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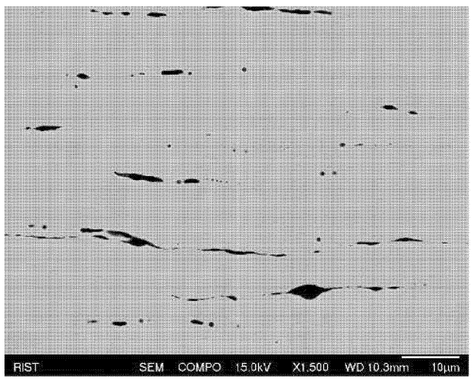
(54) **AUSTENITIC STAINLESS STEEL WITH IMPROVED CORROSION RESISTANCE AND MACHINABILITY AND METHOD FOR MANUFACTURING SAME**

(57) Disclosed is an austenitic stainless steel with improved corrosion resistance and machinability. The austenitic stainless steel with improved corrosion resistance and machinability may comprise, in percent by weight (wt%), 0.05% or less of C (excluding 0), 2% or less of Si (excluding 0), 2% or less of Mn (excluding 0), 0.01% or less of S, 16 to 22% of Cr, 9 to 15% of Ni, 3% or less of Mo (excluding 0), 0.15 to 0.25% of N, 0.004 to 0.06% of B, and the remainder being Fe and inevitable impurities.

【FIG 2a】



EP 4 265 799 A1

Description

[0001] This application is based on and claims the benefit of priority to Korean Patent Application No. 10-2020-0179748, filed on Dec. 21, 2020 in the Korean Intellectual Property Office, the disclosure of which is incorporated herein by reference.

TECHNICAL FIELD

[0002] The disclosure relates to an austenitic stainless steel with improved corrosion resistance and machinability and a manufacturing method the same, and more specifically, to an austenitic stainless steel with improved corrosion resistance and machinability for use in corrosive environments such as salt water and in an environment requiring machinability, and a manufacturing method the same.

BACKGROUND ART

[0003] Austenitic stainless steels used in mechanical parts such as frames, chambers, molds, and the like, are manufactured into final shapes by cutting processes such as milling. Machinability of stainless steels is required to reduce cutting load, increase cutting speed and improve tool life.

[0004] A type of steel to which Mn and S are added and uses MnS compounds which are a non-metallic inclusion is widely known as stainless steels with excellent machinability. However, MnS compounds readily elute in corrosive environments such as salt water or act as a starting point for pitting, which deteriorates the corrosion resistance of stainless steels. Therefore, stainless steels utilizing MnS compounds are limited in applications where corrosion resistance is required due to exposure to corrosive environments. Thus, stainless steels that are both machinable and corrosion resistant are required to be developed.

TECHNICAL PROBLEM

[0005] An aspect of the disclosure provides an austenitic stainless steel with improved corrosion resistance and machinability and a manufacturing method the same.

TECHNICAL SOLUTION

[0006] According to an embodiment of the disclosure, an austenitic stainless steel with improved corrosion resistance and machinability comprises, in percent by weight (wt%), 0.05% or less of C (excluding 0), 2% or less of Si (excluding 0), 2% or less of Mn (excluding 0), 0.01% or less of S, 16 to 22% of Cr, 9 to 15% of Ni, 3% or less of Mo (excluding 0), 0.15 to 0.25% of N, 0.004 to 0.06% of B, and the remainder being Fe and inevitable impurities. 10 or more BN precipitates are distributed per $100 \times 100\ \mu m^2$.

[0007] According to an embodiment of the disclosure, 10 or less MnS precipitates may be distributed per 100x100 μm^2.

[0008] According to an embodiment of the disclosure, 10 or less MnS precipitates whose length of a major axis of 1 μm or more may be distributed per 100x100 μm^2.

[0009] According to an embodiment of the disclosure, the austenitic stainless steel with improved corrosion resistance and machinability may further comprise, in percent by weight (wt%), 1 % or less of Cu (excluding 0).

[0010] According to an embodiment of the disclosure, a pitting potential may be 300 mV or more.

[0011] According to an embodiment of the disclosure, a manufacturing method of an austenitic stainless steel with improved corrosion resistance and machinability may comprise: heating a stainless steel comprising, in percent by weight (wt%), 0.05% or less of C (excluding 0), 2% or less of Si (excluding 0), 2% or less of Mn (excluding 0), 0.01% or less of S, 16 to 22% of Cr, 9 to 15% of Ni, 3% or less of Mo (excluding 0), 0.15 to 0.25% of N, 0.004 to 0.06% of B, and the remainder being Fe and inevitable impurities at 1150 to 1250 °C for 1 hour and 30 minutes or more; hot rolling the heated stainless steel; and maintaining the hot-rolled steel at 1100 to 1250 °C for 30 seconds or more.

ADVANTAGEOUS EFFECTS

[0012] The present disclosure provides an austenitic stainless steel with improved corrosion resistance and machinability and a manufacturing method the same.

DESCRIPTION OF THE DRAWINGS

[0013] These and/or other aspects of the disclosure will become apparent and more readily appreciated from the following description of the embodiments, taken in conjunction with the accompanying drawings of which:

FIGS. 1A and 1B are photographs showing appearances of Example 7 and Comparative Example 2 after hot rolling, respectively; and

FIGS. 2A and 2B are photographs of cross sections of stainless steels of Example 7 and Comparative Example 1 observed by scanning electron microscope (SEM), respectively.

BEST MODE

[0014] An austenitic stainless steel with improved corrosion resistance and machinability according to an embodiment of the present disclosure comprises, in percent by weight (wt%), 0.05% or less of C (excluding 0), 2% or less of Si (excluding 0), 2% or less of Mn (excluding 0), 0.01% or less of S, 16 to 22% of Cr, 9 to 15% of Ni, 3% or less of Mo (excluding 0), 0.15 to 0.25% of N, 0.004 to 0.06% of B, and the remainder being Fe and inevitable impurities, and 10 or more BN precipitates are distributed per 100 $\times$ 100 μm^2.

MODES OF THE INVENTION

[0015] This specification does not describe all the elements according to embodiments of the disclosure, and descriptions well-known in the art to which the disclosure pertains or overlapped portions are omitted.
[0016] Throughout the specification, the term "include" an element does not preclude other elements but may further include another element, unless otherwise stated.
[0017] As used herein, the singular forms are intended to include the plural forms as well, unless the context clearly dictates otherwise.
[0018] Hereinafter, embodiments of the disclosure will be described in detail.
[0019] The following embodiments of the present disclosure are provided to fully convey the spirit of the present disclosure to a person having ordinary skill in the art to which the present disclosure belongs. The present disclosure is not limited to the embodiments shown herein, but may be embodied in other forms.
[0020] According to the present disclosure, formation of MnS deteriorating corrosion resistance is excluded to prevent the formation of MnS precipitates. In addition, BN compounds are introduced to replace MnS to improve machinability.
[0021] However, addition of B in excess of an appropriate level causes fracture during hot rolling for producing a plate. Thus, the present inventors have found the optimized content of B, N and other elements to enable the formation of BN at an effective level for improving machinability while suppressing fracture during hot rolling.
[0022] According to an embodiment of the disclosure, the austenitic stainless steel with improved corrosion resistance and machinability comprises, in percent by weight (wt%), 0.05% or less of C (excluding 0), 2% or less of Si (excluding 0), 2% or less of Mn (excluding 0), 0.01% or less of S, 16 to 22% of Cr, 9 to 15% of Ni, 3% or less of Mo (excluding 0), 0.15 to 0.25% of N, 0.004 to 0.06% of B, and the remainder being Fe and inevitable impurities.
[0023] In addition, the austenitic stainless steel with improved corrosion resistance and machinability may further comprise, in percent by weight (wt%), 1% or less of Cu (excluding 0).
[0024] Hereinafter, reasons for numerical limitations on the contents of alloying elements in the embodiment of the present disclosure will be described. The unit is wt% unless otherwise stated.
[0025] The content of carbon (C) is 0.05% or less (excluding 0).
[0026] Carbon (C) is an austenite forming element and acts as an inevitable impurity. When the content of C exceeds 0.05%, the corrosion resistance of the welded part may be impaired, and thus the content of C is controlled to 0.05%.
[0027] The content of silicon (Si) is 2% or less (excluding 0).
[0028] Si is added as a deoxidizer and is an element for improving corrosion resistance. However, when the content of Si exceeds 2%, toughness may be deteriorated, and thus the Si content is controlled to 2% or less in the present disclosure.
[0029] The content of manganese (Mn) is 2% or less (excluding 0).
[0030] Mn is an austenite phase-stabilizing element. However, when the content of Mn exceeds 2%, corrosion resistance may be deteriorated, and thus the Mn content is controlled to 2% or less in the present disclosure.
[0031] The content of sulfur (S) is 0.01% or less.
[0032] The S content is controlled to 0.01% or less in order to prevent the formation of MnS to be excluded in the present disclosure.
[0033] The content of chromium (Cr) is from 16 to 22%.
[0034] Cr is an element for improving corrosion resistance of an austenitic stainless steel. When the Cr content is less than 16%, the above-described effect may not be obtained. The Cr content exceeding 22% may increase the raw material cost and decrease toughness. Therefore, the Cr content is controlled from 16 to 22% or less in the present disclosure.
[0035] The content of nickel (Ni) is from 9 to 15%.
[0036] Ni is an austenite phase-stabilizing element. When the Ni content is less than 9%, the above-described effect

may not be obtained. The Ni content exceeding 15% causes an increase in raw material cost. Therefore, the Ni content is controlled from 9 to 15% or less in the present disclosure.

[0037] The content of molybdenum (Mo) is 3% or less (excluding 0).

[0038] Mo is an element for improving corrosion resistance. However, the Mo content exceeding 3% causes an increase in raw material cost, and thus the Mo content is controlled to 3% in the present disclosure.

[0039] The content of boron (B) is from 0.004 to 0.06%.

[0040] B is added to secure BN. When the content of B is less than 0.004%, sufficient BN targeted by the present disclosure may not be formed, and when the content of B exceeds 0.06%, fracture occurs during hot rolling. Therefore, the content of B is controlled to 0.004 to 0.06% in the present disclosure.

[0041] The content of nitrogen (N) is 0.15 to 0.25%.

[0042] N is added to secure BN. When the content of N is less than 0.15%, sufficient BN may not be formed, and when the content of N exceeds 0.25%, toughness is deteriorated. Therefore, the content of N is controlled to 0.15 to 0.25% in the present disclosure.

[0043] The content of copper (Cu) is 1% or less (excluding 0).

[0044] Cu is an element for improving corrosion resistance, and is added as required in the present disclosure. However, when the content of Cu exceeds 1%, hot workability may deteriorate, and thus the Cu content is controlled to 1% in the present disclosure.

[0045] The remaining component of the alloy composition of the present disclosure is iron (Fe). The austenitic stainless steel with improved corrosion resistance and machinability of the present disclosure may include other impurities that may be included in a typical industrial production process of steel. Since these impurities are known to those skilled in the art to which the present disclosure belongs, the type and content thereof are not specifically limited in the present disclosure.

[0046] In any section of the austenitic stainless steel according to the present disclosure, 10 or less MnS precipitates whose length of a major axis of 1 μm or more per 100x100 μm^2 are distributed. In this instance, the MnS precipitate may comprise 50 at.% or more of the sum of Mn and S.

[0047] According to the present disclosure, since the formation of MnS causing deterioration of corrosion resistance is suppressed, corrosion resistance may be secured, and a pitting potential of the austenitic stainless steel of the present disclosure may be 300 mV or more.

[0048] In any section of the austenitic stainless steel according to the present disclosure, 10 or more BN precipitates per $100\times100pm^2$ are distributed. In this instance, the BN precipitates may comprise 50 at.% or more of the sum of B and N. According to the present disclosure, MnS is replaced with BN, thereby securing machinability while suppressing deterioration of corrosion resistance.

[0049] Next, a manufacturing method of austenitic stainless steel with improved corrosion resistance and machinability according to an embodiment of the present disclosure will be described.

[0050] The austenitic stainless steel with improved corrosion resistance and machinability according to an embodiment of the present disclosure may be manufactured in various methods, and the manufacturing method is not particularly limited. As an embodiment, however, the austenitic stainless steel with improved corrosion resistance and machinability according to an embodiment of the present disclosure may be manufactured as described below.

[0051] For example, the manufacturing method of austenitic stainless steel with improved corrosion resistance and machinability according to an embodiment of the present disclosure comprises, heating a stainless steel comprising, in percent by weight (wt%), 0.05% or less of C (excluding 0), 2% or less of Si (excluding 0), 2% or less of Mn (excluding 0), 0.01% or less of S, 16 to 22% of Cr, 9 to 15% of Ni, 3% or less of Mo (excluding 0), 0.15 to 0.25% of N, 0.004 to 0.06% of B, and the remainder being Fe and inevitable impurities, at 1150 to 1250 °C for 1 hour and 30 minutes or more; hot rolling the heated stainless steel; and maintaining the hot-rolled steel at 1100 to 1250 °C for 30 seconds or more.

[0052] In this instance, the heating is a process for forming as many BNs as possible, and may be performed at 1150 to 1250 C for 1 hour and 30 minutes or more.

[0053] Also, the hot rolling may be performed up to a thickness of 8 mm, without being limited thereto, since the thickness may vary depending on the use.

[0054] In addition, the maintaining process after hot rolling is for forming BN again, and may be performed at 1100 to 1250 °C for 30 seconds or more.

[0055] Hereinafter, the present disclosure will be described in greater detail through examples. However, it is necessary to note that the following examples are only intended to illustrate the present disclosure in more detail and are not intended to limit the scope of the present disclosure. This is because the scope of the present disclosure is determined by matters described in the claims and able to be reasonably inferred therefrom.

Examples

[0056] An alloy satisfying the alloy composition of Table 1 was melt-cast, and the austenitic stainless steel cast was heated at 1200 °C for 1 hour and 30 minutes. Thereafter, the heated steel cast was hot-rolled to become a thickness of 8 mm. Subsequently, the hot-rolled steel was maintained at a temperature of 1150 °C for 30 seconds or more to form BN precipitates, thereby obtaining a hot-rolled steel specimen.

[Table 1]

	Alloying element (wt%)								
	C	Si	Mn	S	Cr	Ni	Mo	B	N
Comparative Example 1	0.020	0.6	1.1	0.003	16.2	10.1	2.1	0.000	0.015
Comparative Example 2	0.020	0.6	1.1	0.003	16.2	10.2	2.1	0.031	0.018
Comparative Example 3	0.025	0.4	0.8	0.008	21.3	14.6	0.6	0.012	0.020
Comparative Example 4	0.018	0.6	1.5	0.240	17.4	10.9	2.0	0.001	0.023
Comparative Example 5	0.018	0.6	1.3	0.180	17.5	10.8	2.1	0.001	0.017
Comparative Example 6	0.022	0.4	0.8	-	21.4	9.3	0.6	0.001	0.210
Example 1	0.022	0.4	0.8	0.002	21.1	9.2	0.6	0.013	0.210
Example 2	0.027	0.4	0.8	0.002	21.8	9.3	0.6	0.058	0.200
Example 3	0.025	0.4	0.8	0.008	21.3	14.6	0.6	0.029	0.200
Example 4	0.022	0.4	0.8	0.002	19.2	12.3	0.6	0.004	0.200
Example 5	0.025	0.4	0.8	0.001	19.2	12.3	0.6	0.007	0.200
Example 6	0.024	0.4	0.8	0.003	19.4	12.3	0.6	0.014	0.160
Example 7	0.026	0.4	0.8	0.002	19.3	12.4	0.6	0.020	0.240
Example 8	0.025	0.4	0.8	0.002	19.3	12.3	0.6	0.028	0.200
Example 9	0.048	1.5	1.8	0.001	16.4	12.1	1.5	0.007	0.210
Example 10	0.022	1.8	1.5	0.001	16.3	12.1	2.6	0.008	0.200

[0057] For the hot-rolled steel specimens of Examples 1 to 10 and Comparative Examples 1 to 7, whether fracture occurred after hot rolling was observed, and the case where fracture occurred was marked as O, and the case where fracture did not occur was marked as X in Table 2 below.

[Table 2]

Example	Fracture during hot rolling
Comparative Example 1	X
Comparative Example 2	O
Comparative Example 3	O
Comparative Example 4	X
Comparative Example 5	X
Comparative Example 6	X
Comparative Example 7	O
Example 1	X
Example 2	X
Example 3	X
Example 4	X
Example 5	X
Example 6	X

(continued)

Example	Fracture during hot rolling
Example 7	X
Example 8	X
Example 9	X
Example 10	X

[0058] Referring to Table 2, in Examples 1 to 10 satisfying the alloy composition of the present disclosure, no fracture occurred during hot rolling. However, in Comparative Example 2, the B content was satisfactory, but the N content did not reach the lower limit proposed in the present disclosure, resulting in fracture during hot rolling. FIG. 1A and FIG. 1B are photographs showing the appearances of Example 7 and Comparative Example 2 after hot rolling. Referring to FIG. 1A, it may be confirmed that the appearance of the steel plate in Example 7 according to the present disclosure has no fracture. On the contrary, referring to FIG. 1B, it may be confirmed that Comparative Example 2 has a satisfactory B content, but the N content did not reach the lower limit proposed in the present disclosure, and thus fracture occurred during hot rolling.

[0059] In Comparative Example 3, although the B content was satisfactory, the N content did not reach the lower limit proposed in the present disclosure, and thus fracture occurred during hot rolling.

[0060] Subsequently, for the hot-rolled steel specimens of Comparative Examples 1 and 4 to 6 and Examples 1 to 10, which were not fractured during hot rolling, BN precipitates and MnS precipitates were observed and corrosion resistance and machinability were evaluated, which are shown in Table 3 below.

[0061] BN precipitates and MnS precipitates were mirror-polished on an arbitrary cut surface of the steel plate, and then the number of MnS precipitates of 1 μm or more per 100x100 μm^2 and the number of BN precipitates per 100x100 μm^2 were observed using a Scanning Electron Microscope (SEM) to which an Energy Dispersive Spectrometer (EDS) is attached, and the numbers are shown.

[0062] Corrosion resistance was evaluated by pitting potential. The pitting potential is measured by immersing a hot-rolled steel specimen in an aqueous solution containing 3.5 wt% NaCl, connecting the electrodes, applying voltage, and measuring a voltage at the point where the current reaches 0.1mA when the voltage was gradually raised from the natural potential.

[0063] Machinability was evaluated by measuring a cutting load torque under the conditions of cutting depth of 2 mm, cutting thickness of 5 mm, and end mill rotational speed of 2000 rpm, when cutting using an end mill. However, since the cutting environment may change, the torque of Comparative Example 1 is used as a reference (100%).

[Table 3]

	Number of MnSs of 1 μm or more per 100x100 μm^2	Number of BNs per 100x100μm^2	pitting potential (mV)	cutting load (%)
Comparative Example 1	-	-	550	100
Comparative Example 4	35	-	2	82
Comparative Example 5	15	-	50	80
Comparative Example 6	-	-	1000	105
Example 1	-	40	1000	91
Example 2	-	205	1000	81
Example 3	-	90	1000	85
Example 4	-	11	1000	94
Example 5	-	20	651	91
Example 6	-	54	510	90

(continued)

	Number of MnSs of 1 μm or more per 100x100 μm²	Number of BNs per 100x100μm²	pitting potential (mV)	cutting load (%)
Example 7	-	88	453	86
Example 8	-	150	329	84
Example 9	-	15	372	92
Example 10	-	21	567	93

[0064] Referring to Table 2 and Table 3, Examples 1 to 10 satisfying the alloy composition of the present disclosure do not form MnS precipitates, and thus corrosion resistance thereof are satisfactory with a pitting potential of more than 300 mV. Also, the cutting load is lower than that of Comparative Example 1, as the number of BN precipitates is more than 11 per 100x100 μm^2, and thus it may be confirmed that machinability is also secured. FIGS. 2A and 2B are photographs of cross sections of stainless steels of Example 7 and Comparative Example 1 observed by SEM, respectively. Referring to FIG. 2A, it may be confirmed in Example 7 that a large amount of BN to be implemented in the present disclosure was formed. Referring to FIG. 2B, however, it may be confirmed in Comparative Example 1that BN was not formed because conditions for forming BN were not formed. Some black areas appear to be oxide rather than BN.

[0065] On the contrary, Comparative Example 1 shows satisfactory corrosion resistance with a pitting potential of 550 mV because MnS was not formed. However, BN was not formed because B was not added, and the cutting load was inferior to that of Examples.

[0066] In Comparative Example 4, MnS was formed and the cutting load was low, but the content of N did not reach the lower limit proposed in the present disclosure. Therefore, sufficient BN was not formed and corrosion resistance was inferior.

[0067] In Comparative Example 5, MnS was formed and the cutting load was low, but the B content and the N content did not reach the lower limit proposed in the present disclosure, and thus sufficient BN was not formed and corrosion resistance was inferior.

[0068] Comparative Example 6 shows satisfactory corrosion resistance with a pitting potential of 1000 mV because MnS was not formed. However, the cutting load was inferior because the content of B did not reach the lower limit proposed in the present disclosure.

[0069] Although embodiments have been described for illustrative purposes, those skilled in the art will appreciate that various modifications, additions and substitutions are possible, without departing from the scope and spirit of the disclosure. Therefore, embodiments have not been described for limiting purposes.

INDUSTRIAL APPLICABILITY

[0070] According to the present disclosure, provided are an austenitic stainless steel with improved corrosion resistance and machinability and a manufacturing method the same.

Claims

1. An austenitic stainless steel with improved corrosion resistance and machinability comprising, in percent by weight (wt%), 0.05% or less of C (excluding 0), 2% or less of Si (excluding 0), 2% or less of Mn (excluding 0), 0.01% or less of S, 16 to 22% of Cr, 9 to 15% of Ni, 3% or less of Mo (excluding 0), 0.15 to 0.25% of N, 0.004 to 0.06% of B, and the remainder being Fe and inevitable impurities,
   wherein 10 or more BN precipitates are distributed per $100 \times 100\ \mu m^2$.

2. The austenitic stainless steel according to claim 1, wherein 10 or less MnS precipitates are distributed per 100x100 μm^2.

3. The austenitic stainless steel according to claim 2, wherein a length of a major axis of the MnS precipitates is 1 μm or more.

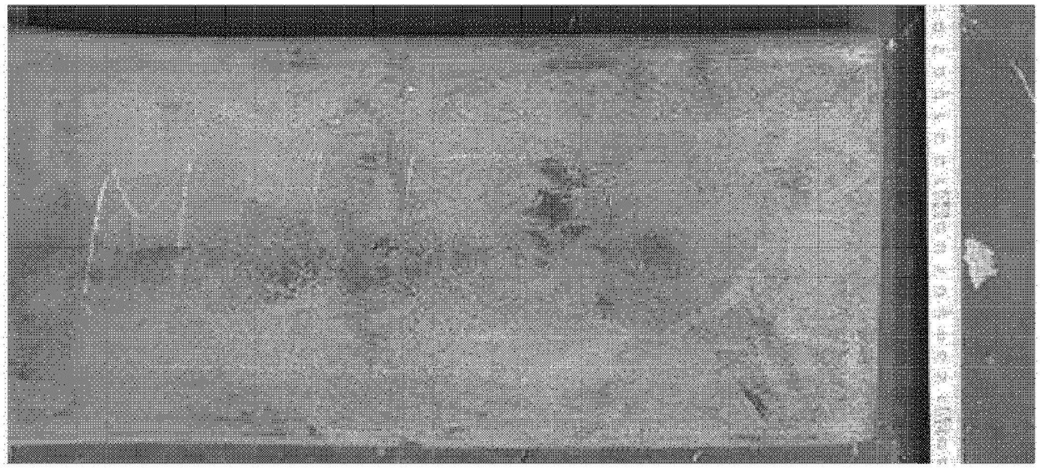
4. The austenitic stainless steel according to claim 1, further comprising, in percent by weight (wt%), 1 % or less of Cu (excluding 0).

5. The austenitic stainless steel according to claim 1, wherein a pitting potential is 300 mV or more.

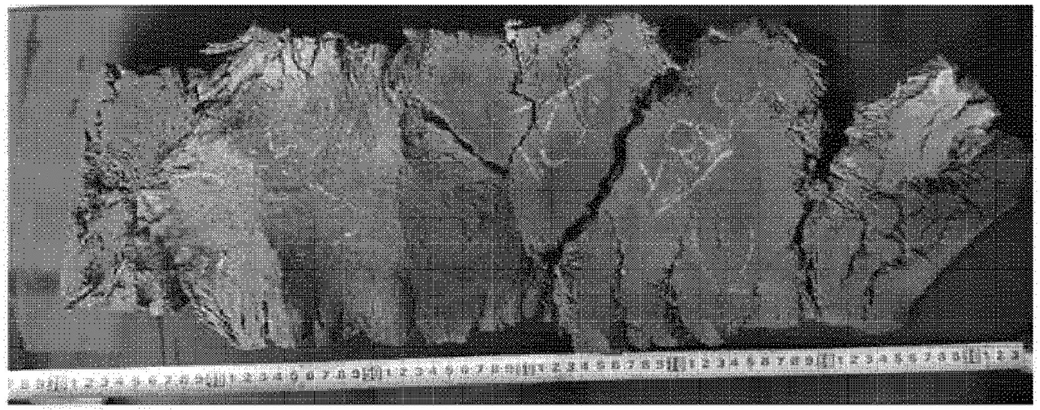
6. A manufacturing method of an austenitic stainless steel with improved corrosion resistance and machinability, the manufacturing method comprising:

heating a stainless steel comprising, in percent by weight (wt%), 0.05% or less of C (excluding 0), 2% or less of Si (excluding 0), 2% or less of Mn (excluding 0), 0.01% or less of S, 16 to 22% of Cr, 9 to 15% of Ni, 3% or less of Mo (excluding 0), 0.15 to 0.25% of N, 0.004 to 0.06% of B, and the remainder being Fe and inevitable impurities at 1150 to 1250 °C for 1 hour and 30 minutes or more;
hot rolling the heated stainless steel; and
maintaining the hot-rolled steel at 1100 to 1250 °C for 30 seconds or more.

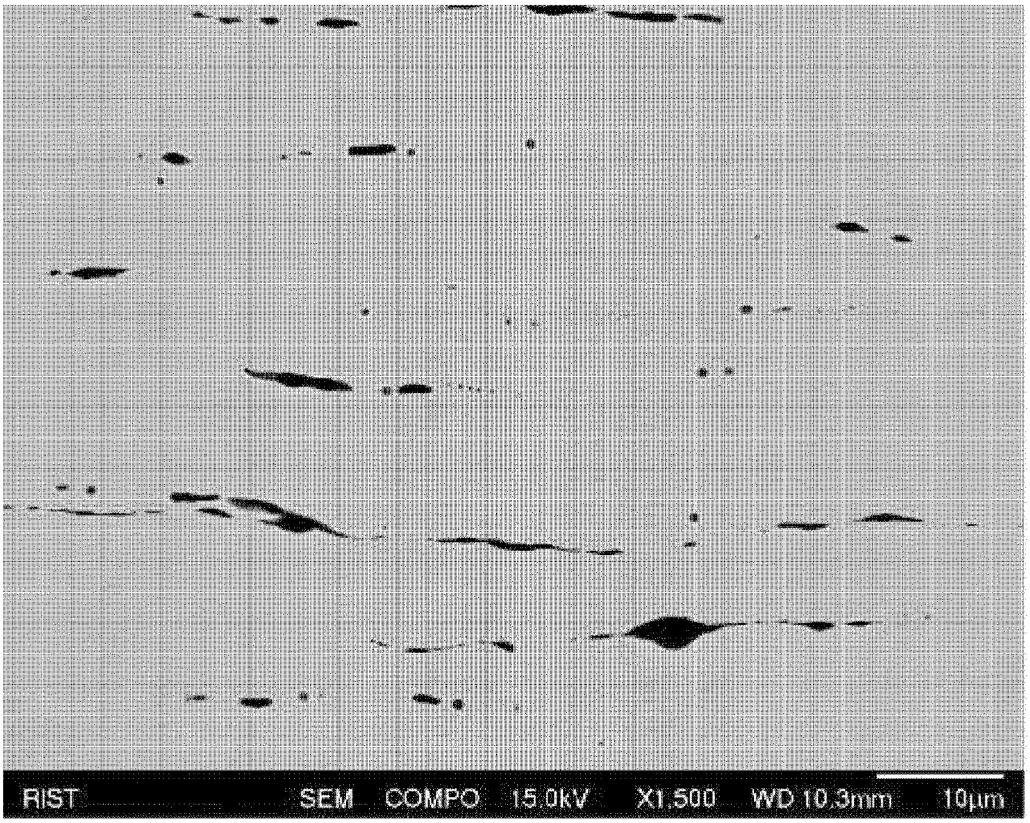
【FIG 1a】



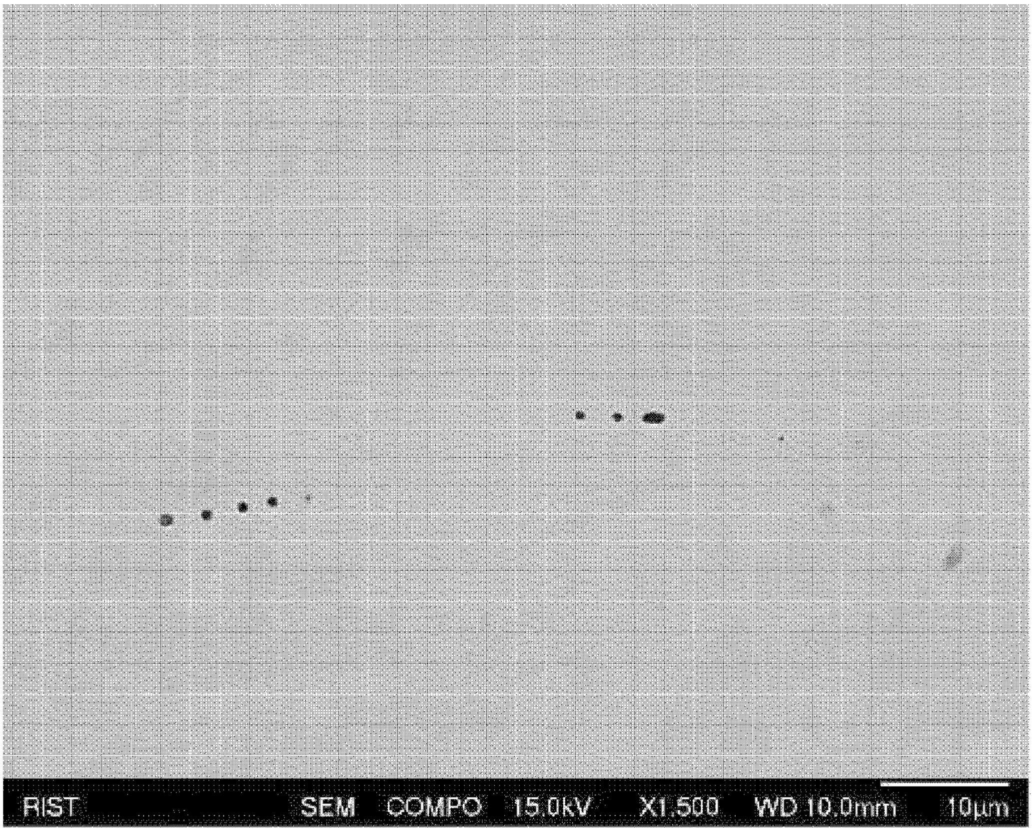
【FIG 1b】



【FIG 2a】



【FIG 2b】



INTERNATIONAL SEARCH REPORT

International application No. **PCT/KR2021/018701**

A. CLASSIFICATION OF SUBJECT MATTER

C22C 38/58(2006.01)i; **C22C 38/54**(2006.01)i; **C22C 38/44**(2006.01)i; **C22C 38/42**(2006.01)i; **C21D 8/00**(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 38/58(2006.01); B23K 20/00(2006.01); C21D 6/00(2006.01); C21D 8/02(2006.01); C22C 38/00(2006.01); C22C 38/04(2006.01); C22C 38/40(2006.01); C22C 38/44(2006.01); C22C 38/54(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: 오스테나이트계 스테인리스강(austenitic stainless steel), 보론(B), 크롬(Cr), 니켈(Ni), 몰리브덴(Mo), 보론나이트라이드(BN)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP 07-197205 A (NKK CORP.) 01 August 1995 (1995-08-01) See paragraphs [0016] and [0025] and claims 1 and 3.	1-6
A	JP 07-113144 A (NISSHIN STEEL CO., LTD.) 02 May 1995 (1995-05-02) See paragraphs [0010] and [0020].	1-6
A	KR 10-2015510 B1 (POSCO) 28 August 2019 (2019-08-28) See claims 1, 3-4 and 10.	1-6
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☐ Further documents are listed in the continuation of Box C. ☑ See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
23 March 2022	**24 March 2022**

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INTERNATIONAL SEARCH REPORT
Information on patent family members

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