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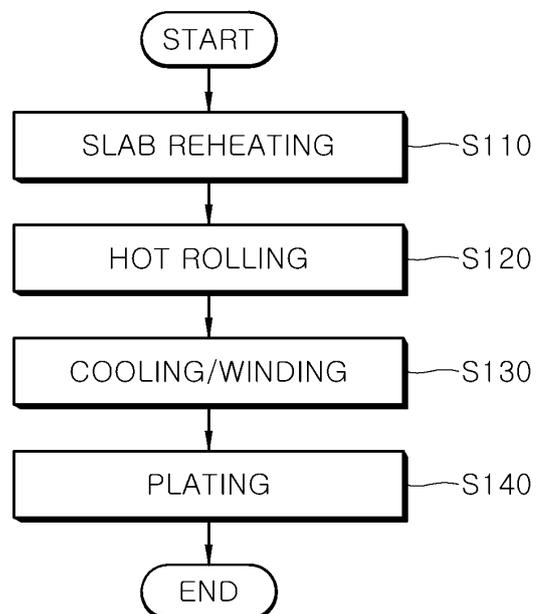
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(54) **HIGH-STRENGTH HOT-ROLLED PLATED STEEL SHEET AND METHOD FOR MANUFACTURING SAME**

(57) Disclosed is a high-strength hot-rolled plated steel sheet capable of suppressing material deterioration at the time of plating, while having high strength, and a method for manufacturing the same. The high-strength hot-rolled plated steel sheet may include: a hot-rolled steel sheet base material composed of 0.03-0.1wt% of C, below 0.06wt% of Si, 0.7-2.0wt% of Mn, below 0.02wt% of P, below 0.01wt% of S, 0.1-0.5wt% of one or more precipitate forming elements, 0.3-1.0wt% of Al, 0.1-0.5wt% of Mo, Fe, and unavoidable impurities; and a plated layer formed on the surface of the hot-rolled steel sheet base material.

**FIG. 1**



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**Description**

[Technical Field]

5 **[0001]** The present invention relates to a technology for manufacturing a hot-rolled steel sheet having a plated layer formed thereon, and more particularly, to a high-strength hot-rolled plated steel sheet capable of suppressing material deterioration at the time of plating, while having a high tensile strength of 780MPa or more, and a method for manufacturing the same.

10 [Background Art]

**[0002]** In order to overcome the age of high oil prices, the automobile industry has tried to reduce the weight of a vehicle body. Thus, much research has been conducted on the development of high-strength steel for reducing the weights of parts.

15 **[0003]** Representative examples of automobile parts requiring high-strength steel may include a chassis. The material for a chassis requires high tensile strength for durability and high elongation and burring property for implementing the shape of a complex part. In the winter season, a snow-removing work using calcium chloride is frequently conducted. Thus, the chassis may be corroded by the calcium chloride. Therefore, the material for a chassis requires a corrosion-resistant property in order to prevent such corrosion.

20 **[0004]** As the material for a chassis, a plated steel sheet is usually used. Most plated steel sheets are cold-rolled plated steel sheets. The cold-rolled plated steel sheets require a cold rolling process and an anneal heat treatment. Thus, the manufacturing process is complex, and the manufacturing cost for the cold-rolled plated steel sheets is high.

25 **[0005]** Therefore, a hot-rolled plated steel sheet obtained by plating a hot-rolled steel sheet has been developed. In the case of a general hot-rolled plated steel sheet, however, material deterioration may occur at the time of plating. Thus, the plating is applied only to hot-rolled steel sheets having a tensile strength of 440MPa or less.

**[0006]** The related art of the present invention is disclosed in Korean Patent Laid-open Publication No. 10-2012-0121810 published on November 6, 2012 and entitled "Method of manufacturing high strength steel sheet".

30 [Disclosure]

[Technical Problem]

35 **[0007]** Embodiments of the present invention are directed to a high-strength hot-rolled plated steel sheet of which the material quality is not almost changed at the time of plating, while having high strength, through process control and alloy elements such as aluminum and silicon, and a method for manufacturing the same.

[Technical Solution]

40 **[0008]** In an embodiment, a method for manufacturing a high-strength hot-rolled plated steel sheet may include: (a) reheating a slab composed of 0.03-0.1wt% of carbon (C), below 0.06wt% of silicon (Si), 0.7-2.0wt% of manganese (Mn), below 0.02wt% of phosphorous (P), below 0.01wt% of sulfur (S), 0.1-0.5wt% of one or more precipitate forming elements, 0.3-1.0wt% of aluminum (Al), 0.1-0.5wt% of molybdenum (Mo), steel (Fe), and unavoidable impurities, the precipitate forming elements forming a precipitate at 500 to 900 °C; (b) hot-rolling the slab; (c) cooling the hot-rolled slab, and then winding the cooled slab; and (d) plating the wound slab.

45 **[0009]** The method may further include (e) alloying the slab having the plated layer formed thereon.

**[0010]** The step (b) may include: roughing rolling the reheated slab at 950 to 1,050 °C; and finishing rolling the roughing-rolled slab at a finishing temperature condition of 800 to 900 °C.

**[0011]** The step (c) may include cooling the hot-rolled slab at an average cooling speed of 100 °C/sec or more, and then winding the cooled slab at 580 to 660 °C.

50 **[0012]** The step (d) may include uncoiling and pickling the wound slab, and hot-dip plating the slab without a heat treatment at a temperature of Ac1 or more.

**[0013]** The precipitate forming element may include one or more of 0.03-0.1wt% of niobium (Nb), 0.03-0.1wt% of titanium (Ti), and 0.08-0.3wt% of vanadium (V), or include all of Nb, Ti, and V.

55 **[0014]** In another embodiment, a high-strength hot-rolled plated steel sheet may include: a hot-rolled steel sheet base material composed of 0.03-0.1wt% of C, below 0.06wt% of Si, 0.7-2.0wt% of Mn, below 0.02wt% of P, below 0.01wt% of S, 0.1-0.5wt% of one or more precipitate forming elements, 0.3-1.0wt% of Al, 0.1-0.5wt% of Mo, Fe, and unavoidable impurities, the precipitate forming elements forming a precipitate at 500 to 900 °C; and a plated layer formed on the surface of the hot-rolled steel sheet base material, wherein the high-strength hot-rolled plated steel sheet exhibits a

tensile strength of 780 to 900MPa, a yield strength of 700 to 850MPa, an elongation of 14 to 22%, and a hole expansion of 55% or more.

[0015] The hot-rolled steel sheet base material of the hot-rolled plated steel sheet may have a microstructure which is composed of a ferrite single-phase structure and in which fine precipitates having a size of less than 10nm are formed.

[0016] The precipitate forming element may include one or more of 0.03-0.1wt% of Nb, 0.03-0.1wt% of Ti, and 0.08-0.3wt% of V, or include all of Nb, Ti, and V.

[Advantageous Effects]

[0017] According to the embodiments of the present invention, the strength can be secured through the precipitate forming elements such as Nb, Ti, and V, and the plateability can be improved through the suppression for Si and the addition of Al.

[0018] In particular, as 0.1-0.5wt% of Mo is included in the hot-rolled steel sheet base material, the activity of C can be reduced at the time of plating, and the coarsening of the precipitate can be suppressed. Thus, since material deterioration can be prevented at the time of plating, it is possible to manufacture a high-strength hot-rolled plated steel sheet which has an excellent elongation and burring property, while having high strength.

[Description of Drawings]

[0019] The above and other aspects, features and advantages of the invention will become apparent from the following detailed description in conjunction with the accompanying drawings, in which:

FIG. 1 schematically shows a method for manufacturing a high-strength hot-rolled plated steel sheet in accordance with an embodiment of the present invention;

FIG. 2 shows precipitates of a specimen in accordance with Embodiment 1 before and after plating;

FIG. 3 shows the microstructure of the specimen in accordance with Embodiment 1 before and after plating;

FIG. 4 shows the tensile strength and yield strength of the specimen in accordance with Embodiment 1 before and after plating; and

FIG. 5 shows the surfaces of specimens in accordance with Embodiment 1 and Comparative Examples 1 to 4.

[Best Mode]

[0020] Hereafter, a high-strength hot-rolled plated steel sheet and a method for manufacturing the same in accordance with an embodiment of the present invention will be described in detail with reference to the accompanying drawings.

### High-strength hot-rolled plated steel sheet

[0021] The high-strength hot-rolled plated steel sheet in accordance with the embodiment of the present invention may include a hot-rolled steel sheet base material and a plated layer formed on the surface thereof.

[0022] At this time, the hot-rolled steel sheet base material of the high-strength hot-rolled plated steel sheet in accordance with the embodiment of the present invention may include 0.03-0.1wt% of carbon (C), below 0.06wt% of silicon (Si), 0.7-2.0wt% of manganese (Mn), below 0.02wt% of phosphorous (P), below 0.01wt% of sulfur (S), 0.1-0.5wt% of one or more precipitate forming elements, 0.3-1.0wt% of aluminum (Al), and 0.1-0.5wt% of molybdenum (Mo). The precipitate forming element may form a precipitate at a temperature of 500 to 900 °C.

[0023] The other elements excluding the above-described alloy elements may include steel (Fe) and unavoidable impurities which occur during a steelmaking process.

[0024] Hereafter, the roles and contents of the elements included in the high-strength hot-rolled plated steel sheet in accordance with the embodiment of the present invention will be described as follows.

#### Carbon (C)

[0025] C is an element which contributes to increasing the strength of steel.

[0026] Desirably, C may be added at 0.03-0.1wt% with respect to the entire weight of the hot-rolled steel sheet base material in accordance with the embodiment of the present invention. When the addition of C is less than 0.03wt%, it is difficult to secure a target tensile strength of 780MPa or more. On the other hand, when the addition of C exceeds 0.1 wt%, the elongation and burring property may be degraded.

Silicon (Si)

**[0027]** Si is an element which contributes to securing strength, and serves as a deoxidizer for removing oxygen in steel.

**[0028]** Desirably, Si may be added at below 0.06wt% with respect to the entire weight of the hot-rolled steel sheet base material in accordance with the embodiment of the present invention. When the addition of Si exceeds 0.06wt%, the plateability and alloying degree may be degraded.

Manganese (Mn)

**[0029]** Mn is an element which increases the strength and toughness of steel and improves the hardenability of steel. The addition of Mn may suppress the reduction of ductility with the increase of strength, compared to the addition of C.

**[0030]** Desirably, Mn may be added at 0.7-2.0wt% with respect to the entire weight of the hot-rolled steel sheet base material in accordance with the embodiment of the present invention. When the addition of Mn is less than 0.7wt%, the addition may have no effect. On the other hand, when the addition of Mn exceeds 2.0wt%, MnS-based non-metallic inclusions may be excessively formed. During a welding operation, a crack or the like may occur to reduce the weldability.

Phosphorous (P)

**[0031]** P is an element which contributes to improving strength. However, when a large amount is included, fine segregations as well as center segregations may be formed to have a bad effect on the material quality, and degrade the weldability.

**[0032]** Thus, in the present embodiment, the content of P is limited to below 0.02wt% with respect to the entire weight of the hot-rolled steel sheet base material.

Sulfur (S)

**[0033]** S is an element which is coupled to Mn and forms non-metallic inclusions, and the non-metallic inclusions may degrade the toughness and weldability.

**[0034]** Thus, in the present embodiment, the content of S is limited to below 0.01wt% with respect to the entire weight of the hot-rolled steel sheet base material.

Precipitate Forming Element

**[0035]** The precipitate forming element serves to form a precipitate at a temperature of 500 to 900 °C. Representative examples of the precipitate forming element may include niobium (Nb), titanium (Ti), and vanadium (V). The hot-rolled steel sheet base material may include one or two or more kinds of precipitate forming elements.

**[0036]** The precipitate forming element may be added at 0.1-0.5wt% with respect to the entire weight of the hot-rolled steel sheet base material in accordance with the embodiment of the present invention. When the content of the precipitate forming element is less than 0.1wt%, the effect of strength improvement by precipitation hardening is insufficient. On the other hand, when the content of the precipitate forming element exceeds 0.5wt%, an excessive amount of precipitate may be formed to degrade the processability and the surface quality.

**[0037]** Ti precipitate may be formed at a temperature of 900 to 1,000 °C, Ni precipitate may be formed at a temperature of 600 to 800 °C and V precipitate may be formed at a temperature of 400 to 600 °C. Considering this aspect, all of Ni, Ti, and V may be included in the precipitate forming element such that the precipitation is performed during a hot rolling and cooling process.

**[0038]** When all of Nb, Ti, and V are included in the precipitate forming element, Nb, Ti, and V may be added at 0.03 to 0.1 wt%, 0.03-0.1%, and 0.08-0.3%, respectively, which considers the following aspects. When Nb and Ti are added at over 0.03wt%, the precipitation hardening effect may be obtained, but when Nb and Ti are added at over 0.1wt%, the processability and surface quality may be degraded. Furthermore, when V is added at over 0.08wt%, the precipitation hardening effect may be obtained, but when V is added at over 0.3wt%, the processability may be degraded.

Aluminum (Al)

**[0039]** In the present embodiment, Al may serve as a deoxidizer, and serve to improve the plateability.

**[0040]** Desirably, Al may be added at 0.3-1.0 wt% with respect to the entire weight of the hot-rolled steel sheet base material in accordance with the embodiment of the present invention. When the addition of Al is less than 0.3wt%, the deoxidation effect may be insufficient. On the other hand, when the content of Al exceeds 1.0wt%, the toughness of the steel sheet may be reduced.

Molybdenum (Mo)

[0041] In the present embodiment, plating may be performed on the surface of the hot-rolled steel sheet, and an alloying heat treatment may be performed, if necessary. The plating and the alloying heat treatment may be performed at a temperature of 450 to 550 °C which overlaps the precipitation temperature range of V. Thus, among the precipitate forming elements, V is the most suitable for precipitation hardening. However, when the V precipitate is coarsened, the material quality may be significantly changed during the plating process or alloying heat treatment.

[0042] At this time, when Mo is added, Mo may reduce the activity of C at a high temperature including the temperature range of the plating and alloying heat treatment, and disturb the growth of the precipitate. As a result, the material deterioration at the time of the plating process or alloying heat treatment can be prevented.

[0043] Desirably, Mo may be added at 0.1-0.5 wt% with respect to the entire weight of the hot-rolled steel sheet base material. When the addition of Mo is less than 0.1 wt%, the addition may have no effect. On the other hand, when the addition of Mo exceeds 0.5wt%, the formability and burring property of the steel sheet may be degraded.

[0044] The high-strength hot-rolled plated steel sheet in accordance with the embodiment of the present invention may be manufactured as a variety of hot-dip plated steel sheets, through a hot-dip plating process after a hot-rolled steel sheet is manufactured from a slab. More specifically, the high-strength hot-rolled plated steel sheet may include an HGI (Hot-dip Galvanized) steel sheet having a hot-rolled galvanized layer formed thereon or an HGA (Hot-rolled Galvanized) steel sheet having an alloyed hot-rolled galvanized layer formed on a hot-rolled steel sheet base material.

[0045] The high-strength hot-rolled plated steel sheet in accordance with the embodiment of the present invention may have a final microstructure which is composed of a ferrite single-phase structure and in which fine precipitates having a size of 10nm or less are formed, through the alloy composition of Mo, Al, and the precipitate forming elements and the hot-rolling and plating process. In the ferrite single-phase structure, the ferrite may have an area rate of 98% or more.

[0046] Furthermore, the high-strength hot-rolled plated steel sheet in accordance with the embodiment of the present invention may exhibit a tensile strength of 780 to 900Mpa, a yield strength of 700 to 850MPa, an elongation of 14 to 22%, and a hole expansion rate of 55% or more.

Method for manufacturing high-strength hot-rolled plated steel sheet

[0047] Hereafter, a method for manufacturing a high-strength hot-rolled plated steel sheet in accordance with an embodiment of the present invention will be described.

[0048] FIG. 1 schematically shows a method for manufacturing a high-strength hot-rolled plated steel sheet in accordance with an embodiment of the present invention.

[0049] Referring to FIG. 1, the method for manufacturing a high-strength hot-rolled plated steel sheet in accordance with the embodiment of the present invention may include slab reheating (S110), hot rolling (S120), cooling/winding (S130), and plating (S140).

Slab reheating

[0050] At the slab reheating step S110, a half-finished slab having the above-described composition may be reheated. The slab reheating may be performed at a temperature of 1,200 °C or more for 80 minutes or more, for example. Through the slab heating, the precipitate forming elements such as Ti, Nb, and V may be reemployed. Thus, fine precipitates may be formed during the hot rolling process.

Hot rolling

[0051] At the hot rolling step S120, the slab may be hot-rolled.

[0052] The hot rolling may include a variety of publicly-known methods which are performed under the condition that the finishing rolling temperature is equal to or more than Ar3. More desirably, roughing rolling may be performed at a temperature of 950 to 1,050 °C, and finishing rolling may be then performed at a temperature of 800 to 900 °C. Under the above-described roughing rolling condition, a large quantity of fine high-temperature precipitates may be formed. Under the finishing rolling condition, austenite grains before ferrite transformation may have a size of 10 to 30 $\mu$ m, which is preferable in terms of strength and elongation.

Cooling/winding

[0053] At the cooling/winding step S130, the hot-rolled slab may be cooled and wound, in order to secure sufficient strength and toughness.

5 [0054] At this time, the cooling may be performed at an average cooling speed of 100 °C/sec or more such that grain precipitates are grown. Furthermore, the winding may be performed at a temperature of 580 to 660 °C which is the most suitable for forming the ferrite single-phase structure, and a large quantity of fine precipitates may be formed due to a difference in employment rate among Ti, Nb, and V during ferrite transformation. The grain size of the ferrite structure may be set in the range of 2 to 7 μm through the cooling/winding process.

[0055] After the winding process, the slab may be naturally cooled to the room temperature.

#### Plating

10 [0056] At the plating step S140, the manufactured hot-rolled steel sheet base material may be plated to manufacture a hot-rolled plated steel sheet. Through the plating process, the steel sheet can have corrosion resistance.

[0057] Before the plating process, a pickling process may be further performed to pickle the surface of the steel sheet using hydrochloric acid, in order to remove scales on the hot-rolled steel sheet base material.

15 [0058] The plating process may include successively dipping the steel sheet in a plating bath. After the plating process, an alloying heat treatment may be further performed.

[0059] Before the plating process, a heat treatment may be performed to heat the steel sheet at a temperature of Ac1 or more. However, since the steel sheet in accordance with the embodiment of the present invention has a small difference in material quality between before and after the plating process, hot-dip plating may be performed without a heat treatment after the pickling process. When a heat treatment is skipped, the manufacturing cost for the hot-rolled plated steel sheet can be significantly reduced.

20 [0060] Through the plating process, an HGI or HGA steel sheet may be manufactured.

[0061] The plating process may be performed at a temperature of 450 to 500 °C. Furthermore, the alloying heat treatment may be performed at a temperature of 460 to 500 °C for about 5 to 100 seconds.

#### 25 Embodiments

[0062] Hereafter, the structure and operation of the present invention will be described in more detail with reference to preferred embodiments. However, the embodiments are only examples, and cannot limit the scope of the present invention.

30 [0063] Since contents which are not described herein can be easily understood by those skilled in the art, the descriptions thereof are omitted herein.

#### 1. Manufacturing specimens of hot-rolled plated steel sheet

35 [0064] Ingots having compositions of Table 1 below were manufactured, and then reheated at a temperature of 1,250 °C for 120 minutes. Then, roughing rolling was performed at a temperature of about 1,000 °C, and finishing rolling was performed at a temperature of 850 °C. Then, the ingots were cooled to 600 °C at an average cooling speed of 150 °C/sec, and maintained at 600 °C for 30 seconds. Then, the ingots were naturally cooled to manufacture specimens of the hot-rolled steel sheet base material.

40 [0065] Then, the specimens of the hot-rolled steel sheet base material were pickled, hot-dip galvanized at a temperature of 460 °C, and alloying-heat-treated at a temperature of 500 °C.

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[Table 1] (Unit: wt%)

		C	Si	Mn	P	S	Nb	Ti	V	Al	Mo
Embodiments	1	0.05	0.005	1.7	0.02	0.003	0.07	0.06	0.09	0.3	0.3
	2	0.08	0.01	1.2	0.01	0.005	0.05	-	0.20	0.4	0.3
	3	0.04	0.02	1.5	0.01	0.005	-	0.08	0.15	0.5	0.4
Comparative examples	1	0.05	0.005	1.8	0.02	0.003	0.01	0.01	0.01	0.4	0.3
	2	0.05	0.03	1.5	0.01	0.005	0.05	0.04	0.08	0.5	-
	3	0.05	0.15	1.5	0.01	0.01	0.07	0.06	0.09	0.3	0.3
	4	0.05	0.30	1.7	0.02	0.003	0.07	0.06	0.09	0.3	0.3
	5	0.05	0.40	1.7	0.02	0.003	0.07	0.06	0.09	0.3	0.3
	6	0.05	0.50	1.7	0.02	0.003	0.07	0.06	0.09	0.3	0.3

## 2. Microstructure

**[0066]** FIG. 2 shows precipitates of the specimen in accordance with Embodiment 1 before and after plating. Referring to FIG. 2, the size of precipitates in the specimen in accordance with Embodiment 1 is not changed before and after plating.

**[0067]** FIG. 3 shows the microstructure of the specimen in accordance with Embodiment 1 before and after plating. Referring to FIG. 3, the specimen in accordance with Embodiment 1 has a ferrite single-phase structure before and after plating, and the structure thereof is not changed.

**[0068]** The results of FIGS. 2 and 3 are because, as the activity of C was reduced due to the addition of Mo, material deterioration did not occur at the time of plating.

## 3. Mechanical property evaluation

**[0069]** For the specimens in accordance with Embodiments 1 to 3 and Comparative Examples 1 to 7, a tensile test and a burring property (hole expansion) test were performed. After an alloying heat treatment, the surfaces of the specimens were observed.

**[0070]** The tensile test was performed by a JIS-5 specimen.

**[0071]** The hole expansion test was performed as follows: a hole having the initial diameter  $d_0$  of 10mm was formed and then expanded by a 60-degree cone punch, and the diameter  $d$  of the hole at the point of time that a crack passed through the sheet was measured to evaluate the hole expansion ( $(d-d_0)/d_0 \times 100$ ).

[Table 2]

		Tensile strength (MPa)	Yield strength (MPa)	Elongation (%)	Hole Expansion (%)
Embodiments	1	840	800	22	65
	2	828	792	22	66
	3	853	816	21	61
Comparative	1	736	624	24	68

(continued)

		Tensile strength (MPa)	Yield strength (MPa)	Elongation (%)	Hole Expansion (%)	
5	Examples	2	772	714	23	64
		3	844	801	21	64
		4	867	816	19	62
		5	868	821	18	62
10		6	871	822	16	61

**[0072]** Referring to Table 2, the specimens in accordance with Embodiments 1 to 3, which satisfy the conditions suggested in the present invention, satisfy a tensile strength of 780 to 900MPa, a yield strength of 700 to 850MPa, an elongation of 14 to 22%, and a hole expansion of 55% or more, which correspond to the target values of the tensile strength, the yield strength, the elongation, and the hole expansion.

**[0073]** On the other hand, the specimen in accordance with Comparative Example 1, which does not include a sufficient amount of precipitate forming element, exhibits low strength, and the specimen in accordance with Comparative Example 2, which does not include Mo, also exhibits low strength. The results of Comparative Examples 1 and 2 are because no precipitates were formed due to an insufficient amount of precipitate forming element, or precipitates were coarsened during a plating process or a maintenance process after a cooling process, which corresponds to a winding process.

**[0074]** Furthermore, the specimens in accordance with Comparative Examples 3 to 6, which include an excessive amount of Si, have mechanical properties which satisfy the target values.

**[0075]** As illustrated in FIG. 5, however, when an excessive amount of Si is added, the plated layers of the specimens are not uniform, and the surface states of the specimens are not satisfactory.

**[0076]** Although some embodiments have been provided to illustrate the invention in conjunction with the drawings, it will be apparent to those skilled in the art that the embodiments are given by way of illustration only, and that various modifications and equivalent embodiments can be made without departing from the spirit and scope of the invention. The scope of the invention should be limited only by the accompanying claims.

## Claims

1. A method for manufacturing a high-strength hot-rolled plated steel sheet, comprising:

(a) reheating a slab composed of 0.03-0.1wt% of carbon (C), below 0.06wt% of silicon (Si), 0.7-2.0wt% of manganese (Mn), below 0.02wt% of phosphorous (P), below 0.01wt% of sulfur (S), 0.1-0.5wt% of one or more precipitate forming elements, 0.3-1.0wt% of aluminum (Al), 0.1-0.5wt% of molybdenum (Mo), steel (Fe), and unavoidable impurities, the precipitate forming elements forming a precipitate at 500 to 900 °C;

(b) hot-rolling the slab;

(c) cooling the hot-rolled slab, and then winding the cooled slab; and

(d) plating the wound slab.

2. The method of claim 1, further comprising the step of alloying the slab having the plated layer formed thereon.

3. The method of claim 1, wherein the step of hot rolling the slab comprises:

roughing rolling the reheated slab at 950 to 1,050 °C; and

finishing rolling the roughing-rolled slab at a finishing temperature condition of 800 to 900 °C.

4. The method of claim 1, wherein the step of cooling the hot-rolled slab, and the winding the cooled slab comprises cooling the hot-rolled slab at an average cooling speed of 100 °C/sec or more, and then winding the cooled slab at 580 to 660 °C.

5. The method of claim 1, wherein the step of plating the wound slab comprises uncoiling and pickling the wound slab, and hot-dip plating the slab without a heat treatment at a temperature of Ac1 or more.

6. The method of claim 1, wherein the precipitate forming element comprises at least one of 0.03-0.1wt% of niobium

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(Nb), 0.03-0.1wt% of titanium (Ti), and 0.08-0.3wt% of vanadium (V).

- 5
7. The method of claim 1, wherein the precipitate forming element comprises 0.03-0.1wt% of Nb, 0.03-0.1wt% of Ti, and 0.08-0.3wt% of V.

8. A high-strength hot-rolled plated steel sheet comprising:

10 a hot-rolled steel sheet base material composed of 0.03-0.1wt% of C, below 0.06wt% of Si, 0.7-2.0wt% of Mn, below 0.02wt% of P, below 0.01wt% of S, 0.1-0.5wt% of one or more precipitate forming elements, 0.3-1.0wt% of Al, 0.1-0.5wt% of Mo, Fe, and unavoidable impurities, the precipitate forming elements forming a precipitate at 500 to 900 °C; and

15 a plated layer formed on the surface of the hot-rolled steel sheet base material, wherein the high-strength hot-rolled plated steel sheet exhibits a tensile strength of 780 to 900MPa, a yield strength of 700 to 850MPa, an elongation of 14 to 22%, and a hole expansion of 55% or more.

9. The high-strength hot-rolled plated steel sheet of claim 8, wherein the hot-rolled steel sheet base material of the hot-rolled plated steel sheet has a microstructure which is composed of a ferrite single-phase structure and in which fine precipitates having a size of less than 10nm are formed.

- 20 10. The high-strength hot-rolled plated steel sheet of claim 8, wherein the precipitate forming element comprises at least one of 0.03-0.1wt% of Nb, 0.03-0.1wt% of Ti, and 0.08-0.3wt% of V.

- 25 11. The high-strength hot-rolled plated steel sheet of claim 8, wherein the precipitate forming element comprises 0.03-0.1wt% of Nb, 0.03-0.1wt% of Ti, and 0.08-0.3wt% of V.

FIG. 1

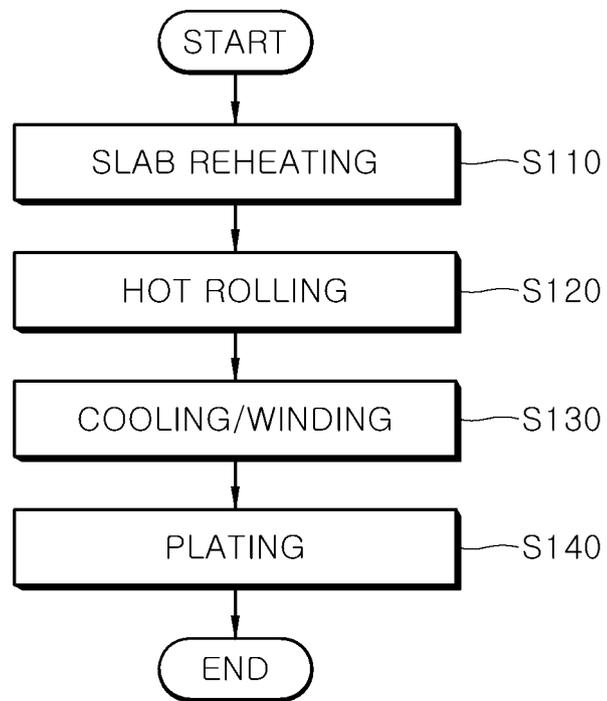


FIG. 2

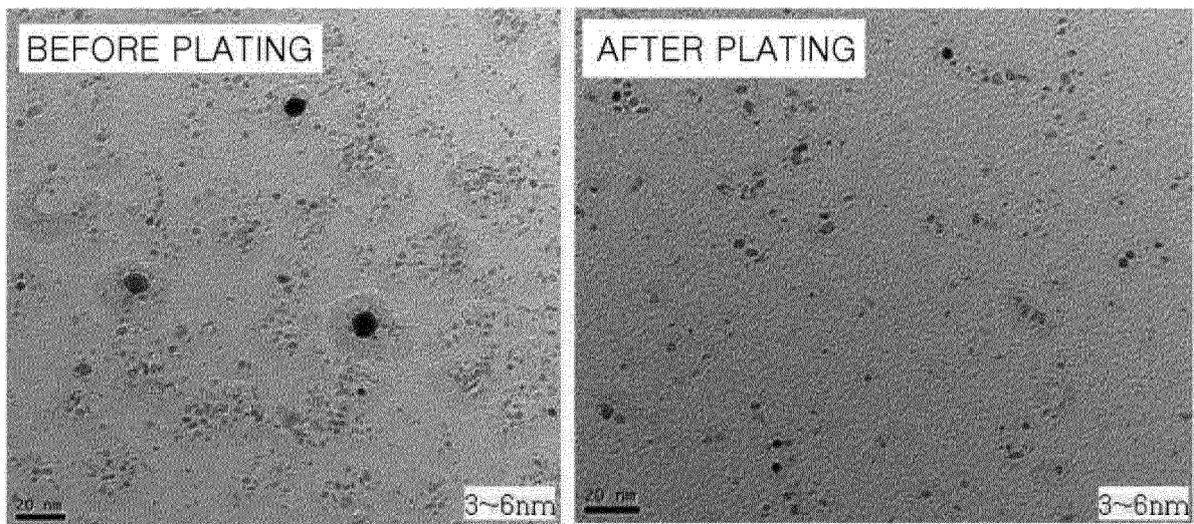


FIG. 3

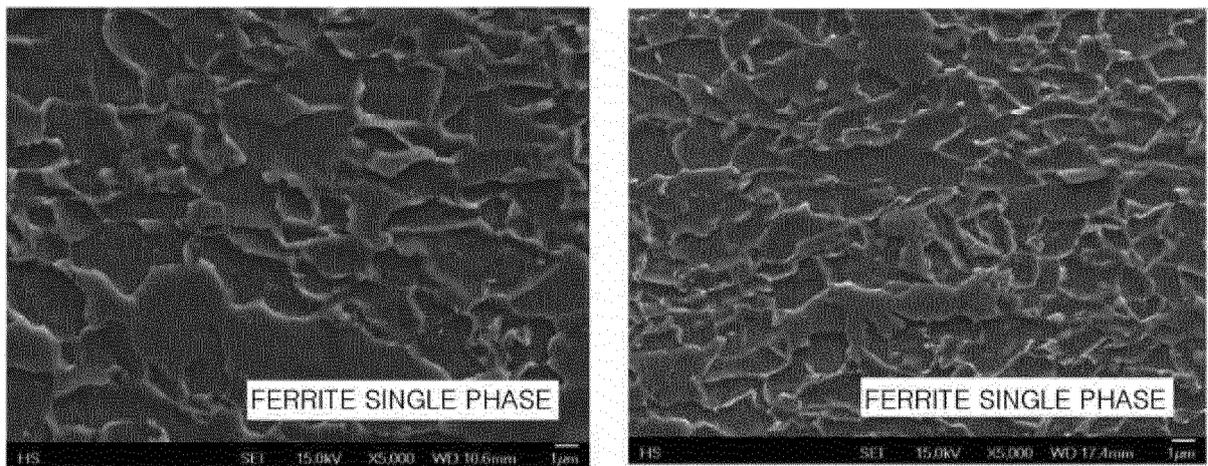


FIG. 4

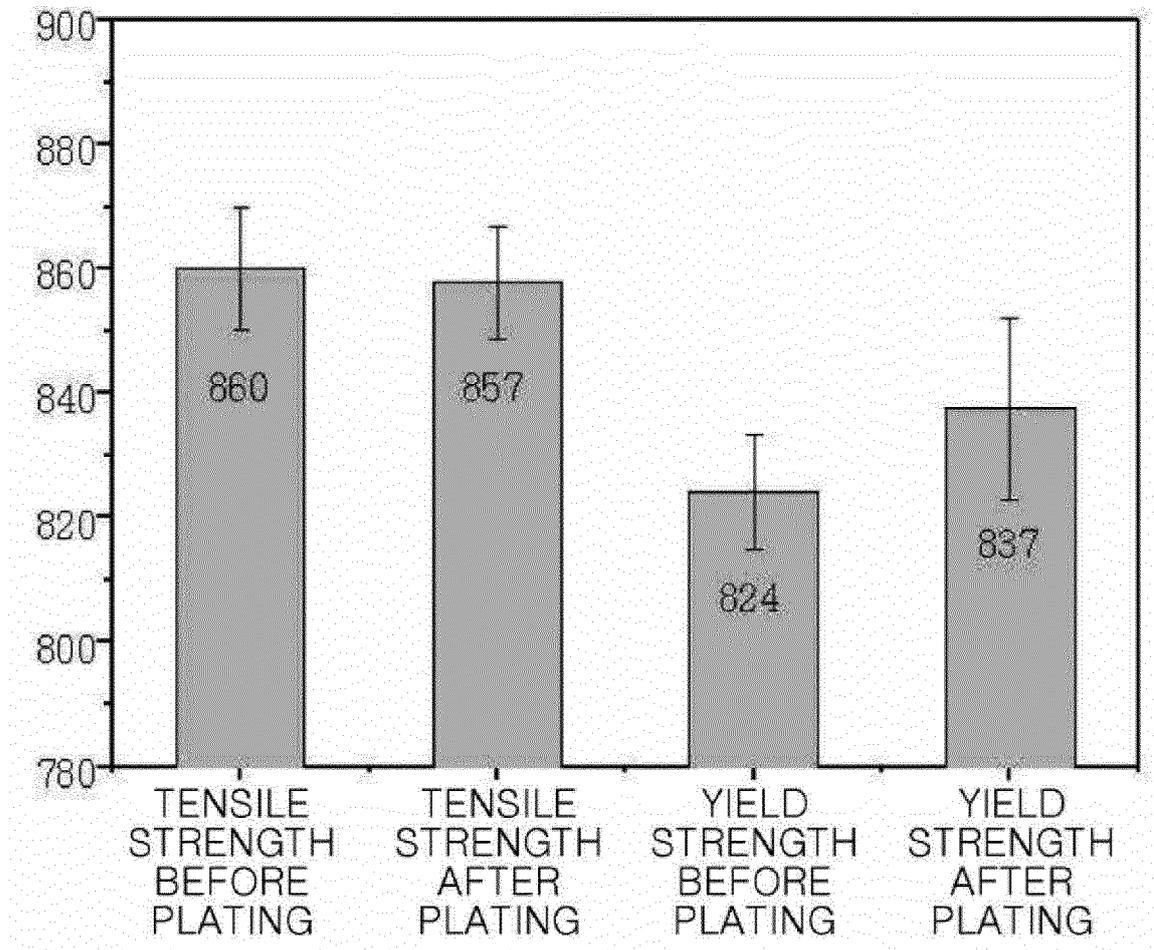
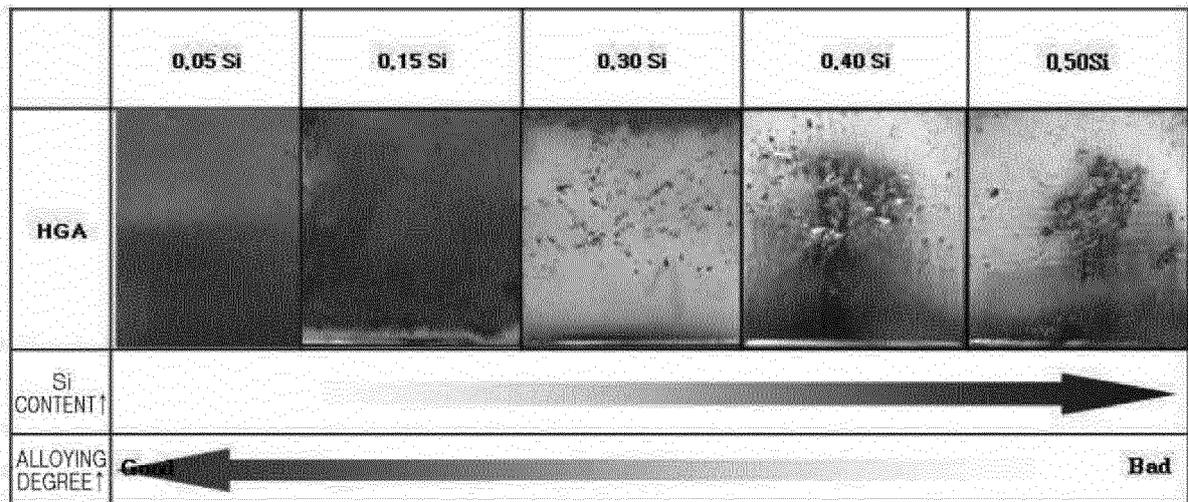


FIG. 5



INTERNATIONAL SEARCH REPORT

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<p>A. CLASSIFICATION OF SUBJECT MATTER</p> <p><b>C21D 8/02(2006.01)i, C22C 38/00(2006.01)i, C21D 9/46(2006.01)i, B21B 3/00(2006.01)i</b></p> <p>According to International Patent Classification (IPC) or to both national classification and IPC</p>																							
<p>B. FIELDS SEARCHED</p> <p>Minimum documentation searched (classification system followed by classification symbols) C21D 8/02; C21D 9/46; C22C 38/00; B21B 9/00; B21B 1/26; B21B 3/00</p> <p>Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched Korean Utility models and applications for Utility models: IPC as above Japanese Utility models and applications for Utility models: IPC as above</p> <p>Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) eKOMPASS (KIPO internal) &amp; Keywords: hot rolled steel sheets, plating, titanium, niobium, vanadium, molybdenum</p>																							
<p>C. DOCUMENTS CONSIDERED TO BE RELEVANT</p> <table border="1"> <thead> <tr> <th>Category*</th> <th>Citation of document, with indication, where appropriate, of the relevant passages</th> <th>Relevant to claim No.</th> </tr> </thead> <tbody> <tr> <td>X</td> <td>KR 10-2009-0115877 A (NIPPON STEEL CORP.) 09 November 2009</td> <td>1,2,4-8,10,11</td> </tr> <tr> <td>A</td> <td>See paragraphs [0172], [0235], [0261] and claims 1, 4, 7-10.</td> <td>3,9</td> </tr> <tr> <td>A</td> <td>KR 10-0754035 B1 (NIPPON STEEL CORP.) 04 September 2007 See paragraph [0302] and claims 4-6, 10, 12.</td> <td>1-11</td> </tr> <tr> <td>A</td> <td>JP 5047649 B2 (NIPPON STEEL CORP.) 10 October 2012 See paragraphs [0061]-[0074] and claims 1-3.</td> <td>1-11</td> </tr> <tr> <td>A</td> <td>KR 10-2013-0018846 A (JFE STEEL CORPORATION) 25 February 2013 See paragraphs [0036]-[0038] and claims 4, 5.</td> <td>1-11</td> </tr> <tr> <td>A</td> <td>KR 10-2002-0070282 A (NKK CORP.) 05 September 2002 See pages 8-10 and claims 1, 11, 12, 23.</td> <td>1-11</td> </tr> </tbody> </table>			Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.	X	KR 10-2009-0115877 A (NIPPON STEEL CORP.) 09 November 2009	1,2,4-8,10,11	A	See paragraphs [0172], [0235], [0261] and claims 1, 4, 7-10.	3,9	A	KR 10-0754035 B1 (NIPPON STEEL CORP.) 04 September 2007 See paragraph [0302] and claims 4-6, 10, 12.	1-11	A	JP 5047649 B2 (NIPPON STEEL CORP.) 10 October 2012 See paragraphs [0061]-[0074] and claims 1-3.	1-11	A	KR 10-2013-0018846 A (JFE STEEL CORPORATION) 25 February 2013 See paragraphs [0036]-[0038] and claims 4, 5.	1-11	A	KR 10-2002-0070282 A (NKK CORP.) 05 September 2002 See pages 8-10 and claims 1, 11, 12, 23.	1-11
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A	KR 10-2002-0070282 A (NKK CORP.) 05 September 2002 See pages 8-10 and claims 1, 11, 12, 23.	1-11																					
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<p>Date of the actual completion of the international search</p> <p><b>20 MAY 2014 (20.05.2014)</b></p>		<p>Date of mailing of the international search report</p> <p><b>21 MAY 2014 (21.05.2014)</b></p>																					
<p>Name and mailing address of the ISA/KR</p> <p> Korean Intellectual Property Office Government Complex-Daejeon, 189 Seonsa-ro, Daejeon 302-701, Republic of Korea Facsimile No. 82-42-472-7140</p>		<p>Authorized officer</p> <p>Telephone No.</p>																					

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