0009] Technical solution 1 of the present invention relates to steel used for hot stamping, which comprises by weight percent 0.1~0.19% of C, 5.09~9.5% of Mn, 0.11~0.4% of V, and 0~2% of Si+Al, wherein the combination of C and V meets one of the following two requirements: 1) 0.1~0.17% of C and 0.11~0.4% of V; and 2) 0.171~0.19% of C and 0.209~0.4% of V.

[0010] According to the technical solution 1, the steel used for hot stamping of the present invention reduces the martensitic transformation start temperature (Ms) and the martensitic transformation finish temperature (Mf) of the material by addition of austenite stabilizing elements, such as C and Mn, so as to ensure that the quenching temperature could be set to a lower temperature (e.g., below 100° C.) to remain a reasonable amount of retained austenite in a quenching state. Thus, the quenching temperature may be set to room temperature, and the temperature accuracy and uniformity are easy to control, and the process is quite simple.

[0011] To be specific, in steel utilizing a quenching-and-partitioning (Q&P) mechanism, the initial quenched structure needs to comprise a substantial amount of retained austenite as “seeds” so that carbon can be diffused from martensite to retained austenite during the carbon-partitioning process, thereby enhancing the stability of retained austenite to improve the material properties. In order to enable the initial structure to comprise a substantial amount of retained austenite, the quenching temperature (QT) must be set between the martensitic transformation start temperature (Ms) and the martensitic transformation finish temperature (Mf). In the conventional Q&P steel, for example, Ms is set to be equal to 500° C., and Mf is set to be equal to 150° C. Under such circumstances, the QT needs to be set to a temperature ranging from 200 to 300° C., which requires a particular quenching medium, like salt, oil or a special quenching gas, for the sake of quenching. In contrast, in the present invention, Mf is surely lower than room temperature. Even if the QT is set to room temperature or a temperature ranging from 0 to 100° C. (with water as a medium), it is also possible to readily obtain a structure containing a large amount of retained austenite to guarantee the material properties.

[0012] Moreover, the steel used for hot stamping of the present invention is added with Vanadium (V), and the precipitation of vanadium carbide (VC) or a composite carbonitride formed of V, Ti and Nb etc. from austenite can be controlled by means of processes. On the one hand, crystalline grains are refined; on the other hand, the precipitation of vanadium carbide (VC) or the composite carbonitride consumes the C content in a matrix, thereby reducing the C content in martensite in a hot stamping state. Reduction of the C content in the matrix by the two mechanisms,

i.e., grain refinement and precipitation of vanadium carbide (VC) or the composite carbonitride, guarantees the toughness of the material after hot stamping, the elongation being $\geq 6\%$ thereby avoiding delayed cracking and meeting the requirements for welding and assembling. When there is 0.1 to 0.17% of C, more than 0.11% of V can ensure that enough vanadium carbide precipitates to meet the above requirement; when there is 0.171 to 0.19% of C, more V needs to be added for formation of vanadium carbide, and V needs to be higher than 0.209% to meet the object of reducing the C content in the matrix.

[0013] The steel used for hot stamping of the present invention may also comprise at least one of the following components by weight percent: 0~5% of Cr, 0~0.2% of Ti, 0~0.2% of Nb, 0~0.2% of Zr, 0~0.005% of B, 0~4% of Ni, 0~2% of Cu, 0~2% of Mo and 0~2% of W.

[0014] The C content preferably ranges from 0.12 to 0.17%, and the Mn content preferably ranges from 5.09 to 8%. The inventors find that although the yield strength of 1100 MPa can be substantially achieved when the C content is 0.11%, the C content of more than 0.12% will further ensure that the yield strength is greater than 1100 MPa. On the other hand, although a risk of brittle cracking during the hot stamping can be substantially avoided when the C content is 0.19%, the C content of below 0.17% will further ensure that the material has a good toughness in the hot stamping. In addition, if the C content is set to be from 0.12 to 0.17%, 5.09~8% of Mn can just obtain a suitable martensitic transformation start temperature so as to set the quenching temperature to room temperature to facilitate manufacturing of parts to the maximum extent.

[0015] The steel used for hot stamping of the present invention may also be provided on its surface with a coating selecting from the group comprising an Al—Si coating, a galvanized coating and a high-temperature oxidation coating. The galvanized coating and iron are alloyed to have a highest melting point of about 780° C. Conventional steel used for hot stamping usually has an austenitic heating temperature of over 900° C. Zinc may evaporate and the zinc-iron coating may melt during the hot stamping, which may result in liquid zinc induced embrittlement and reduce the strength and toughness of the steel used for hot stamping. In addition, liquid zinc is severely oxidized at a high temperature, and the hot stamped component must undergo a high-cost dry ice treatment or shot-blasting treatment to remove the zinc oxides on the surface, thereby guaranteeing subsequent painting process. Preferably, the complete austenitizing temperature of the steel used for hot stamping of the present invention may be lower than 780° C., and hot stamping may be conducted at a temperature below 650° C., thus meeting the requirements of hot stamping formation of galvanized sheets.

[0016] Preferably, the component ratio of the steel used for hot stamping meets the following requirement: the actual measured value of the martensitic transformation start temperature (Ms) of the steel used for hot stamping after hot stamping is from 150 to 280° C.

[0017] Whereby, it can further ensure that the quenching temperature can be set to room temperature to facilitate the manufacturing of the parts.

[0018] The technical solution 2 of the present invention relates to a hot stamping process, characterized in that the hot stamping process comprises: Step A: heating the steel used for hot stamping of technical solution 1 or its pre-

formed component to a temperature ranging from 700 to 890° C. and maintaining the temperature for 0.1 to 10000 seconds; Step B: transferring the steel used for hot stamping or its preformed component processed in the Step A into a die for stamping so as to obtain a formed component; and Step C: cooling the formed component at an average cooling speed of 0.1 to 1000° C./s.

[0019] In Step A, if the temperature is lower than 700° C., there may occur insufficient austenization, which fails to meet the requirement of a ferrite being 0-10%; on the other hand, if the temperature is greater than 890° C., it will lead to grain growth and vanadium carbide dissolution and growth, thereby resulting in poor performance. In addition, the average cooling speed in Step C is set to 0.1 to 1000° C./s, which can avoid non-martensite structures like ferrite, pearlite, bainite to provide the material with good hardenability.

[0020] Preferably, in Step A, the steel used for hot stamping of technical solution 1 or its preformed component is heated to a temperature ranging from 740 to 850° C. and maintaining the temperature. If the heating temperature is greater than 740° C., it takes shorter time for heating and may increase the production efficiency; and if the temperature is lower than 850° C., it may be helpful for better grain control and precipitation of vanadium carbide; and preferably the temperature maintaining time lasts for 10 to 800 seconds, a shorter heating time may lead to non-uniform and unstable heating, and a longer heating time may result in poor production efficiency. Further preferably, in Step A, the steel used for hot stamping of technical solution 1 or its preformed component is heated to a temperature ranging from 740 to 780° C. and maintaining the temperature. If the heating temperature is lower than 780° C., liquefaction and oxidization of galvanized sheets during hot stamping can be better inhibited.

[0021] More preferably, in Step C, the average cooling speed is between 1 and 100° C./s. A slower cooling speed will result in prolonged cooling time and poor production efficiency, but it is very different to carry out the hot stamping process at a higher cooling speed.

[0022] The technical solution 3 of the present invention relates to a formed component, which is obtained by hot stamping the steel used for hot stamping of the technical solution 1 or the preformed component made by preforming the steel used for hot stamping.

[0023] Preferably, the formed component comprises, by volume, 0.1 to 5% of vanadium carbide or composite carbonitride, 2 to 15% of retained austenite, 0 to 10% of ferrite, with the balance being martensite.

[0024] The formed component obtained according to the technical solution 3 of the present invention has an elongation of $\geq 6\%$, which can meet the requirements for prevention of delayed cracking and weld cracking.

[0025] Preferably, the formed component is heated and maintained within the temperature range from 140 to 220° C., the time for the heating and temperature maintaining is 1 to 100000 seconds.

[0026] Preferably, the formed component is used as a vehicle component, and the heating and temperature maintaining is conducted for 5 to 30 minutes during the paint baking of the vehicle production procedure.

[0027] Therefore, carbon partitioning can be realized in the baking and coating steps of the vehicle assembling procedure without additional heat treatment process, and the

coated and baked material will be improved in terms of elongation and toughness, so as to meet the collision performance requirement.

[0028] Preferably, the formed component after the heating and temperature maintaining treatment comprises, by volume, the following structure: 0.1 to 2% of vanadium carbide or composite carbonitride, 5 to 25% of retained austenite, 0 to 10% of ferrite, with the balance being martensite.

[0029] The formed component after the heating and temperature maintaining treatment has a yield strength of ≥ 1100 MPa, a tensile strength of ≥ 1400 MPa and an elongation of $\geq 10\%$, which can meet the collision performance requirement.

[0030] The present invention reduces the C content in initial martensite and reduces or avoids the brittleness of quenched martensite by setting the components of steel, thereby ensuring a stable performance of the component under a hot stamping state and an elongation of $\geq 6\%$, and preventing delayed cracking and meeting the requirement for welded assembling; in addition, the material under a hot stamping state, after baking and painting process, can be carbon-partitioned from martensite to retained austenite, and transformed reversely from a portion of martensite to austenite, finally resulting in a formed component with more than 5% of retained austenite, stable performance, a yield strength of ≥ 1100 MPa, a tensile strength of ≥ 1400 MPa and an elongation of $\geq 10\%$.

BRIEF DESCRIPTION OF THE DRAWINGS

[0031] FIG. 1 illustrates an example of a heat treatment process of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[0032] The technical solutions of the present invention will be explained with reference to the embodiments.

[0033] Steel used for hot stamping of the present invention comprises the following components by weight percent: 0.1–0.19% of C, 5.09–9.5% of Mn, 0.11–0.4% of V, and 0–2% Si+Al. The steel used for hot stamping may also comprise at least one of the following components: 0–5% of Cr, 0–0.2% of Ti, 0–0.2% of Nb, 0–0.2% of Zr, 0–0.005% of B, 0–4% of Ni, 0–2% of Cu, 0–2% of Mo and 0–2% of W, the content of which is also calculated by weight percent. The component ratio of the steel used for hot stamping is made in such a way that the actual measured value of the martensitic transformation start temperature (M_s) of the steel used for hot stamping after hot stamping is from 150 to 280° C.

[0034] The chemical components of the steel used for hot stamping of the present invention are listed as follows for the above reasons:

[0035] C: 0.1% to 0.19%

[0036] Carbon is the cheapest strengthening element that can greatly increase the strength of steel by interstitial solid solution. And the increase in the carbon content will greatly reduce the complete austenitizing temperature (Ac_3), thereby reducing the heating temperature and saving energy. Although carbon can greatly reduce the martensitic transformation start temperature, the requirements of the alloy design for the martensitic transformation start temperature being $\leq 280^\circ$ C. and the requirements for the microstructure of the steel must be met, and carbon is the most important

interstitial solid solution strengthening element, therefore the lower limit of the carbon content is 0.1%. However, an excessively high carbon content may greatly affect the mechanical performance of steel and cause a great increase in strength and decrease in toughness of the steel, therefore the upper limit of carbon is 0.19%, and the carbon content that is higher than the value may cause brittle cracking of steels under the hot stamping state. More preferably, the C content ranges from 0.12% to 0.17%.

[0037] Mn: 5.09% to 9.5%

[0038] Mn is an important element in the present invention. Mn is a good deoxidizer and desulfurizer. Mn is an austenite stabilizing element that can expand the austenite region and reduce the Ac_3 temperature. Mn has a good effect on inhibiting the transformation of austenite to ferrite and improving hardenability of steel. In order to decrease the heating temperature during the heat treatment, the lower limit of Mn is set to 5.09% so as to ensure that the martensitic transformation start temperature is $\leq 280^\circ$ C., and meanwhile the complete austenitizing temperature (Ac_3) of the material is guaranteed to be $\leq 780^\circ$ C. so as to facilitate the formation of the galvanized sheet by hot stamping. Addition of too much Mn may result in that the material after quenching forms a brittle martensite, therefore the upper limit of Mn is set to 9.5%. More preferably, the Mn content ranges from 5.09 to 8%.

[0039] V: 0.11% to 0.4%

[0040] Vanadium is precipitated as strong carbide. Precipitation of vanadium carbide can achieve the effect of grain refinement and strength improvement. Vanadium carbide is precipitated from Vanadium during the austenitizing phase and the hot stamping phase, which, on the one hand, refines the original austenite grains, and, on the other hand, reduces the carbon content in the matrix, thereby keeping the carbon content in martensite at a low level after hot stamping. The present invention controls the carbon content in martensite after hot stamping by adding vanadium element and precipitating vanadium carbide, in order to guarantee the elongation and the elongation stability of the hot stamped material. Less than 0.11% of V cannot achieve an obvious effect and fails to meet the material design requirement of the present invention. However, addition of a large amount of vanadium element will lead to an increase in size of VC, and in steel cost. In order to keep stable elongation of initial steel after hot stamping, the V content shall be not more than 0.4%.

[0041] Si+Al: 0% to 2%

[0042] Si and Al can both inhibit the formation of carbides. When the steel is maintained at a temperature range below the Ac_1 temperature after being quenched to room temperature, Si and Al can both inhibit precipitation of carbides in martensite and partition carbon to retained austenite to improve the stability of austenite and improve the product of strength and elongation of steel. In the industrial production, too much Al may block the nozzle in the continuous casting, increasing the difficulty in continuous casting, and Al may increase the martensitic transformation start temperature and the complete austenitizing temperature of the material, which does not meet the requirement of structure temperature control of the steel of the present invention. A high Si content will lead to more impurities in steel. The present invention adopts carbon-partitioning at a low temperature ranging from 140 to 220° C. During the low-temperature range, the formation of

cementite will be inhibited, and only a portion of transitional carbides may be formed, but the portion of carbides will not significantly affect the toughness of the material. Addition of a large amount of Si and Al cannot inhibit the production of transitional carbides, so the present invention does not depend on the addition of Si+Al. The content of Si+Al in the present invention is not more than 2%.

[0043] Cr: 0% to 5%

[0044] Cr is also an element that can improve hardenability of a material and reduce the martensitic transformation start temperature. Thus, the percentage of Mn and Cr in steel is determined according to the requirements of the alloy design for the martensitic transformation start temperature and the carbon content in steel. Mn and Cr are added either alone or both. Preferably, Cr is not added due to high cost.

[0045] Ti, Nb, Zr: 0% to 0.2%

[0046] Ti, Nb and Zr refine the crystalline grains of steel, increase the strength of steel and render the steel a good heat treatment property. The excessive low concentration of Ti, Nb and Zr does not work, but more than 0.2% thereof will increase unnecessary costs. The steel of the present invention can obtain a strength of more than 1600 MPa and good elongation because of a reasonable design of C and Mn, so preferably it does not need to add extra Ti, Nb and Zr for the sake of cost reduction.

[0047] B: 0% to 0.005%

[0048] The segregation of B at austenite grain boundaries prevents the nucleation of ferrite, which may greatly improve the hardenability of steel, and significantly improve the strength of steel after the heat treatment. The B content of more than 0.005% cannot obviously make improvement. Since the design of high Mn content in steel of the present invention has a high hardenability, preferably it does not need to add extra B for the sake of cost reduction.

[0049] Ni: 0% to 4%; Cu: 0% to 2%

[0050] Ni can increase the strength of steel and maintain the good plasticity and toughness of steel. If the concentration of Ni is more than 4.0%, the costs will be increased. Cu can increase the strength and toughness, especially atmospheric corrosion resistance. When the Cu content is greater than 2%, the processability may be deteriorated, and a liquid phase may be formed during hot rolling, which results in cracking. The high Cu content may also cause an increase in unnecessary costs. The steel of the present invention can obtain a strength of more than 1600 MPa and good elongation because of a reasonable design of C and Mn, so preferably it does not need to add extra Ni and Cu for the sake of cost reduction.

[0051] Mo and W: 0% to 2%

[0052] Mo and W can improve the hardenability of steel, and effectively increase the strength of steel. In addition, even if the steel is not sufficiently cooled due to its unstable contact with the die during the high-temperature forming process, the steel may still have a suitable strength due to the increased hardenability resulting from Mo and W. In the case of Mo and W being greater than 2%, no additional effects can be achieved, and costs will rise instead. Since the design of high Mn content in steel of the present invention has high hardenability, preferably it does not need to add extra Mo and W for the sake of cost reduction.

[0053] Unavoidable Impurities Such as P, S and N

[0054] In general, P is a harmful element in steel, which may increase the cold brittleness of steel, worsen the weldability, reduce the plasticity and deteriorate the cold bending

property. Generally speaking, S is also a harmful element, which may cause hot brittleness of steel, and reduce the elongation and weldability of steel. N is an unavoidable element in steel. N is similar to carbon in terms of function and is helpful in bake hardening.

[0055] The steel used for hot stamping or its preformed component of the present invention is hot stamped.

[0056] In one embodiment, the steel used for hot stamping or its preformed component is heated to a temperature ranging from 700 to 890° C. and maintains the temperature for 0.1 to 10000 seconds (Step A). In a process used in the experiment, the heating temperature ranges from 750 to 840° C. and the temperature is maintained for 5 minutes. As shown in FIG. 1, the heating temperature may be 780° C. and maintaining the temperature for 5 minutes. Then, the steel used for hot stamping or its preformed component is transferred into a die for hot stamping (Step B), and the formed component is cooled by air or other means to a temperature below 100° C. at an average cooling speed of 0.1 to 1000° C./s (Step C). After a period of time, the processed component is heated and maintains the temperature within a temperature range from 140 to 220° C. for 1 to 100000 seconds for a carbon-partitioning treatment and then cooled to room temperature. The cooling media may include, but are not limited to, air, water, oil and die surface. In a process used in the experiment, the heating and temperature maintaining is conducted within a temperature from 150 to 210° C. for 5 to 30 minutes. As shown in FIG. 1, the heating and temperature maintaining can be conducted during the paint baking of the vehicle production procedure.

[0057] Table 1 shows the components of steel used in an embodiment. The steel can be made into a sheet by the following processes, namely, a cast blank is maintained at the temperature of 1200° C. for 3 hours and then forged into a sheet blank, the sheet blank is maintained at the temperature of 1200° C. for 10 hours before undergoing a homogenization treatment and ground to make its superficial decarburized layer off, and then is heated to 1200° C. and maintains the temperature for 1 hour before being hot-rolled at a temperature ranging from 800° C. to 1200° C. to form a hot-rolled sheet. The hot-rolled pickled sheet is maintained at the temperature of 600° C. for 10 hours to simulate hooded annealing so as to reduce the strength of the hot-rolled sheet for the sake of cold rolling, the hot-rolled, pickled and annealed sheet is cold-rolled to be, e.g., 1.5 mm thick, and the cold-rolled sheet is annealed to simulate industrial cold-rolled sheet continuous annealing or coated sheet production process to obtain a steel sheet used for hot stamping.

[0058] In the tables, BT series is the steel of the present invention, and CT series is the compared steel, and the components of the CT series steel extend beyond the scope of the present invention.

[0059] Table 2 shows the processes adopted, and Table 3 shows the properties of the formed component obtained by treating the steel of Table 1 by means of the process shown in Table 2.

TABLE 1

	Main Chemical Components of Steel			
	C	Mn	Si	V
BT1	0.15	7.5	0.2	0.15
BT2	0.15	7.5	0.2	0.25

TABLE 1-continued

Main Chemical Components of Steel				
	C	Mn	Si	V
BT3	0.17	6.4	0.19	0.34
BT4	0.12	7.43	0.21	0.18
CT1	0.22	8	1.26	—
CT2	0.24	7.3	1.21	0.25
CT3	0.17	7.2	0.2	—

TABLE 2

Heat Treatment Processes of Steel					
No.		austenitizing temperature (° C.) and time for temperature maintaining	quenching temperature (° C.)	baking temperature (° C.)	baking Time (min)
Steel Type	Process No.	(min) in Step A			
BT1	1-1	780; 5	room temperature 20	—	—
			room temperature 20	—	—
	1-2	850; 15	room temperature 20	—	—
			room temperature 20	—	—
	1-1-200	780; 5	room temperature 20	200	30
			room temperature 20	200	30
	1-2-200	800; 5	room temperature 20	200	30
			room temperature 20	—	—
	1-3	800; 5	room temperature 20	—	—
			room temperature 20	—	—
	1-4	760; 5	room temperature 20	—	—
			room temperature 20	—	—
	1-5	780; 5	room temperature 20	—	—
			room temperature 20	—	—
	1-5-170	780; 5	room temperature 20	170	25
room temperature 20			—	—	
BT2	2-1	800; 5	room temperature 20	—	—
			room temperature 20	—	—
	2-2	850; 15	room temperature 20	—	—
			room temperature 20	—	—
	2-3	800; 5	room temperature 20	—	—
			room temperature 20	—	—
	2-4	780; 5	room temperature 20	—	—
			room temperature 20	—	—
2-4-180	780; 5	room temperature 20	180	30	
		room temperature 20	—	—	
2-4-200	780; 5	room temperature 20	200	20	
		room temperature 20	—	—	
BT3	3-1	780; 5	room temperature 20	—	—
			room temperature 20	200	20
BT4	4-1	780; 5	room temperature 20	—	—
			room temperature 20	200	20
CT1	CT1-1	800; 6	room temperature 20	—	—
			room temperature 20	—	—
	CT1-1-200	800; 6	room temperature 20	200	30
CT2	CT2-1	780; 5	room temperature 20	—	—
			room temperature 20	—	—
CT2-2-170	780; 5	780; 5	room temperature 20	170	30
			room temperature 20	—	—
CT3	CT3-1	780; 5	room temperature 20	—	—

TABLE 2-continued

Heat Treatment Processes of Steel					
No.		austenitizing temperature (° C.) and time for temperature maintaining	quenching temperature (° C.)	baking temperature (° C.)	baking Time (min)
Steel Type	Process No.	(min) in Step A			
CT3-2	780; 5	780; 5	room temperature 20	—	—
			room temperature 20	170	30

TABLE 3

Mechanical Properties of Formed Component					
No.		yield strength (MPa)	tensile strength (MPa)	elongation (%)	
BT1	1-1	970	1889	6.7	
		985	1826	7.1	
	1-1-200	1269	1630	12.2	
		1182	1611	10.2	
	1-3	989	1860	8.4	
		944	1810	9.6	
	1-5	930	1827	9.5	
		1148	1722	12.4	
	BT2	2-1	1001	1804	10.1
			1024	1722	6.8
2-3		1016	1753	8.9	
		1020	1776	9.9	
2-4-180	1210	1625	11.2		
	1234	1594	11.8		
BT3	3-1	1083	1566	7.8	
		1220	1505	10.5	
BT4	4-1	984	1545	9.1	
		1158	1458	10.8	
CT1	CT1-1	—	1145	1.7(brittle failure)	
		—	1211	1.9(brittle failure)	
CT1-1-200	1020	1020	1844	8.8	
		—	1355	2.2(brittle failure)	
CT2	CT2-1	—	1327	1.9(brittle failure)	
		—	1327	1.9(brittle failure)	
CT2-2-170	1095	1095	1941	10.2	
		—	1418	3.5(brittle failure)	
CT3	CT3-1	—	1418	2.8(brittle failure)	
		—	1390	2.8(brittle failure)	
CT3-2-170	1180	1180	1729	10.6	
		—	1729	10.6	

[0060] The formed component which has not undergone the heating and temperature maintaining treatment (baking treatment) comprises, by volume, the following structures: 0.1 to 5% of vanadium carbide or a composite carbonitride, 2 to 15% of retained austenite, 0 to 10% of ferrite, with the balance being martensite. As known from 1-1, 1-2, 1-3, 1-4, 1-5, 2-1, 2-2, 2-3, 2-4, 3-1 and 4-1 of Table 3, all of these formed components have an elongation of more than 6%.

[0061] The formed component which has undergone the heating and temperature maintaining treatment comprises, by volume, the following structures: 0.1 to 2% of vanadium carbide or a composite carbonitride, 5 to 25% of retained austenite, 0 to 10% of ferrite, with the balance being

martensite. As known from 1-1-200, 1-2-200, 1-5-170, 2-4-180, 3-1-200 and 4-1-200 of Table 3, all of these formed components have a yield strength of more than 1100 MPa, a tensile strength of more than 1400 MPa, and an elongation of more than 10%.

[0062] In contrast, irrespective of the heat treatment processes, the steels CT1, CT2, CT3 in the compared examples all fail to meet the four properties of the steel of the present invention: an elongation of $\geq 6\%$ under hot stamping state (before carbon-partitioning); a yield strength of ≥ 1100 MPa, a tensile strength of ≥ 1400 MPa, and an elongation of $\geq 10\%$ after carbon-partitioning (such as paint baking). In particular, as known from CT1-1, CT1-2, CT2-1, CT2-2, CT3-1, CT3-2, the steels CT1, CT2 and CT3 in the compared examples are very likely to suffer from brittle cracking before carbon-partitioning, whereas the steel of the present invention has an elongation of $\geq 6\%$ before carbon-partitioning, which helps to avoid brittle cracking and can meet the requirement for weld assembling.

[0063] The formed component of the present invention can be used as a high-strength component for land vehicles, including, but not limited to, B-post reinforcers, bumpers, vehicle door anti-collision beams and wheel spokes.

[0064] The above embodiments and experimental data are intended to exemplarily explain the present invention. Those skilled in the art shall understand that the present invention is not limited to these embodiments, and can be changed without departing from the protection scope of the present invention.

1. A steel used for hot stamping, characterized in that the steel used for hot stamping comprises, by weight percent, the following components: 0.1~0.19% of C, 5.09~9.5% of Mn, 0.11~0.4% of V, and 0~2% Si+Al, wherein the combination of C and V also meets one of the following two requirements: 1) 0.1~0.17% of C and 0.11~0.4% of V; and 2) 0.171~0.19% of C and 0.209~0.4% of V.

2. The steel used for hot stamping according to claim 1, characterized in that the steel used for hot stamping also comprises at least one of the following components: 0~5% of Cr, 0~0.2% of Ti, 0~0.2% of Nb, 0~0.2% of Zr, 0~0.005% of B, 0~4% of Ni, 0~2% of Cu, 0~2% of Mo and 0~2% of W.

3. The steel used for hot stamping of claim 1, wherein the C content ranges from 0.12 to 0.17%, and the Mn content ranges from 5.09 to 8%.

4. The steel used for hot stamping of claim 1, wherein the steel used for hot stamping is provided on its surface with a coating selecting from the group comprising an Al—Si coating, a galvanized coating and a high-temperature oxidation coating.

5. The steel used for hot stamping of claim 1, wherein the component ratio of the steel used for hot stamping meets the following requirement: the actual measured value of the martensitic transformation start temperature of the steel used for hot stamping after hot stamping is from 150 to 280° C.

6. A hot stamping process, wherein the hot stamping process comprises:

Step A: heating the steel used for hot stamping of claim 1, or a preformed component obtained by preforming the steel used for hot stamping to a temperature ranging from 700 to 890° C. and maintaining the temperature for 0.1 to 10000 seconds;

Step B: transferring the steel used for hot stamping or the preformed component processed in the Step A into a die for stamping so as to obtain a formed component; and

Step C: cooling the formed component at an average cooling speed of 0.1 to 1000° C./s.

7. The hot stamping process according to claim 6, characterized in that in the Step A, the heating temperature ranges from 740 to 850° C.

8. The hot stamping process according to claim 7, characterized in that in the Step A, the heating temperature ranges from 740 to 780° C.

9. The hot stamping process according to claim 7, characterized in that in Step C, the average cooling speed is between 1 and 100° C./s.

10. A formed component, wherein the formed component is obtained by hot stamping the steel used for hot stamping of claim 1 or a preformed component made by preforming the steel used for hot stamping.

11. The formed component according to claim 10, characterized in that the formed component comprises, by volume, the following structures: 0.1 to 5% of vanadium carbide or composite carbonitride, 2 to 15% of retained austenite, 0 to 10% of ferrite, with the balance being martensite.

12. The formed component according to claim 10, characterized in that the formed component has an elongation of $\geq 6\%$.

13. The formed component of claim 10, wherein the formed component is heated and maintains the temperature within the temperature range from 140 to 220° C., and the time for the temperature maintaining lasts for 1 to 100000 seconds.

14. The formed component according to claim 13, characterized in that the formed component is used as a vehicle component, and the temperature maintaining is conducted for 5 to 30 minutes during the paint baking of the vehicle production procedure.

15. The formed component according to claim 13, characterized in that the formed component comprises, by volume, the following structures: 0.1 to 2% of vanadium carbide or composite carbonitride, 5 to 25% of retained austenite, 0 to 10% of ferrite, with the balance being martensite.

16. The formed component according to claim 13, characterized in that the formed component has a yield strength of ≥ 1100 MPa, a tensile strength of ≥ 1400 MPa and an elongation of $\geq 10\%$.

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