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(71) Applicant: **POSCO Co., Ltd**
Pohang-si, Gyeongsangbuk-do 37859 (KR)

(72) Inventor: **PARK, Hyung-Jin**
Seoul 06194 (KR)

(74) Representative: **Meissner Bolte Partnerschaft
mbB**
Patentanwlte Rechtsanwälte
Postfach 86 06 24
81633 Mnchen (DE)

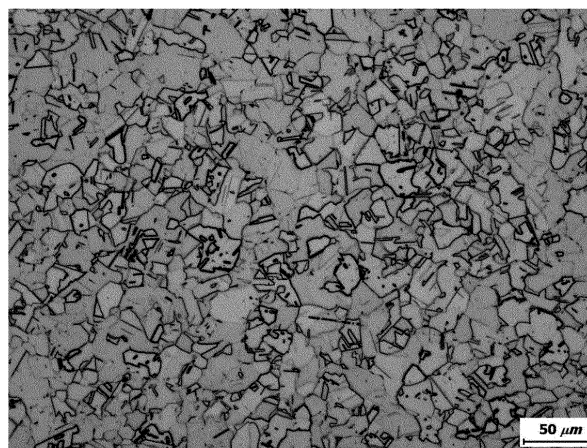
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(54) **HOT-ROLLED STEEL PLATE AND STEEL TUBE HAVING EXCELLENT ABRASION
RESISTANCE, AND MANUFACTURING METHOD THEREOF**

(57) The present invention pertains to: a hot-rolled steel plate; a steel tube; and methods for manufacturing the steel plate and steel tube. More specifically, the present invention pertains to: a high manganese

hot-rolled steel plate having excellent abrasion resistance; a steel tube manufactured using the hot-rolled steel plate; and methods for manufacturing the steel plate and steel tube.

FIG. 1



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Description

Technical Field

5 **[0001]** The present disclosure relates to a hot-rolled steel plate, a steel tube, and a manufacturing method thereof, and more specifically, to a high-manganese hot-rolled steel plate having excellent abrasion resistance, a steel tube manufactured using the hot-rolled steel plate, and a manufacturing method thereof.

Background Art

10 **[0002]** When dredging a route to secure a water depth and water area of a sailing vessel or dredging landfill to create a hinterland, a steel tube used for dredging is required to have excellent abrasion resistance against gravel, sand, or the like. In addition, in the case of a steel tube used in the mining industry to extract and transport resources such as minerals, abrasion resistance characteristics are closely related to production costs, so excellent abrasion resistance characteristics are required for efficient production costs.

15 **[0003]** In the case of carbon steel of which a main structure is ferrite or martensite, which is used as an abrasion-resistant steel tube, there is a need for substitute materials that can overcome these disadvantages as limitations in abrasion resistance have recently appeared.

20 **[0004]** Meanwhile, an austenitic steel material has excellent abrasion resistance due to work hardenability characteristics, which is used as abrasion-resistant parts in various industries. In order to increase abrasion resistance, high manganese steel contains a high content of carbon and a large amount of manganese, and efforts have been made to increase an austenite structure and resistance.

25 **[0005]** In addition, in the case of steel tubes for dredging and mineral extraction/transport, as well as small and medium-diameter steel tubes, ERW steel tubes are manufactured and used using hot-rolled materials, and in the case of large diameter steel tubes, spiral steel tubes using hot-rolled materials and submerged arc welding (SAW) steel tubes using thick plates are manufactured and used. In the case of high manganese steel, much development has been performed on steel tubes using thick plates, but the development of high manganese hot-rolled steel and steel tubes using the same is required.

Summary of Invention

Technical Problem

35 **[0006]** An aspect of the present disclosure is to provide a hot-rolled steel plate, a steel tube, having excellent abrasion resistance, and a manufacturing method thereof.

[0007] The object of the present disclosure is not limited to the above. A person skilled in the art would have no difficulty in understanding the further subject matter of the present disclosure from the general content of this specification.

Solution to Problem

40 **[0008]** According to an aspect of the present disclosure, provided is a hot-rolled steel plate, the hot-rolled steel plate including, by weight: manganese (Mn): 10 to 20%, carbon (C): 0.6 to 2.0%, chromium (Cr): 5.0% or less, aluminum (Al): 0.5% or less, silicon (Si): 1.0% or less, phosphorus (P): 0.1% or less, sulfur (S): 0.02% or less, with a remainder of Fe, and other unavoidable impurities,

45 wherein the hot-rolled steel plate has a microstructure with austenite as a main phase, and includes film-shaped precipitates formed along austenite grain boundaries,
wherein hardness of the hot-rolled steel plate increases by 1.1 times or more by work hardening after piping.

50 **[0009]** The precipitate may have a thickness of 0.1 to 2.0 μm .

[0010] The steel plate may have a tensile strength of 800 MPa or more and elongation of 30% or more.

[0011] The steel plate may have a Vickers hardness of 220Hv or more.

[0012] The steel plate may have a thickness of 4 to 20 mm.

55 **[0013]** According to another aspect of the present disclosure, provided is a steel tube, the steel tube including, by weight: manganese (Mn): 10 to 20%, carbon (C): 0.6 to 2.0%, chromium (Cr): 5.0% or less, aluminum (Al): 0.5% or less, silicon (Si): 1.0% or less, phosphorus (P): 0.1% or less, sulfur (S): 0.02% or less, with a remainder of Fe, and other unavoidable impurities,

wherein the steel tube has a microstructure with austenite as a main phase, and includes film-shaped precipitates formed along austenite grain boundaries,
wherein hardness of the steel tube, as compared to that of the steel plate, is 1.1 times or more.

[0014] The steel tube may have a Vickers hardness of 250Hv or more.

[0015] According to an aspect of the present disclosure, provided is a manufacturing method of a hot-rolled steel plate, the manufacturing method including operations of: reheating a steel slab including, by weight: manganese (Mn): 10 to 20%, carbon (C) : 0.6 to 2.0%, chromium (Cr) : 5.0% or less, aluminum (Al) : 0.5% or less, silicon (Si): 1.0% or less, phosphorus (P): 0.1% or less, sulfur (S) : 0.02% or less, with a remainder of Fe, and other unavoidable impurities,

hot rolling the reheated steel slab to obtain a hot-rolled steel plate; and
cooling the hot-rolled steel plate to a temperature range of less than 500°C and then coiled,
wherein a coiling start temperature is 500°C or lower, and an average coiling temperature is less than 300°C.

[0016] The reheating may be performed at a temperature within a range of 1000 to 1250°C.

[0017] The hot rolling may be performed at a finishing temperature of 800°C or higher,

[0018] During the cooling, a cooling rate may be 5°C/s or more.

[0019] The steel plate after the hot rolling may have a thickness of 4 to 20 mm.

[0020] Another aspect of the present disclosure may provide a manufacturing method of a steel tube including the operation of piping the hot-rolled steel plate to obtain a steel tube.

Advantageous Effects of Invention

[0021] As set forth above, according an aspect of the present disclosure, a hot-rolled steel plate and a steel tube having excellent abrasion resistance, and a manufacturing method thereof may be provided.

Brief description of drawings

[0022] FIG. 1 is a photograph of a microstructure of Inventive Example 1 according to an aspect of the present disclosure observed with an optical microscope (200x magnification).

Best Mode for Invention

[0023] Hereinafter, the present disclosure will be described in detail. Embodiments of the present disclosure may be modified in various forms, and the scope of the present disclosure should not be construed as limited to the embodiments described below. These embodiments are provided to explain the present disclosure in more detail to those skilled in the art.

[0024] Hereinafter, the present disclosure will be described in detail.

[0025] Hereinafter, a steel composition of the present disclosure will be described in detail.

[0026] In the present disclosure, unless other specified, % indicating a content of each element is based on weight.

[0027] A hot-rolled steel plate may include, by weight: manganese (Mn): 10 to 20%, carbon (C): 0.6 to 2.0%, chromium (Cr): 5.0% or less, aluminum (Al): 0.5% or less, silicon (Si): 1.0 % or less, phosphorus (P): 0.1% or less, sulfur (S): 0.02% or less, with a remainder of Fe and other unavoidable impurities.

Manganese (Mn): 10 to 20%

[0028] Manganese (Mn) is a very important element that plays a role in stabilizing austenite and may improve uniform elongation. Manganese (Mn) is preferably included in an amount of 10% or more in order to secure austenite as a main structure. If a content of manganese (Mn) is less than 10%, austenite stability may decrease and a martensite structure may be formed during a rolling process in a manufacturing process. As a result, an austenite structure may not be sufficiently secured, making it difficult to secure sufficiently uniform elongation. On the other hand, if the content of manganese (Mn) exceeds 20%, manufacturing costs may increase significantly, corrosion resistance may be reduced due to excessive addition of manganese (Mn), and internal oxidation may occur severely when heated in the manufacturing process, which may cause a problem such as deterioration in surface quality. A more preferable lower limit of the manganese (Mn) content may be 11.5%, and a more preferable upper limit may be 19.5%.

Carbon (C): 0.6 to 2.0%

[0029] Carbon (C) is an austenite stabilizing element that only plays a role in improving uniform elongation, but is also a very advantageous element in improving strength and a work hardening rate. If a carbon (C) content is less than 0.6%, it may be difficult to form stable austenite at room temperature, causing a problem in that it may be difficult to secure sufficient strength and work hardening rate. Meanwhile, if the carbon (C) content exceeds 2.0%, a large amount of carbides are precipitated and the uniform elongation is reduced, making it difficult to secure excellent elongation, and premature fracturing may occur. In order to increase abrasion resistance, it is advantageous to increase the carbon (C) content as much as possible, but even if precipitation of carbides is suppressed through heat treatment, there is a limitation in solid solutioning of carbon (C), since there are concerns about deterioration in physical properties of the steel material, an upper limit of the carbon (C) content is preferably limited to 2.0%. A more preferable lower limit of the carbon (C) content may be 0.75%, and a more preferable upper limit of the carbon (C) content may be 1.85%.

Chromium (Cr): 5.0% or less

[0030] Chromium (Cr) may serve to increase strength of a steel material by being dissolved in austenite. In addition, chromium (Cr) is an element for improving corrosion resistance of the steel material, but it may reduce toughness by forming carbides at austenite grain boundaries. Therefore, a chromium (Cr) content added in the present disclosure is preferably determined considering the relationship with C and other elements added together, and in order to prevent formation of carbides, chromium (Cr) is preferably included in an amount of 5% or less. More preferably, chromium (Cr) is preferably included in an amount of 4% or less. If the chromium (Cr) content exceeds 5%, it may be difficult to effectively suppress formation of chromium-based carbides at austenite grain boundaries, which may reduce impact toughness. In the present disclosure, the chromium (Cr) content may be controlled as needed, and 0% may be included.

Aluminum (Al): 0.5% or less

[0031] Aluminum (Al) is a component included as a deoxidizer during a steelmaking process, and in the present disclosure, aluminum (Al) may be included in an amount of 0.5% or less. In the present disclosure, 0% can be excluded as an aluminum (Al) content.

Silicon (Si): 1.0% or less

[0032] Silicon (Si) is a component included as a deoxidizer during a steelmaking process along with Al, and in the present disclosure, silicon (Si) may be included in an amount of 1.0% or less, and 0% may be excluded.

Phosphorus (P): 0.1% or less

[0033] Phosphorus (P) is a representative impurity that is inevitably added to steel. If phosphorus (P) is added excessively, it can cause quality deterioration, so an upper limit thereof may be limited to 0.1%.

Sulfur (S): 0.02% or less

[0034] Sulfur (S) is an impurity that is inevitably added to steel along with P, and an upper limit thereof may be limited to 0.02%.

[0035] The steel of the present disclosure may include remaining iron (Fe) and unavoidable impurities in addition to the above-described composition. Since unavoidable impurities may be unintentionally incorporated in a common manufacturing process, the component may not be excluded. Since these impurities are known to any person skilled in the common manufacturing process, the entire contents thereof are not particularly mentioned in the present specification.

[0036] Hereinafter, a microstructure of steel of the present disclosure will be described in detail.

[0037] In the present disclosure, unless specifically stated otherwise, % indicating a fraction of microstructure is based on area.

[0038] The hot-rolled steel plate according to an aspect of the present disclosure may have a microstructure with austenite as a main phase.

[0039] In the present invention, the hot-rolled steel plate may have a microstructure with austenite as the main phase in order to secure abrasion resistance by increasing hardness due to excellent work hardening of the material itself in an abrasive environment. More preferably, the microstructure may include 97 area% or more of austenite.

[0040] A steel according to an aspect of the present disclosure may include film-shaped precipitates formed along austenite grain boundaries, and a thickness of the precipitates may be 0.1 to 2.0 μm .

[0041] In the present disclosure, it is intended to secure sufficient strength and abrasion resistance by forming film-shaped precipitates at austenite grain boundaries. The precipitate according to the present disclosure may include carbides, and may include carbides in which Cr is formed together with C. If the thickness of the precipitates is less than 0.1 μm , sufficient strength may not be secured, causing a problem in that abrasion resistance may be reduced, and if the thickness of the precipitates exceeds 2.0 μm , there is a problem in that ductility and toughness are reduced.

[0042] A steel tube formed by piping a hot-rolled steel plate according to an aspect of the present disclosure may have a microstructure with austenite as a main phase, may include film-shaped precipitates at grain boundaries, and a thickness of the precipitates may be 0.1 to 2.0 μm .

[0043] Hereinafter, a method of manufacturing steel of the present disclosure will be described in detail.

[0044] The steel according to an aspect of the present disclosure can be manufactured by reheating, hot rolling, cooling, and coiling a steel slab satisfying the above-described alloy composition.

Reheating

[0045] A steel slab satisfying the alloy composition of the present disclosure may be reheated to a temperature within a range of 1000 to 1250°C.

[0046] The slab may be reheated before performing hot rolling. In the slab operation, the slab may be reheated to solidify and homonize a casting structure, segregation, and secondary phases of the slab. If the reheating temperature is less than 1000°C, it may be difficult to sufficiently secure the reheating effect, and a heating furnace temperature may become too low, causing a problem of increased deformation resistance during hot rolling. On the other hand, if the temperature exceeds 1250°C, partial melting and deterioration of surface quality may occur in a segregation zone within the casting structure.

Hot rolling

[0047] The reheated slab can be hot rolled at a finishing temperature of 800°C or higher to obtain a hot-rolled steel plate with a thickness of 4 to 20 mm.

[0048] In the present disclosure, hot rolling may be performed to produce a hot rolled steel plate with a thickness of 4 to 20 mm. A finishing temperature is preferably limited to be 800°C or higher for productivity, and more preferably, hot rolling can be performed at a finishing temperature at a non-recrystallization temperature (T_{nr}) or lower.

Cooling and coiling

[0049] The hot-rolled steel plate may be cooled to a temperature range of 500°C or lower at a cooling rate of 5°C/s or higher and then coiled. A coiling start temperature may be 500°C or lower, and an average coiling temperature may be 300°C or lower.

[0050] In the present disclosure, cooling may be performed to a temperature within a range of less than 500°C to prevent formation of coarse carbides. If a cooling end temperature exceeds 500°C, coarse carbides may be formed during cooling to room temperature after coiling to reduce uniform elongation, and it may be difficult to secure excellent elongation, and there may be a risk of premature fracturing. A lower limit of the coiling temperature is not particularly limited, and there is no problem even if the coiling is performed at room temperature.

[0051] If a cooling rate is less than 5°C/s, coarse carbides may be formed, which may cause a problem of a decrease in strength and elongation. An upper limit of the average cooling rate is not particularly limited, but may be appropriately selected depending on equipment specifications.

[0052] In addition, in the present invention, by controlling the coiling start temperature and the average coiling temperature, the formation of coarse carbides can be prevented and the excellent strength and elongation, which is unique to an austenite-based steel material can be secured, and a work hardening rate may be improved to ensure excellent abrasion resistance.

[0053] In the present disclosure, the coiling start temperature represents the temperature of the steel plate when coiling begins using a coiling equipment, and the average coiling temperature refers to the average value of the coiling temperature of an entire length of a coil. If the coiling start temperature exceeds 500°C or the average coiling temperature exceeds 300°C, there may be a problem of reduced ductility and toughness due to excessive formation of carbides.

[0054] A steel tube according to an aspect of the present disclosure may be manufactured by manufacturing the hot-rolled steel plate satisfying the alloy composition and manufacturing method described above.

Piping

[0055] A steel tube can be obtained by piping a steel plate according to an aspect of the present disclosure.

[0056] In the present disclosure, the method of manufacturing a welded steel tube is not particularly limited, and a typical ERW steel tube manufacturing method can be used. However, due to a high Mn content, intrusion defects may occur during ERW welding due to oxides generated during a process of melting and solidifying a steel material. To prevent this, molten metal and oxides in a narrow gap may be completely discharged before entering a welding point, and additional devices may be installed to prevent exposure from the atmosphere and a coolant.

[0057] The steel plate of the present disclosure manufactured in this manner may have a thickness of 4 to 20 mm, a tensile strength of 800 MPa or more, an elongation of 30% or more, and a hardness after piping into a steel tube of 1.1 times or more that of a hot-rolled steel plate, and may have characteristics of excellent work hardening rate and abrasion resistance.

[0058] In addition, the steel plate of the present disclosure may have a hardness of 220Hv or more, and the steel tube may have a hardness of 250Hv or more.

[0059] Hereinafter, the present disclosure will be specifically described through the following Examples. However, it should be noted that the following examples are only for describing the present disclosure by illustration, and not intended to limit the scope of rights of the present disclosure.

Mode for Invention

(Example)

[0060] A steel slab having the alloy composition shown in Table 1 below was manufactured to form a hot-rolled steel plate according to the conditions shown in Table 2 below, and a steel plate was manufactured with the thickness shown in Table 3. In this case, the same reheating temperature of 1150°C was applied.

[Table 1]

Steel type	Alloy composition (wt%)					
	Mn	C	Cr	Al	Si	P
A	13.2	1.09	0	0.002	0.370	0.0127
B	14.2	1.13	3.9	0.002	0.365	0.0125
C	10.4	1.82	2.4	0.003	0.358	0.0128
D	15.3	1.93	1.5	0.002	0.376	0.0124
E	11.7	1.31	3.1	0.003	0.367	0.0123
F	18.1	0.79	0	0.003	0.006	0.0126
G	12.1	0.3	2.9	0.002	0.008	0.0128
H	1.1	0.12	0	0.003	0.007	0.0127
I	11.1	1.14	1.4	0.003	0.328	0.0124

[Table 2]

Sample No.	Steel type	Hot rolling	Cooling		Coiling	
		Finishing temperature (°C)	Temperature (°C)	Rate (°C/s)	Start temperature (°C)	Average temperature (°C)
1	A	950	454	7.3	430	180
2	B	950	478	6.5	370	180
3	C	910	493	8.4	460	160
4	D	970	467	7.8	380	160
5	E	890	484	5.6	370	170
6	F	910	490	18	480	220
7	G	880	470	21	470	250

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(continued)

Sampl e No.	Steel type	Hot rolling	Cooling		Coiling	
		Finishing temperature (°C)	Temperat ure (°C)	Rate (°C/s)	Start temperature (°C)	Average temperature (°C)
8	H	950	480	22	480	260
9	I	890	490	17.1	560	420

[0061] In Table 3 below, a microstructure and mechanical properties were measured for the manufactured steel plate and illustrated, and ERW welding steel tube was manufactured from the steel plate, and then physical properties of the steel tube were also shown. The microstructure was shown by observing a 1/4 portion of a thickness of the steel plate with an optical microscope at 200x magnification, and the tensile strength and elongation were obtained by taking a sample of API 5L standard from the 1/4 portion of the thickness of the steel plate and performing a tensile test and the results thereof were shown. In this case, if the microstructure had 97% or more of austenite, it was indicated as O. In addition, when precipitates with a thickness of 0.1 to 2.0 um were formed at austenite grain boundaries, O was indicated. Regarding the mechanical properties, a hardness of the steel plate was measured using a Vickers hardness test, and after piping, the hardness was measured and the ratio thereof was calculated and shown.

[Table 3]

Sam ple No.	Steel ty pe	Thickness (mm)	Microstructure of steel plate		Physical property of steel plate			Physical property of steel tube	Hardne ss ratio	Divis ion
			Austenite	Precipit ate	Tensile strengt h (MPa)	Elonga tion (%)	Hardne ss (Hv)			
1	A	8	O	O	1097	52	229.3	264.8	1.15	Inven tive Examp le 1
2	B	8	O	O	1086	52	231.5	269.4	1.16	Inven tive Examp le 2
3	C	10	O	O	1133	58	232.3	267.5	1.15	Inven tive Examp le 3
4	D	10	O	O	1159	51	233.9	271.4	1.14	Inven tive Examp le 4
5	E	12	O	O	1140	57	236.1	269.3	1.14	Inven tive Examp le 5
6	F	8	O	O	1012	51	226.2	258.3	1.14	Inven tive Examp le 6
7	G	8	O	O	981	49	216.2	234.1	1.08	Compa rativ e Examp le 1
8	H	8	X	O	501	27	168.7	171.5	1.01	Compa rativ e Examp le 2
9	I	8	O	X	898	29	239.1	261.1	1.09	Compa rativ e Examp le 3

[0062] As shown in Table 3, in the case of the Invention Example satisfying the alloy composition and manufacturing conditions of the present disclosure, the microstructure characteristics proposed in the present disclosure were satisfied and the physical properties desired in the present disclosure were secured.

[0063] FIG. 1 is a photograph of the microstructure of Inventive Example 1 according to an aspect of the present disclosure observed with an optical microscope (200x magnification).

[0064] On the other hand, in Comparative Example 1 in which a C content was below the range proposed in the present disclosure, and compared to Invention Example, the strength was insufficient and a work hardening rate after manufacturing a steel tube was also insufficient.

[0065] In Comparative Example 2 in which contents of Mn and C were outside of the range proposed in the present disclosure, and the strength of the steel plate was inferior, and the elongation was also not secured due to the inferior austenite stability due to a lack of the Mn content.

[0066] In Comparative Example 3 in which a coiling start temperature and average temperature exceeded the range of the present disclosure, and coarse carbides were excessively formed, resulting in poor ductility.

[0067] While example embodiments have been illustrated and described above, it will be apparent to those skilled in the art that modifications and variations could be made without departing from the scope of the present disclosure as defined by the appended claims.

Claims

1. A hot-rolled steel plate, comprising, by weight:

manganese (Mn): 10 to 20%, carbon (C): 0.6 to 2.0%, chromium (Cr): 5.0% or less, aluminum (Al): 0.5% or less, silicon (Si): 1.0% or less, phosphorus (P): 0.1% or less, sulfur (S): 0.02% or less, with a remainder of Fe, and other unavoidable impurities,
wherein the hot-rolled steel plate has a microstructure with austenite as a main phase, and includes film-shaped precipitates formed along austenite grain boundaries,
wherein hardness of the hot-rolled steel plate increases by 1.1 times or more by work hardening after piping.

2. The hot-rolled steel plate of claim 1, wherein the precipitate has a thickness of 0.1 to 2.0 μm .

3. The hot-rolled steel plate of claim 1, wherein the steel plate has a tensile strength of 800MPa or more and elongation of 30% or more.

4. The hot-rolled steel plate of claim 1, wherein the steel plate has a Vickers hardness of 220Hv or more.

5. The hot-rolled steel plate of claim 1, wherein the steel plate has a thickness of 4 to 20 mm.

6. A steel tube, comprising, by weight:

manganese (Mn): 10 to 20%, carbon (C): 0.6 to 2.0%, chromium (Cr): 5.0% or less, aluminum (Al): 0.5% or less, silicon (Si): 1.0% or less, phosphorus (P): 0.1% or less, sulfur (S): 0.02% or less, with a remainder of Fe, and other unavoidable impurities,
wherein the steel tube has a microstructure with austenite as a main phase, and includes film-shaped precipitates formed along austenite grain boundaries,
wherein hardness of the steel tube, as compared to that of the steel plate is 1.1 times or more.

7. The steel tube of claim 6, wherein the steel tube has a Vickers hardness of 250Hv or more.

8. A manufacturing method of a hot-rolled steel plate, comprising operations of:

reheating a steel slab including, by weight: Mn: 10 to 20%, C: 0.6 to 2.0%, Cr: 5.0% or less, Al: 0.5% or less, Si: 1.0% or less, P: 0.1% or less, S: 0.02% or less, with a remainder of Fe, and other unavoidable impurities;
hot rolling the reheated steel slab to obtain a hot-rolled steel plate; and
cooling the hot-rolled steel plate to a temperature range of less than 500°C and then coiled,
wherein a coiling start temperature is 500°C or lower, and an average coiling temperature is less than 300°C.

9. The manufacturing method of a hot-rolled steel plate of claim 8, wherein the reheating is performed at a temperature

within a range of 1000 to 1250°C,

the hot rolling is performed at a finishing temperature of 800°C or higher, and
during the cooling, a cooling rate is 5°C/s or more.

- 5
- 10.** The manufacturing method of a hot-rolled steel plate of claim 8, wherein after the hot rolling, the steel plate has a thickness of 4 to 20 mm.
- 11.** A manufacturing method of a steel tube of one of claims 8 to 10, comprising:
10 an operation of obtaining a steel tube by piping the hot-rolled steel plate.

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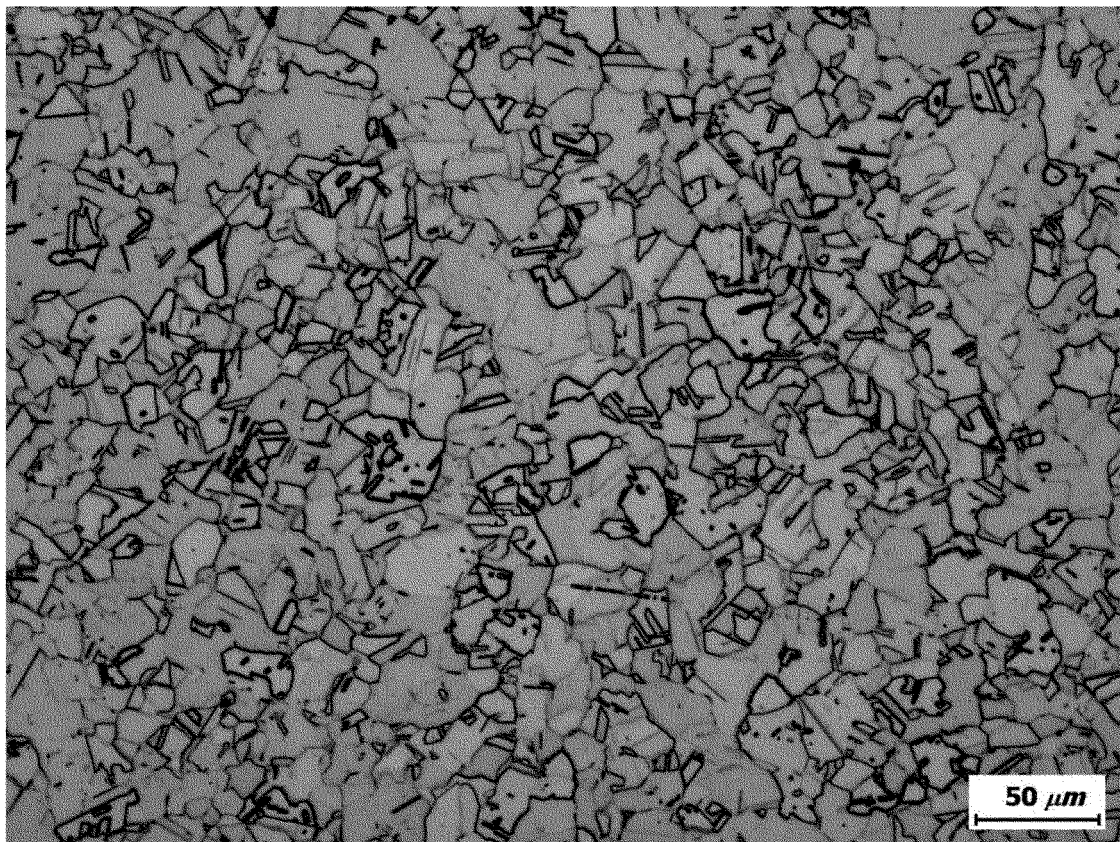
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FIG. 1



INTERNATIONAL SEARCH REPORT

International application No.

PCT/KR2022/018212

A. CLASSIFICATION OF SUBJECT MATTER

C22C 38/38(2006.01)i; C21D 8/02(2006.01)i; C21D 9/46(2006.01)i; B21C 47/02(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

C22C 38/38(2006.01); C21D 6/00(2006.01); C21D 8/02(2006.01); C21D 8/10(2006.01); C22C 38/00(2006.01);
C22C 38/04(2006.01)

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

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

eKOMPASS (KIPO internal) & keywords: 열연강판(hot rolled steel), 오스테나이트(austenite), 석출물(precipitate), 권취
(winding), 강관(steel pipe), 경도(hardness)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	KR 10-2008-0060982 A (POSCO) 02 July 2008 (2008-07-02) See paragraph [0052] and claims 1-3 and 7.	8-10
Y		1-7,11
Y	KR 10-2015-0050701 A (HYUNDAI STEEL COMPANY) 11 May 2015 (2015-05-11) See paragraphs [0002], [0020] and [0075].	1-7,11
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A	KR 10-1714929 B1 (POSCO) 23 March 2017 (2017-03-23) See claims 1 and 6.	1-11
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☐ Further documents are listed in the continuation of Box C.
☒ See patent family annex.

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Name and mailing address of the ISA/KR

Korean Intellectual Property Office
Government Complex-Daejeon Building 4, 189 Cheongsu-ro, Seo-gu, Daejeon 35208

Facsimile No. +82-42-481-8578

Authorized officer

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INTERNATIONAL SEARCH REPORT
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