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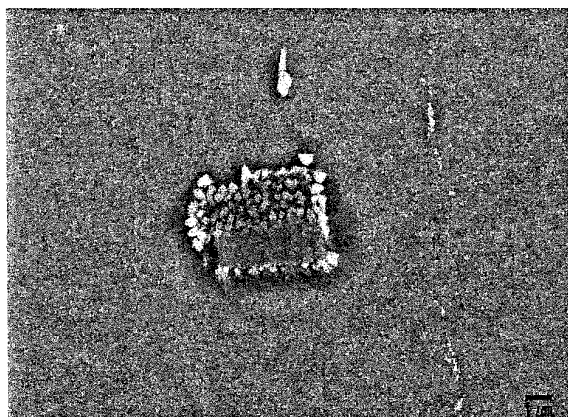
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(54) **FERRITIC STAINLESS STEEL HAVING EXCELLENT DUCTILITY AND METHOD FOR MANUFACTURING SAME**

(57) Ferritic stainless steel having a high degree of ductility and a method for manufacturing the ferritic stainless steel are provided. The stainless steel according to one aspect of an embodiment of the present invention includes, by wt%, C: 0.005% to 0.1%, Si: 0.01 % to 2.0%, Mn: 0.01 % to 1.5%, P: 0.05% or less, S: 0.005% or less,

Cr: 10% to 30%, Ti: 0.005% to 0.5%, Al: 0.01 % to 0.15%, N: 0.005% to 0.03%, and the balance of Fe and inevitable impurities, wherein the ferritic stainless steel includes 3.5 x 10⁶ or fewer particles of an independent Ti(CN) precipitate per square millimeter (mm²) of ferrite matrix.



'A'

FIG. 2

Description

[Technical Field]

5 **[0001]** The present disclosure relates to ferritic stainless steel having a high degree of ductility and a method for manufacturing the ferritic stainless steel, and more particularly, to a new kind of ferritic stainless steel provided by improving ferritic stainless steel having poor ductility compared to austenitic stainless steel for use in applications requiring high ductility, and a method for manufacturing the ferritic stainless steel.

10 [Background Art]

[0002] Ferritic stainless steels have a high degree of corrosion resistance even though the contents of expensive alloying elements in the ferritic stainless steels are low. That is, ferritic stainless steels are more competitive in price than austenitic stainless steels. Ferritic stainless steels are used in applications such as construction materials, transportation vehicles, or kitchen utensils. However, ferrite stainless steels have poor ductility and thus it is difficult to use ferritic stainless steels instead of austenitic stainless steels in many applications. Therefore, many efforts have been made to improve the ductility of ferritic stainless steels and thus to increase the applications of ferritic stainless steels.

15 **[0003]** To this end, attempts to improve the ductility of ferritic stainless steels by limiting the total amount or number of precipitates in ferritic stainless steels have been made. However, meaningful results have not yet been reported.

20

[Disclosure]

[Technical Problem]

25 **[0004]** An aspect of the present disclosure may provide ferritic stainless steel having a high degree of ductility and a method of manufacturing the ferritic stainless steel.

[0005] The present disclosure is not limited to the above-mentioned aspect. Other aspects of the present disclosure are stated in the following description, and the aspects of the present disclosure will be clearly understood by those of ordinary skill in the art through the following description.

30

[Technical Solution]

[0006] According to an aspect of the present disclosure, ferritic stainless steel may include, by wt%, C: 0.005% to 0.1%, Si: 0.01% to 2.0%, Mn: 0.01% to 1.5%, P: 0.05% or less, S: 0.005% or less, Cr: 10% to 30%, Ti: 0.005% to 0.5%, Al: 0.01% to 0.15%, N: 0.005% to 0.03%, and the balance of Fe and inevitable impurities, wherein the ferritic stainless steel may include 3.5×10^6 or fewer particles of an independent Ti(CN) precipitate per square millimeter (mm^2) of ferrite matrix.

35 **[0007]** According to another aspect of the present disclosure, ferritic stainless steel may include, by wt%, C: 0.005% to 0.1%, Si: 0.01% to 2.0%, Mn: 0.01% to 1.5%, P: 0.05% or less, S: 0.005% or less, Cr: 10% to 30%, Ti: 0.005% to 0.5%, Al: 0.01% to 0.15%, N: 0.005% to 0.03%, and the balance of Fe and inevitable impurities, wherein the ferritic stainless steel may include an independent Ti(CN) precipitate and a dependent Ti(CN) precipitate formed using a TiN inclusion as precipitation nuclei, and the ferritic stainless steel may have a P within a range of 60% or less, the P being defined by Formula 1 below:

45

[Formula 1]

$$P(\%) = \{ N_S / (N_S + N_C) \} \times 100$$

50 where N_S refers to the number of independent Ti(CN) precipitate particles per unit area (mm^2), and N_C refers to the number of dependent Ti(CN) precipitate particles per unit area (mm^2).

[0008] The independent Ti(CN) precipitate may have a particle diameter of 0.01 μm or greater.

[0009] The independent Ti(CN) precipitate may have an average particle diameter of 0.15 μm or less.

[0010] The TiN inclusion may have an average particle diameter of 2 μm or greater.

55 **[0011]** The ferritic stainless steel may have an elongation of 34% or greater.

[0012] According to another aspect of the present disclosure, a method for manufacturing ferritic stainless steel may include casting molten steel as a slab, the molten steel including, by wt%, C: 0.005% to 0.1%, Si: 0.01% to 2.0%, Mn: 0.01% to 1.5%, P: 0.05% or less, S: 0.005% or less, Cr: 10% to 30%, Ti: 0.005% to 0.5%, Al: 0.01% to 0.15%, N: 0.005%

to 0.03%, and the balance of Fe and inevitable impurities, wherein in the casting of the molten steel, the slab may be cooled at an average cooling rate of 5°C/sec or less (excluding 0°C/sec) within a temperature range of 1100°C to 1200°C based on a surface temperature of the slab.

[0013] In the casting of the molten steel, the slab may be cooled at an average cooling rate of 5°C/sec or less (excluding 0°C/sec) within a temperature range of 1000°C to 1250°C based on the surface temperature of the slab.

[0014] After the casting of the molten steel, the method may further include: obtaining a hot-rolled sheet by performing a hot rolling process on the slab; and performing a hot band annealing process on the hot-rolled sheet within a temperature range of 450°C to 1080°C for 1 minute to 60 minutes.

[Advantageous Effects]

[0015] The ferritic stainless steel of the present disclosure has a high degree of ductility.

[Description of Drawings]

[0016]

FIG. 1 is a scanning electron microscope (SEM) image illustrating the microstructure of a hot-rolled sheet of Inventive Example 1.

FIG. 2 is a high magnification SEM image illustrating region A in FIG. 1.

[Best Mode]

[0017] The inventors have reviewed various factors to improve the ductility of ferritic stainless steel and have acquired the following knowledge.

(1) In general, a small amount of titanium (Ti) is added to ferritic stainless steel to improve the corrosion resistance of the ferritic stainless steel. In this case, however, a large amount of Ti(CN) inevitably precipitates in the ferrite matrix of Ti-containing ferritic stainless steel, and the Ti(CN) precipitate becomes the main cause of ductility deterioration.

(2) The Ti(CN) precipitate includes a Ti(CN) precipitate independently formed in the ferrite matrix (hereinafter referred to as an "independent Ti(CN) precipitate") and a Ti(CN) precipitate formed with the help of particles of a TiN inclusion that are crystallized during a steel making process and function as precipitation nuclei (hereinafter referred to as a "dependent Ti(CN) precipitate"). The dependent Ti(CN) precipitate does not have a significant effect on ductility deterioration when compared to the independent Ti(CN) precipitate.

(3) Therefore, if a large amount of Ti(CN) precipitates in the form of a dependent Ti(CN) precipitate with the help of TiN inclusion particles functioning as precipitation nuclei, the amount of independent Ti(CN) precipitate particles may decrease. In this manner, the ductility of Ti-containing ferritic stainless steel may be improved.

[0018] Hereinafter, ferritic stainless steel having a high degree of ductility will be described in detail according to an aspect of the present disclosure.

[0019] First, the composition of the ferritic stainless steel of the present disclosure will be described in detail. In the following description, the contents of elements are given in wt% unless otherwise mentioned.

Carbon (C): 0.005% to 0.1%

[0020] Since carbon (C) markedly affects the strength of steel, if the content of carbon (C) in steel is excessively high, the strength of the steel may increase to an excessive degree, and the ductility of the steel may decrease. Therefore, the content of carbon (C) is limited to 0.1% or less. However, if the content of carbon (C) is excessively low, the strength of steel decreases too much. Therefore, the lower limit of the content of carbon (C) may be limited to 0.005%.

Silicon (Si): 0.01% to 2.0%

[0021] Silicon (Si) is an element added to molten steel during a steel making process to remove oxygen and stabilize ferrite. In the present disclosure, silicon (Si) is added in an amount of 0.01% or greater. However, if the content of silicon (Si) in steel is excessively high, the ductility of the steel may decrease due to hardening. Therefore, the content of silicon (Si) is limited to 2.0% or less.

Mn (Manganese): 0.01% to 1.5%

[0022] Manganese (Mn) is an element effective in improving the corrosion resistance of steel. In the present disclosure, manganese (Mn) is added in an amount of 0.01% or greater, more preferably, 0.5% or greater. However, if the content of manganese (Mn) in steel is excessively high, the generation of Mn-containing fumes markedly increases during a welding process, and thus the weldability of the steel decreases. In addition, an MnS precipitate may be excessively formed to result in a decrease in the ductility of the steel. Therefore, the content of manganese (Mn) is limited to 1.5% or less, more preferably 1.0% or less.

Phosphorus (P): 0.05% or less

[0023] Phosphorus (P) is an impurity inevitably included in steel, causing grain boundary corrosion during a pickling process and deteriorating the hot formability of the steel. Therefore, the content of phosphorus (P) is adjusted as low as possible. In the present disclosure, the upper limit of the content of phosphorus (P) is set to 0.05%.

Sulfur (S): 0.005% or less

[0024] Sulfur (S), an impurity inevitably included in steel, segregates along grain boundaries of the steel and deteriorates the hot formability of the steel. Therefore, the content of sulfur (S) is adjusted as low as possible. In the present disclosure, the upper limit of the content of sulfur (S) is set to be 0.005%.

Chromium (Cr): 10% to 30%

[0025] Chromium (Cr) is effective in increasing the corrosion resistance of steel. In the present disclosure, chromium (Cr) is added in an amount of 10% or greater. However, if the content of chromium (Cr) is excessively high, manufacturing costs increase markedly, and grain boundary corrosion occurs. Therefore, the content of chromium (Cr) is limited to 30% or less.

Titanium (Ti): 0.05% to 0.50%

[0026] Titanium (Ti) fixes carbon (C) and nitrogen (N), thereby decreasing the amounts of carbon (C) and nitrogen (N) dissolved in steel. In addition, titanium (Ti) is effective in improving the corrosion resistance of steel. In the present disclosure, titanium (Ti) is added in an amount of 0.05% or greater, more preferably 0.1% or greater. However, if the content of titanium (Ti) is excessively high, manufacturing costs increase markedly, and Ti-containing inclusions are formed causing surface defects. Therefore, the content of titanium (Ti) is limited to 0.50% or less, more preferably 0.30% or less.

Aluminum (Al): 0.01% to 0.15%

[0027] Aluminum (Al) is a powerful deoxidizer used to decrease the oxygen content of molten steel. In the present disclosure, aluminum (Al) is added in an amount of 0.01% or greater. However, if the content of aluminum (Al) is excessively high, nonmetallic inclusions increase, causing defects in sleeves of cold-rolled strips and deteriorating the weldability of steel. Therefore, the content of aluminum (Al) is limited to 0.15% or less, more preferably 0.1% or less.

Nitrogen (N): 0.005% to 0.03%

[0028] Nitrogen (N) is an element facilitating recrystallization by precipitating austenite during a hot rolling process. In the present disclosure, nitrogen (N) is added in an amount of 0.005% or greater. However, if the content of nitrogen (N) in steel is excessively high, the ductility of the steel decreases. Therefore, the content of nitrogen (N) is limited to 0.03% or less.

[0029] The ferritic stainless steel of the present disclosure may include 3.5×10^6 or fewer (excluding zero) independent Ti(CN) precipitate particles per square millimeter (mm^2) of ferrite matrix. As described above, the Ti(CN) precipitate includes an independent Ti(CN) precipitate and a dependent Ti(CN) precipitate formed using TiN inclusion particles as precipitation nuclei. The dependent Ti(CN) precipitate does not have a significant effect on ductility deterioration when compared to the independent Ti(CN) precipitate. Therefore, only the number of independent Ti(CN) precipitate particles is controlled in the present disclosure. If the number of independent Ti(CN) precipitate particles is outside the above-mentioned range, it may be difficult to obtain a desired degree of ductility.

[0030] As described above, a method of reducing the number of independent Ti(CN) precipitate particles is to increase

the amount of Ti(CN) precipitating using TiN inclusion particles as precipitation nuclei. According to an exemplary embodiment of the present disclosure, a desired degree of ductility may be obtained by adjusting P defined by Formula 1 below within the range of 60% or less.

[Formula 1]

$$P(\%) = \{N_S / (N_S + N_C)\} \times 100$$

where N_S refers to the number of independent Ti(CN) precipitate particles per unit area (mm^2), and N_C refers to the number of dependent Ti(CN) precipitate particles per unit area (mm^2).

[0031] In the present disclosure, the independent Ti(CN) precipitate being the subject of control may be limited to having a particle diameter of $0.01 \mu\text{m}$ or greater. Since there is a limit to analyzing and quantifying independent Ti(CN) precipitate having a particle diameter of less than $0.01 \mu\text{m}$, special consideration may not be given thereto. The upper limit of the particle diameter of the independent Ti(CN) precipitate may not be specifically set. However, since it is difficult to form an independent Ti(CN) precipitate having a particle diameter of $2 \mu\text{m}$ or greater, the upper limit of the particle diameter of the independent Ti(CN) precipitate may be set to be $2 \mu\text{m}$.

[0032] It may be preferable that the independent Ti(CN) precipitate have an average particle diameter of $0.15 \mu\text{m}$ or less. If the average particle diameter of the independent Ti(CN) precipitate is greater than $0.15 \mu\text{m}$, surface defects may be formed even though the number of independent Ti(CN) precipitate particles is small. The term "average particle diameter" refers to the average of equivalent circular diameters of particles measured by observing a cross-section of steel.

[0033] In addition, it may be preferable that the average particle diameter of a TiN inclusion be within the range of $2 \mu\text{m}$ or greater. The reason for this is that a relatively coarse TiN inclusion having an average particle diameter of $2 \mu\text{m}$ or greater forms nucleus forming sites more efficiently, and thus facilitates the precipitation of Ti(CN). The upper limit of the average particle diameter of the TiN inclusion is not limited. However, if the TiN inclusion is excessively coarse, the total surface area of the TiN inclusion may be excessively small, and thus it may be difficult to increase the number of dependent Ti(CN) precipitate particles. Therefore, the upper limit of the average particle diameter of the TiN inclusion may be set to be $20 \mu\text{m}$.

[0034] The ferritic stainless steel of the present disclosure has a high degree of ductility. According to an exemplary embodiment of the present disclosure, the ferritic stainless steel may have an elongation of 34% or greater.

[0035] The ferritic stainless steel of the present disclosure may be manufactured by various methods without limit. For example, according to an exemplary embodiment, the ferritic stainless steel may be manufactured as follows.

[0036] Hereinafter, a method for manufacturing ferritic stainless steel having a high degree of ductility will be described in detail according to an aspect of the present disclosure.

[0037] According to the aspect of the present disclosure, the method for manufacturing ferritic stainless steel includes casting molten steel having the above-described composition as a slab. One of the technical features of the method is to maximally restrict the formation of an independent Ti(CN) precipitate by facilitating the diffusion of titanium (Ti), carbon (C), and nitrogen (N), and thus inducing the formation of a dependent Ti(CN) precipitate with the help of TiN inclusion particles functioning as precipitation nuclei.

[0038] In general, a slab produced by casting molten steel is subjected to a cooling process to improve productivity. However, according to the research conducted by the inventors, if a slab is cooled at a normal cooling rate, relatively fine TiN inclusion particles are formed in the slab, and Ti(CN) precipitates randomly in the slab, thereby markedly increasing the number of independent Ti(CN) precipitate particles. The reason for this is speculated as follows: relatively rapid cooling of the slab limits the diffusion of alloying elements in the slab, and sufficient nucleus forming energy facilitates the formation of nuclei of a TiN inclusion and a Ti(CN) precipitate simultaneously across the slab.

[0039] However, according to the present disclosure, after the molten steel is cast as a slab, the slab is cooled within the temperature range of 1100°C to 1200°C based on the surface temperature of the slab at an average cooling rate of $5^\circ\text{C}/\text{sec}$ or less (excluding $0^\circ\text{C}/\text{sec}$), preferably $3^\circ\text{C}/\text{sec}$ or less (excluding $0^\circ\text{C}/\text{sec}$), more preferably $2^\circ\text{C}/\text{sec}$ (excluding $0^\circ\text{C}/\text{sec}$). That is, the inventors have tried to precipitate as much Ti(CN) as possible using TiN inclusion particles as precipitation nuclei by properly controlling the average cooling rate of a slab within the temperature range of 1100°C to 1200°C , and thus to decrease the number of independent Ti(CN) precipitate particles. The inventors have found that if a slab is cooled under the conditions described above, the number of independent Ti(CN) precipitate particles is reduced to a target value or less. The reason for this may be that since slow cooling guarantees a sufficient time period for alloying elements to move, large amounts of Ti, C, and N diffuse toward TiN inclusion particles and precipitate in the form of Ti(CN) using the TiN inclusion particles as precipitation nuclei. In the present disclosure, the average cooling rate of the slab may be controlled using any method or apparatus. For example, a heat insulating material may be disposed around a cast strand.

[0040] As described above, the method of controlling the average cooling rate of the slab is not limited. For example, the slab may be cooled slowly at a constant cooling rate within the above-mentioned temperature range, or the slab may be cooled at a relatively high cooling rate after the slab is constantly maintained at a particular temperature within the temperature range.

[0041] According to an exemplary embodiment of the present disclosure, the temperature range within which the slab is slowly cooled may be widened to a range of 1000°C to 1250°C to induce the formation of a coarse TiN inclusion and enable the coarse TiN inclusion to function as nucleus forming sites more effectively for the precipitation of Ti(CN).

[0042] According to an exemplary embodiment of the present disclosure, the method may further included: forming a hot-rolled sheet by performing a finish hot rolling process on the slab; and performing a hot band annealing process on the hot-rolled sheet. These processes will now be described in detail.

[0043] Hot band annealing process: perform within the range of 450°C to 1080°C for 60 minutes or less.

[0044] The hot band annealing process is performed to improve the ductility of the hot-rolled sheet. Owing to the hot band annealing process, the independent Ti(CN) precipitate may be dissolved again, and dissolved alloying elements may be diffused, thereby further decreasing the number of independent Ti(CN) precipitate particles. To this end, the hot band annealing process may be performed at a temperature of 450°C or higher. However, if the temperature of the hot band annealing process is higher than 1080°C, or the duration of the band annealing process is longer than 60 minutes, the dependent Ti(CN) precipitate may be dissolved again, and thus the above-mentioned effects may be decreased. The lower limit of the duration of the band annealing process is not limited. For example, it may be preferable that the band annealing process be performed for 1 minute or longer to obtain sufficient effects.

[0045] As long as the above-mentioned manufacturing conditions for the ferritic stainless steel are controlled as described above, other conditions may be controlled according to manufacturing conditions for normal ferritic stainless steel. In addition, the annealed hot-rolled sheet may be subjected to a cold rolling process and a cold rolled sheet annealing process to produce a cold-rolled steel sheet.

[0046] Hereinafter, aspects of the present disclosure will be described more specifically according to examples. However, the following examples should be considered in a descriptive sense only and not for purpose of limitation. The scope of the present invention is defined by the appended claims, and modifications and variations reasonably made therefrom.

[Mode for Invention]

[0047] Molten steels having the compositions shown in Table 1 were prepared and were cast at a constant speed under the conditions shown in Table 2 in order to produce slabs. The slabs were subjected to a hot rolling process and a hot band annealing process to obtain hot-rolled sheets. In Table 1, the contents of elements are given in wt%, and in Table 2, the slab cooling rate is an average cooling rate measured based on the surface temperature of a slab within the temperature range of 1100°C to 1200°C.

[Table 1]

Steel	C	Si	Mn	P	S	Cr	Ti	Al	N
A	0.012	0.25	0.16	0.031	0.003	11.0	0.15	0.040	0.012
B	0.015	0.35	0.8	0.025	0.002	12.0	0.21	0.032	0.015

[Table 2]

Steel	Slab Cooling Rate (°C/sec) within the Temperature Range of 1100°C to 1200°C	Hot Band Annealing Temperature (°C)	Hot Band Annealing Time (min)	Notes
A	2	600	30	Inventive Example 1
A	2	800	15	Inventive Example 2
A	6	800	15	Comparative Example 1

(continued)

Steel	Slab Cooling Rate (°C/sec) within the Temperature Range of 1100°C to 1200°C	Hot Band Annealing Temperature (°C)	Hot Band Annealing Time (min)	Notes
B	1	900	15	Inventive Example 3
B	6	900	15	Comparative Example 2

[0048] Thereafter, the hot-rolled sheets were photographed using a transmission electron microscope (TEM), and the number and ratio (P) of independent Ti(CN) precipitate particles having a particle diameter of 0.01 μm or greater were measured using an image analyzer. In addition, samples were taken from the hot-rolled sheets based on a direction making an angle of 90° with the rolling direction of the hot-rolled sheets according to JIS 13B, and the elongation of the samples was measured. Results of the measurements are shown in Table 3.

[Table 3]

Steel	Number of Independent Ti(CN) Precipitate Particles per Millimeters (mm^2)	P (%)	Elongation (%)	Notes
A	3.1×10^6	56	37	Inventive Example 1
A	2.9×10^6	42	37	Inventive Example 2
A	8.9×10^6	88	30	Comparative Example 1
B	2.2×10^6	58	39	Inventive Example 3
B	6.5×10^6	79	32	Comparative Example 2

[0049] Referring to Table 3, Samples of Inventive Examples 1 to 3 satisfying the conditions proposed in the present disclosure had 3.5×10^6 or fewer independent Ti(CN) precipitate particles per square millimeter (mm^2) and thus had an elongation of 34% or greater. However, each sample of Comparative Examples 1 and 2 had an excessive number of independent Ti(CN) precipitate particles because the slab cooling rate was relatively high, and thus the ductility of the samples of Comparative Examples 1 and 2 were poor.

[0050] FIG. 1 is a scanning electron microscope (SEM) image illustrating the microstructure of a hot-rolled sheet of Inventive Example 1, and FIG. 2 is a higher magnification SEM image illustrating region A in FIG. 1. A particle shown in the center of region A in FIG. 1 corresponds to a TiN inclusion particle crystallized during a steel making process. Referring to FIG. 2 illustrating region A on an enlarged scale, a large amount of Ti(CN) has precipitated on the TiN inclusion particle functioning as a precipitation nucleus.

Claims

1. Ferritic stainless steel comprising, by wt%, C: 0.005% to 0.1%, Si: 0.01% to 2.0%, Mn: 0.01% to 1.5%, P: 0.05% or less, S: 0.005% or less, Cr: 10% to 30%, Ti: 0.005% to 0.5%, Al: 0.01% to 0.15%, N: 0.005% to 0.03%, and the balance of Fe and inevitable impurities, wherein the ferritic stainless steel comprises 3.5×10^6 or fewer particles of an independent Ti(CN) precipitate per square millimeter (mm^2) of ferrite matrix.
2. Ferritic stainless steel comprising, by wt%, C: 0.005% to 0.1%, Si: 0.01% to 2.0%, Mn: 0.01% to 1.5%, P: 0.05% or less, S: 0.005% or less, Cr: 10% to 30%, Ti: 0.005% to 0.5%, Al: 0.01% to 0.15%, N: 0.005% to 0.03%, and the balance of Fe and inevitable impurities, wherein the ferritic stainless steel comprises an independent Ti(CN) precipitate and a dependent Ti(CN) precipitate formed using a TiN inclusion as precipitation nuclei, and the ferritic stainless steel has a P within a range of 60% or less, the P being defined by Formula 1 below:

[Formula 1]

$$P(\%) = \{N_S / (N_S + N_C)\} \times 100$$

where N_S refers to the number of independent Ti(CN) precipitate particles per unit area (mm^2), and N_C refers to the number of dependent Ti(CN) precipitate particles per unit area (mm^2).

3. The ferritic stainless steel of claim 2, wherein the P is 58% or less.
4. The ferritic stainless steel of claim 1 or 2, wherein the independent Ti(CN) precipitate has a particle diameter of 0.01 μm or greater.
5. The ferritic stainless steel of claim 1 or 2, wherein the independent Ti(CN) precipitate has an average particle diameter of 0.15 μm or less.
6. The ferritic stainless steel of claim 2, wherein the TiN inclusion has an average particle diameter of 2 μm or greater.
7. The ferritic stainless steel of claim 1 or 2, wherein the ferritic stainless steel has an elongation of 34% or greater.
8. A method for manufacturing ferritic stainless steel, the method comprising casting molten steel as a slab, the molten steel comprising, by wt%, C: 0.005% to 0.1%, Si: 0.01% to 2.0%, Mn: 0.01% to 1.5%, P: 0.05% or less, S: 0.005% or less, Cr: 10% to 30%, Ti: 0.005% to 0.5%, Al: 0.01% to 0.15%, N: 0.005% to 0.03%, and the balance of Fe and inevitable impurities, wherein in the casting of the molten steel, the slab is cooled at an average cooling rate of 5°C/sec or less (excluding 0°C/sec) within a temperature range of 1100°C to 1200°C based on a surface temperature of the slab.
9. The method of claim 8, wherein in the casting of the molten steel, the slab is cooled at an average cooling rate of 5°C/sec or less (excluding 0°C/sec) within a temperature range of 1000°C to 1250°C based on the surface temperature of the slab.
10. The method of claim 8, wherein after the casting of the molten steel, the method further comprises:
 - reheating the slab;
 - obtaining hot-rolled steel by performing a hot rolling process on the reheated slab; and
 - performing a hot band annealing process on the hot-rolled steel within a temperature range of 450°C to 1080°C for 60 minutes or less.

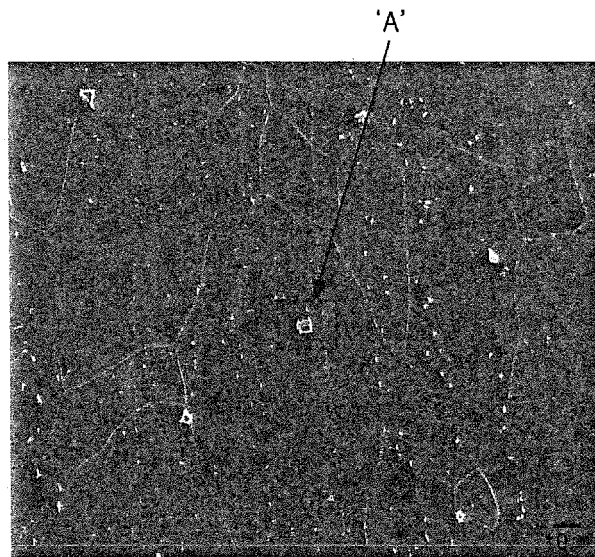
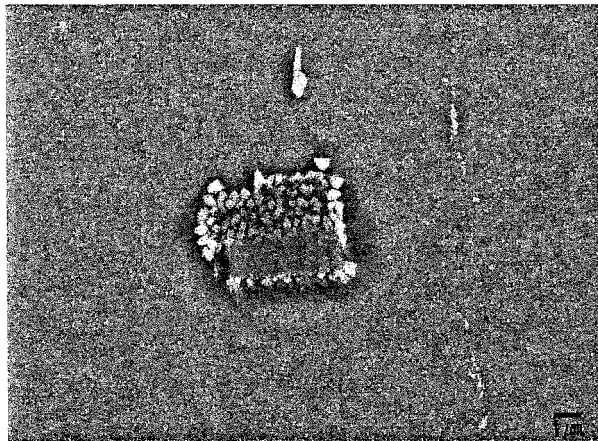


FIG. 1



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FIG. 2

INTERNATIONAL SEARCH REPORT

International application No.

PCT/KR2015/004410

A. CLASSIFICATION OF SUBJECT MATTER

C22C 38/18(2006.01)i, C22C 38/28(2006.01)i, B22D 27/04(2006.01)i, C21D 8/02(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 38/18; C21D 9/46; C21D 9/48; C21D 8/02; C22C 38/00; C22C 38/28; C22C 38/38; B22D 27/04

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: ferrite stainless, Ti sludge

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	KR 10-2005-0008826 A (JFE STEEL CORPORATION) 21 January 2005 See abstract, claims 1 - 12, pages 4 - 5.	1-10
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 ☒ See patent family annex.

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Date of the actual completion of the international search

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