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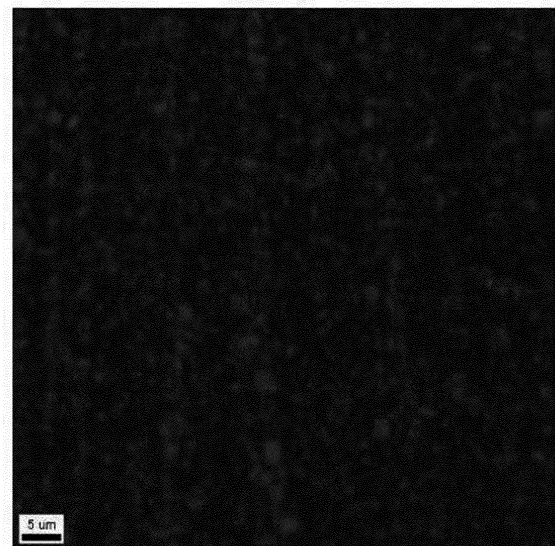
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(54) **AUSTENITIC STAINLESS STEEL AND METHOD FOR MANUFACTURING SAME**

(57) Disclosed is an austenitic stainless steel including, in percent by weight (wt%), 0.005 to 0.03% of C, 0.1 to 1% of Si, 0.1 to 2% of Mn, 0.01 to 0.4 of Cu, 0.01 to 0.2 of Mo, 6 to 9% of Ni, 16 to 19% of Cr, 0.01 to 0.2% of N, and the balance of Fe and inevitable impurities, wherein an austenitic stability parameter (ASP) value calculated by $551-462(C+N)-9.2Si-8.1Mn-13.7Cr-29(Ni+Cu)-18.5Mo$ is from 30 to 60, a $[100 \cdot N]/[Ni+Cu]$ value is 1.4 or more, an average grain size is less than 5 μm , and a fraction (%) of grains with a grain size of 5 μm or more is less than 10%.

[FIG. 1]



[FRACTION OF GRAINS WITH GRAIN SIZE OF 5 μm OR MORE: 0%]

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Description

[Technical Field]

5 **[0001]** The present disclosure relates to an austenitic stainless steel and a method for manufacturing the same, and more particularly, to ultra-fine grain 304 series and 301 series austenitic stainless steels with high strength and high ductility and methods for manufacturing the same.

[Background Art]

10 **[0002]** Because commercially-available 304 series and 301 series austenitic stainless steels have low yield strengths (200 to 350 MPa), there are limits to apply these stainless steels to structural materials that require high strength. A skin pass rolling process is generally applied to obtain a yield strength higher than that of these commercially-available 300 series stainless steels, but a problem of increasing manufacturing costs is caused thereby. A 301 series 1/4H crude material requires a yield strength of 500 MPa or more, a tensile strength of 850 MPa or more, and an elongation of 25% or more, and accordingly, the present disclosure provides a method for manufacturing a ultra-fine grain 300 series stainless steel having high yield strength, high tensile strength, and excellent elongation without performing a skin pass rolling.

15 **[0003]** An ultra-fine grain (UFG) material has excellent strength-elongation balance, fatigue resistance, and etching processibility. International Patent Application Publication No. WO0216/043125 provides a method for manufacturing a 300 series stainless steel for a laser metal mask for photoetching having a small curvature even after half etching by performing stress relief (SR) heat treatment twice after skin pass rolling a cold annealed material. However, the disclosed method does not include technical details on structural components having a thickness of 0.4 to 2 mm as a manufacturing technique to adjust etching properties and curvature after etching.

20 **[0004]** In addition, Japanese Patent Application Laid-open Publication No. 2020-50940 discloses a nuclear power component manufactured by heat treatment performed for a long time over 48 hours in a temperature range of 600 to 700°C to control an average grain size to 10 μm or less. According to the disclosed Japanese Patent Application Laid-open publication, productivity deteriorates in the case of being implemented in a real production line and manufacturing costs increase due to heat treatment performed for a long time.

25 **[0005]** To solve the problems as described above, provided is a method for manufacturing 304 series and 301 series ultra-fine grain austenitic stainless steels having high strength and high ductility for replacing crude materials (particularly, 301 1/4H) such as materials for outer panels of vehicles and components of construction and vehicles.

30 **[0006]** Specifically, because materials having a thickness of 0.4 to 2.0 mm are widely applied to structural components, attempts have been made to solve technical problems by focusing on low-cost component design and low-cost manufacturing technology to have high strength and high ductility within the thickness range. Ultra-fine grains are realized in 300 series stainless steels generally by transforming an austenite phase into a martensite phase by cold rolling, and performing annealing at a low temperature. However, even after a material including ultra-fine grains is obtained, it is difficult for the material to simultaneously obtain excellent yield strength, tensile strength, and elongation. Standards for 304 series and 301 series require different Ni contents and different Cr contents, a transformation amount of martensite phase by cold processing varies according to an austenitic stability parameter (ASP) value, transformation induced plasticity (TRIP) deformation behaviors of a tensile test vary, and tensile curve characteristics significantly vary. Therefore, in the present disclosure, provided is a method of manufacturing ultra-fine grain 300 series stainless steels capable of realizing high strength-high ductility by controlling an austenitic stability parameter (ASP) value calculated by $551-462(C+N)-9.2Si-8.1Mn-13.7Cr-29(Ni+Cu)-18.5Mo$, by controlling a $[100 \cdot N]/[Ni+Cu]$ value, controlling a cold rolling reduction ratio after hot rolling, annealing, and acid pickling a slab, controlling an annealing temperature after cold rolling, and controlling, a grain size, a fraction of crystal grains with a grain size of 5 μm or more.

[Technical Solution]

35 **[0007]** In accordance with an aspect of the present disclosure, an austenitic stainless steel according to an embodiment of the present disclosure includes, in percent by weight (wt%), 0.005 to 0.03% of C, 0.1 to 1% of Si, 0.1 to 2% of Mn, 0.01 to 0.4 of Cu, 0.01 to 0.2 of Mo, 6 to 9% of Ni, 16 to 19% of Cr, 0.01 to 0.2% of N, and the balance of Fe and inevitable impurities, an austenitic stability parameter (ASP) value calculated by $551-462(C+N)-9.2Si-8.1Mn-13.7Cr-29(Ni+Cu)-$

18.5Mo is from 30 to 60, a $[100 \cdot N]/[Ni+Cu]$ value is 1.4 or more, an average grain size is less than 5 μm , and a fraction (%) of grains with a grain size of 5 μm or more is less than 10%.

[0008] In accordance with an aspect of the present disclosure, a method for manufacturing an austenitic stainless steel includes: preparing a slab by casting an austenitic stainless steel including, in percent by weight (wt%), 0.005 to 0.03% of C, 0.1 to 1% of Si, 0.1 to 2% of Mn, 0.01 to 0.4 of Cu, 0.01 to 0.2 of Mo, 6 to 9% of Ni, 16 to 19% of Cr, 0.01 to 0.2% of N, and the balance of Fe and inevitable impurities, wherein an austenitic stability parameter (ASP) value calculated by $551-462(C+N)-9.2Si-8.1Mn-13.7Cr-29(Ni+Cu)-18.5Mo$ is from 30 to 60, a $[100 \cdot N]/[Ni+Cu]$ value is 1.4 or more, an average grain size is less than 5 μm , and a fraction (%) of grains with a grain size of 5 μm or more is less than 10%; hot rolling, annealing, and acid pickling the slab, and cold-rolling a resultant steel sheet with a cold rolling reduction ratio of 60% or more; and annealing the steel sheet in a temperature range of 800 to 850°C.

[Advantageous Effects]

[0009] The present disclosure may provide a method for manufacturing a 300 series ultra-fine grain product capable of replacing a 301 series 1/4H crude material by satisfying requirements of 301 series 1/4H crude materials having a thickness of 0.4 to 2.0 mm, (i.e., a yield strength of 500 MPa or more, a tensile strength of 850 MPa or more, and an elongation of 25% or more).

[Description of Drawings]

[0010]

FIG. 1 is an image of a transverse direction (TD) surface of a thickness central region of a final cold-rolled product of Example 1 analyzed by electron back scatter diffraction (EBSD), in which crystal grains with a grain size of 5 μm or more are expressed in gray and a fraction thereof is shown.

FIG. 2 is an image of a transverse direction (TD) surface of a thickness central region of a final cold-rolled product of Example 3 analyzed by electron back scatter diffraction (EBSD), in which crystal grains with a grain size of 5 μm or more are expressed in gray and a fraction thereof is shown.

FIG. 3 is an image of a transverse direction (TD) surface of a thickness central region of a final cold-rolled product of Comparative Example 1 analyzed by electron back scatter diffraction (EBSD), in which crystal grains with a grain size of 5 μm or more are expressed in gray and a fraction thereof is shown.

FIG. 4 is an image of a transverse direction (TD) surface of a thickness central region of a final cold-rolled product of Comparative Example 2 analyzed by electron back scatter diffraction (EBSD), in which crystal grains with a grain size of 5 μm or more are expressed in gray and a fraction thereof is shown.

FIG. 5 is a graph showing a stress-strain curve of Example 1.

FIG. 6 is a graph showing a stress-strain curve of Comparative Example 1.

FIG. 7 is a graph showing a stress-strain curve of Comparative Example 2.

FIG. 8 is a graph showing a stress-strain curve of Comparative Example 5.

[Best Mode]

[0011] An austenitic stainless steel according to an embodiment of the present disclosure includes, in percent by weight (wt%), 0.005 to 0.03% of C, 0.1 to 1% of Si, 0.1 to 2% of Mn, 0.01 to 0.4 of Cu, 0.01 to 0.2 of Mo, 6 to 9% of Ni, 16 to 19% of Cr, 0.01 to 0.2% of N, and the balance of Fe and inevitable impurities, wherein an austenitic stability parameter (ASP) value calculated by $551-462(C+N)-9.2Si-8.1Mn-13.7Cr-29(Ni+Cu)-18.5Mo$ is from 30 to 60, a $[100 \cdot N]/[Ni+Cu]$ value is 1.4 or more, an average grain size is less than 5 μm , and a fraction (%) of grains with a grain size of 5 μm or more is less than 10%.

[Modes of the Invention]

[0012] Hereinafter, preferred embodiments of the present disclosure will now be described. However, the present disclosure may be embodied in many different forms and should not be construed as being limited to the embodiments set forth herein. Rather, these embodiments are provided so that this disclosure will be thorough and complete, and will fully convey the scope of the disclosure to those skilled in the art.

[0013] The terms used herein are merely used to describe particular embodiments. Thus, an expression used in the singular encompasses the expression of the plural, unless it has a clearly different meaning in the context. It is to be understood that the terms such as "including" or "having" are intended to indicate the existence of features, regions, integers, processes, operations, elements, and/or components disclosed in the specification, and are not intended to

preclude the possibility that one or more other features, regions, integers, processes, operations, elements, and/or components thereof may exist or may be added. In this regard, unless otherwise defined, technical terms or scientific terms used herein have meanings that are obvious to one of ordinary skill in the art. Terms defined in dictionaries generally used should be construed to have meanings matching with contextual meanings in the related art and are not to be construed as an ideal or excessively formal meaning unless otherwise defined herein.

[Austenitic Stainless Steel]

[0014] An austenitic stainless steel according to an embodiment of the present disclosure includes, in percent by weight (wt%), 0.005 to 0.03% of C, 0.1 to 1% of Si, 0.1 to 2% of Mn, 0.01 to 0.4 of Cu, 0.01 to 0.2 of Mo, 6 to 9% of Ni, 16 to 19% of Cr, 0.01 to 0.2% of N, and the balance of Fe and inevitable impurities, wherein an austenitic stability parameter (ASP) value calculated by $551-462(C+N)-9.2Si-8.1Mn-13.7Cr-29(Ni+Cu)-18.5Mo$ is from 30 to 60, a $[100*N]/[Ni+Cu]$ value is 1.4 or more, an average grain size is less than 5 μm , and a fraction (%) of grains with a grain size of 5 μm or more is less than 10%.

(Contents of Alloying Elements)

[0015] The content of carbon (C) is from 0.005 to 0.03 wt%.

[0016] C is an austenite phase-stabilizing element. In consideration thereof, C is added in an amount of 0.005 wt% or more. However, because an excess of C causes a problem of forming a chromium carbide during low-temperature annealing to deteriorate grain boundary corrosion resistance, the C content is controlled to 0.03 wt% or less in the present disclosure.

[0017] The content of silicon (Si) is from 0.1 to 1 wt%.

[0018] Si is an element added as a deoxidizer during a steel-making process and has an effect on improving corrosion resistance of a steel by forming an Si oxide in a passivated layer in the case of performing a bright annealing process. In consideration thereof, Si is added in an amount of 0.1 wt% or more in the present disclosure. However, since an excess of Si causes a problem of deteriorating ductility, the Si content is controlled to 1.0 wt% or less in the present disclosure.

[0019] The content of manganese (Mn) is from 0.1 to 2.0 wt%.

[0020] Mn is an austenite phase-stabilizing element. In consideration thereof, Mn is added in an amount of 0.1 wt% or more in the present disclosure. However, since an excess of Mn causes a problem of deteriorating corrosion resistance, the Mn content is controlled to 2.0 wt% or less in the present disclosure.

[0021] The content of nickel (Ni) is from 6.0 to 9.0 wt%.

[0022] Ni, as an austenite phase-stabilizing element, has an effect on softening a steel material. In consideration thereof, Ni is added in an amount of 6.0 wt% or more in the present disclosure. However, since an excess of Ni causes a problem of increasing costs, the Ni content is controlled to 9.0 wt% or less in the present disclosure.

[0023] The content of chromium (Cr) is from 16.0 to 19.0 wt%.

[0024] Cr is a major element for improving corrosion resistance of a stainless steel. In consideration thereof, Cr is added in an amount of 16.0 wt% or more in the present disclosure. However, since an excess of Cr causes problems of hardening a steel material and suppressing strain-induced martensite transformation during cold rolling, the Cr content is controlled to 19.0 wt% or less in the present disclosure.

[0025] The content of nitrogen (N) is from 0.01 to 0.2 wt%.

[0026] N is an austenite phase-stabilizing element and improves strength of a steel material. In consideration thereof, N may be added in an amount of 0.01% or more. However, since an excess of N causes problems of hardening a steel material and deteriorating hot workability, the N content is controlled to 0.2 wt% or less in the present disclosure.

[0027] The content of copper (Cu) is from 0.01 to 0.4 wt%.

[0028] Cu is an austenite phase-stabilizing element and may be added in an amount of 0.01% or more. However, since an excess of Cu causes problems of deteriorating corrosion resistance of a steel material and increasing costs, the Cu content is controlled to 0.4 wt% or less in the present disclosure.

[0029] The content of molybdenum (Mo) is from 0.01 to 0.2 wt%.

[0030] Mo having an effect on improving corrosion resistance and workability may be added in an amount of 0.01% or more. However, since an excess of Mo causes a problem of increasing costs, the Mo content is controlled to 0.2 wt% or less in the present disclosure.

[0031] The remaining component of the composition of the present disclosure is iron (Fe). However, the composition may include unintended impurities inevitably incorporated from raw materials or surrounding environments, and thus addition of other alloying elements is not excluded. These impurities are known to any person skilled in the art of manufacturing and details thereof are not specifically mentioned in the present disclosure.

[0032] In the present disclosure, the austenitic stability parameter (ASP) value is calculated by $551-462(C+N)-9.2Si-$

8.1Mn-13.7Cr-29(Ni+Cu)-18.5Mo and satisfies a range of 30 to 60. When the ASP value is out of the range described above, elongation desired to obtain in the present disclosure is not satisfied due to excessive transformation induced plasticity (TRIP) deformation of a material (due to excessive work hardening).

[0033] According to the present disclosure, the $[100 \cdot \text{N}]/[\text{Ni} + \text{Cu}]$ value is 1.4 or more. When the value is less than 1.4, yield strength desired to obtain in the present disclosure is not satisfied due to a low amount of solute nitrogen contributing to yield strength.

(Microstructure)

[0034] The microstructure has an average grain size less than 5 μm and a fraction of grains with a grain size of 5 μm or more is less than 10%. When they are out of these ranges, yield strength and tensile strength desired to obtain in the present disclosure may not be satisfied.

(Properties)

[0035] In addition, in an embodiment of the present disclosure, the austenitic stainless steel may have a tensile strength of 850 MPa or more.

[0036] In addition, in an embodiment of the present disclosure, the austenitic stainless steel may have a yield strength of 500 MPa or more.

[0037] In addition, in an embodiment of the present disclosure, the austenitic stainless steel may have an elongation of 25% or more.

[Method for Manufacturing Austenitic Stainless Steel]

[0038] A method for manufacturing an austenitic stainless steel according to another embodiment includes: preparing a slab by casting an austenitic stainless steel including, in percent by weight (wt%), 0.005 to 0.03% of C, 0.1 to 1% of Si, 0.1 to 2% of Mn, 0.01 to 0.4 of Cu, 0.01 to 0.2 of Mo, 6 to 9% of Ni, 16 to 19% of Cr, 0.01 to 0.2% of N, and the balance of Fe and inevitable impurities, wherein an austenitic stability parameter (ASP) value calculated by $551 - 462(\text{C} + \text{N}) - 9.2\text{Si} - 8.1\text{Mn} - 13.7\text{Cr} - 29(\text{Ni} + \text{Cu}) - 18.5\text{Mo}$ is from 30 to 60, a $[100 \cdot \text{N}]/[\text{Ni} + \text{Cu}]$ value is 1.4 or more, an average grain size is less than 5 μm , and a fraction (%) of grains with a grain size of 5 μm or more is less than 10%; hot rolling, annealing, and acid pickling the slab, and cold-rolling a resultant steel sheet with a cold rolling reduction ratio of 60% or more; and annealing the steel sheet in a temperature range of 800 to 850°C.

[0039] When a cold annealing temperature is out of the range of the present disclosure, the average grain size is not less than 5 μm and the fraction of grains with a grain size of 5 μm or more is not less than 10%, and thus the yield strength and tensile strength desired to obtain in the present disclosure are not satisfied.

[0040] When the cold rolling reduction ratio (%) is less than 60%, the average grain size is not less than 5 μm and the fraction of grains with a grain size of 5 μm or more is not less than 10%, and thus the yield strength desired to obtain in the present disclosure is not satisfied.

(Examples)

[0041] Table 1 shows carbon, silicon, manganese, nickel, chromium, copper, and nitrogen contents of austenitic stainless steels of examples and comparative examples and also shows austenitic stability parameter (ASP) values, $[100 \cdot \text{N}]/[\text{Ni} + \text{Cu}]$ values, cold rolling rates (%), and cold annealing temperatures (°C) [within 5 minutes of annealing time] thereof as main parameters.

[0042] Slabs produced by a casting process according to an embodiment of the present disclosure were hot rolled and annealed, cold rolled at room temperature, and cold annealed to prepare coils. Some of the steels were vacuum dissolved in a Lab to prepare ingot and some were subjected to an electric furnace casting process to prepare slabs. In Examples 1 to 6, the austenitic stability parameter (ASP) values calculated by $551 - 462(\text{C} + \text{N}) - 9.2\text{Si} - 8.1\text{Mn} - 13.7\text{Cr} - 29(\text{Ni} + \text{Cu}) - 18.5\text{Mo}$ were within the range of 30 to 60, the $[100 \cdot \text{N}]/[\text{Ni} + \text{Cu}]$ values were not less than 1.4, the cold rolling rates (%) were not less than 60%, and the cold annealing temperatures (°C) satisfied the range of 800 to 850. In Comparative Examples 1 to 11, the austenitic stability parameter (ASP) values were out of the range of 30 to 60, the $[100 \cdot \text{N}]/[\text{Ni} + \text{Cu}]$ values were less than 1.4, the cold rolling rates (%) were less than 60%, or the cold annealing temperatures (°C) were out of the range of 800 to 850.

Table 1

	Composition of alloying elements (wt%)								ASP	[100 *N]/ [Ni+Cu]	Cold rolling rate (%)	Cold annealing temperature (°C), (within 5 min of annealing time)
	C	Si	Mn	Cr	Ni	Cu	Mo	N				
Example 1	0.025	0.39	1.24	17.2	6.6	0.34	0.07	0.111	36.3	1.6	67.0	800
Example 2	0.025	0.39	1.24	17.2	6.6	0.34	0.07	0.111	36.3	1.6	67.0	825
Example 3	0.025	0.39	1.24	17.2	6.6	0.34	0.07	0.111	36.3	1.6	67.0	850
Example 4	0.021	0.41	1.35	17.1	6.5	0.25	0.03	0.121	40.1	1.8	65.0	800
Example 5	0.027	0.28	1.72	17.1	6.6	0.11	0.01	0.101	46.3	1.5	65.0	800
Example 6	0.021	0.25	0.95	17.2	6.7	0.21	0.03	0.111	43.4	1.6	65.0	800
Comparative Example 1	0.025	0.39	1.24	17.2	6.6	0.34	0.07	0.111	36.3	1.6	67.0	1100
Comparative Example 2	0.022	0.41	1.31	17.4	6.7	0.38	0.08	0.117	27.2	1.7	67.0	800
Comparative Example 3	0.022	0.41	1.31	17.4	6.7	0.38	0.08	0.117	27.2	1.7	67.0	825
Comparative Example 4	0.022	0.41	1.31	17.4	6.7	0.38	0.08	0.117	27.2	1.7	67.0	850
Comparative Example 5	0.02	0.31	0.98	17.1	6.2	0.21	0.03	0.100	64.1	1.6	67.0	800
Comparative Example 6	0.02	0.12	0.50	17.1	6.2	0.22	0.04	0.100	69.2	1.6	67.0	850
Comparative Example 7	0.027	0.28	1.72	17.1	6.9	0.1	0.01	0.072	51.3	1.0	65.0	800
Comparative Example 8	0.04	0.28	1.72	17.1	8.1	0.1	0.01	0.040	25.3	0.5	65.0	800
Comparative Example 9	0.04	0.28	1.72	18.1	8.1	0.1	0.01	0.040	11.6	0.5	65.0	800
Comparative Example 10	0.027	0.28	1.72	17.1	6.6	0.11	0.01	0.101	46.3	1.5	45.0	800
Comparative Example 11	0.021	0.25	0.95	17.2	6.7	0.21	0.03	0.111	43.4	1.6	45.0	800

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[0043] Table 2 shows average grain sizes, fractions of grains with a grain size of 5 μm or more obtained by analyzing transverse direction (TD) surfaces of thickness central regions of final cold-rolled products and yield strength, tensile strength, and elongation of JIS13B tensile test samples obtained by a room temperature tensile test.

Table 2

Category	Average grain size	Fraction of grains with grain size of 5 μm or more (%)	Yield strength (MPa)	Tensile strength (MPa)	Elongation (%)
Example 1	2.7	0	629	892	36.8
Example 2	3.2	2	570	864	39.2
Example 3	4.1	7	526	854	40.8
Example 4	2.5	0	635	895	35.2
Example 5	2.2	0	631	902	31.5
Example 6	2.7	0	629	899	33.4
Comparative Example 1	28.5	85	299	818	39.3
Comparative Example 2	4.7	14	571	839	43.6
Comparative Example 3	5.1	17	533	825	45.1
Comparative Example 4	5.6	21	515	816	45.9
Comparative Example 5	2.5	0	628	904	24.9
Comparative Example 6	2.2	0	632	908	23.2
Comparative Example 7	2.5	0	485	852	30.3
Comparative Example 8	5.3	18	473	755	41.2
Comparative Example 9	7.2	32	425	736	45.2
Comparative Example 10	5.7	15	497	891	33.4
Comparative Example 11	6.2	21	492	884	33.5

[0044] In Examples 1 to 6, it was confirmed that the average grain sizes were less than 5 μm , the fractions of crystal grains with a grain size of 5 μm or more were less than 10%, the austenitic stability parameter (ASP) values satisfied the range of 30 to 60, the $[100\text{N}]/[\text{Ni}+\text{Cu}]$ values of 1.4 or more were satisfied, and finally, requirements of 301 series 1/4H crude materials (yield strength of 500 MPa or more, tensile strength of 850 MPa or more, and elongation of 25% or more) were satisfied.

[0045] Because the cold annealing temperature of Comparative Example 1 was out of the range of the present disclosure, the average grain size was greater than 5 μm and the fraction of crystal grains with a grain size of 5 μm or more was greater than 10%, so that the yield strength and tensile strength desired to obtain in the present disclosure were not satisfied. Because the ASP values of Comparative Examples 2, 3, and 4 were out of the range disclosed in the present disclosure, TRIP deformation of the material did not easily occur during the tensile test (work hardening did not easily occur), so that the tensile strength desired to obtain in the present disclosure was not satisfied.

[0046] Because the ASP values of Comparative Examples 5 and 6 were out of the range of the present disclosure,

TRIP deformation of the materials excessively occurred (work hardening excessively occurred), so that the elongation desired to obtain in the present disclosure was not satisfied. Because the $[100 \cdot N]/[Ni+Cu]$ value of Comparative Example 7 was out of the range of the present disclosure, the amount of solute nitrogen contributing to the yield strength was too small, so that the yield strength desired to obtain in the present disclosure was not satisfied. Because the ASP values and $[100 \cdot N]/[Ni+Cu]$ values of Comparative Examples 8 and 9 were out of range of the present disclosure, the average grain size was greater than 5 μm and the fraction of the crystal grains with a grain size of 5 μm or more was greater than 10%, so that the yield strength and tensile strength desired to obtain in the present disclosure were not satisfied. Because the cold rolling reduction ratios (%) of Comparative Examples 10 and 11 were out of range disclosed in the present disclosure, the average grain size was greater than 5 μm and the fraction of the crystal grains with a grain size of 5 μm or more was greater than 10%, so that the yield strength desired to obtain in the present disclosure was not satisfied.

[0047] Referring to FIG. 1, as a result of analyzing a transverse direction (TD) surface of a thickness central region of a final cold-rolled product of Example 1 by electron back scatter diffraction (EBSD), it was confirmed that the fraction of crystal grains with a grain size of 5 μm or more was 0%.

[0048] Referring to FIG. 2, as a result of analyzing a transverse direction (TD) surface of a thickness central region of a final cold-rolled product of Example 3 by electron back scatter diffraction (EBSD), it was confirmed that the fraction of crystal grains with a grain size of 5 μm or more was 7%.

[0049] Referring to FIG. 3, as a result of analyzing a transverse direction (TD) surface of a thickness central region of a final cold-rolled product of Comparative Example 1 by electron back scatter diffraction (EBSD), it was confirmed that the fraction of crystal grains with a grain size of 5 μm or more was 85%.

[0050] Referring to FIG. 4, as a result of analyzing a transverse direction (TD) surface of a thickness central region of a final cold-rolled product of Comparative Example 2 by electron back scatter diffraction (EBSD), it was confirmed that the fraction of crystal grains with a grain size of 5 μm or more was 14%.

[0051] FIGS. 5 to 8 are graphs showing stress-strain curves of the examples and comparative examples. FIG. 5 is a graph of Example 1, FIG. 6 is a graph of Comparative Example 1, FIG. 7 is a graph of Comparative Example 2, and FIG. 8 is a graph of Comparative Example 5. Upon comparison of FIGS. 5 to 8, it was confirmed that the austenitic stainless steel according to an embodiment of the present disclosure may satisfy both high strength and high elongation compared to the comparative examples because a relative change in the stress was not significantly great.

[0052] While the present disclosure has been particularly described with reference to exemplary embodiments, it should be understood by those of skilled in the art that various changes in form and details may be made without departing from the spirit and scope of the present disclosure.

[Industrial Applicability]

[0053] According to the present disclosure, the requirements of 301 series 1/4H crude materials with a thickness of 0.4 to 2.0 mm, (i.e., a yield strength of 500 MPa or more, a tensile strength of 850 MPa or more, and an elongation of 25% or more) were satisfied, and thus a ultra-fine grain stainless steel capable of replacing 301 series 1/4H materials may be provided. Therefore, industrial applicability of the present disclosure was verified.

Claims

1. An austenitic stainless steel comprising, in percent by weight (wt%), 0.005 to 0.03% of C, 0.1 to 1% of Si, 0.1 to 2% of Mn, 0.01 to 0.4 of Cu, 0.01 to 0.2 of Mo, 6 to 9% of Ni, 16 to 19% of Cr, 0.01 to 0.2% of N, and the balance of Fe and inevitable impurities,

wherein an austenitic stability parameter (ASP) value calculated by $551-462(C+N)-9.2Si-8.1Mn-13.7Cr-29(Ni+Cu)-18.5Mo$ is from 30 to 60,

a $[100 \cdot N]/[Ni+Cu]$ value is 1.4 or more,

an average grain size is less than 5 μm , and a fraction (%) of grains with a grain size of 5 μm or more is less than 10%.

2. The austenitic stainless steel according to claim 1, wherein the austenitic stainless steel has a tensile strength of 850 MPa or more.

3. The austenitic stainless steel according to claim 1, wherein the austenitic stainless steel has a yield strength of 500 MPa or more.

4. The austenitic stainless steel according to claim 1, wherein the austenitic stainless steel has an elongation of 25% or more.

5. A method for manufacturing an austenitic stainless steel, the method comprising:

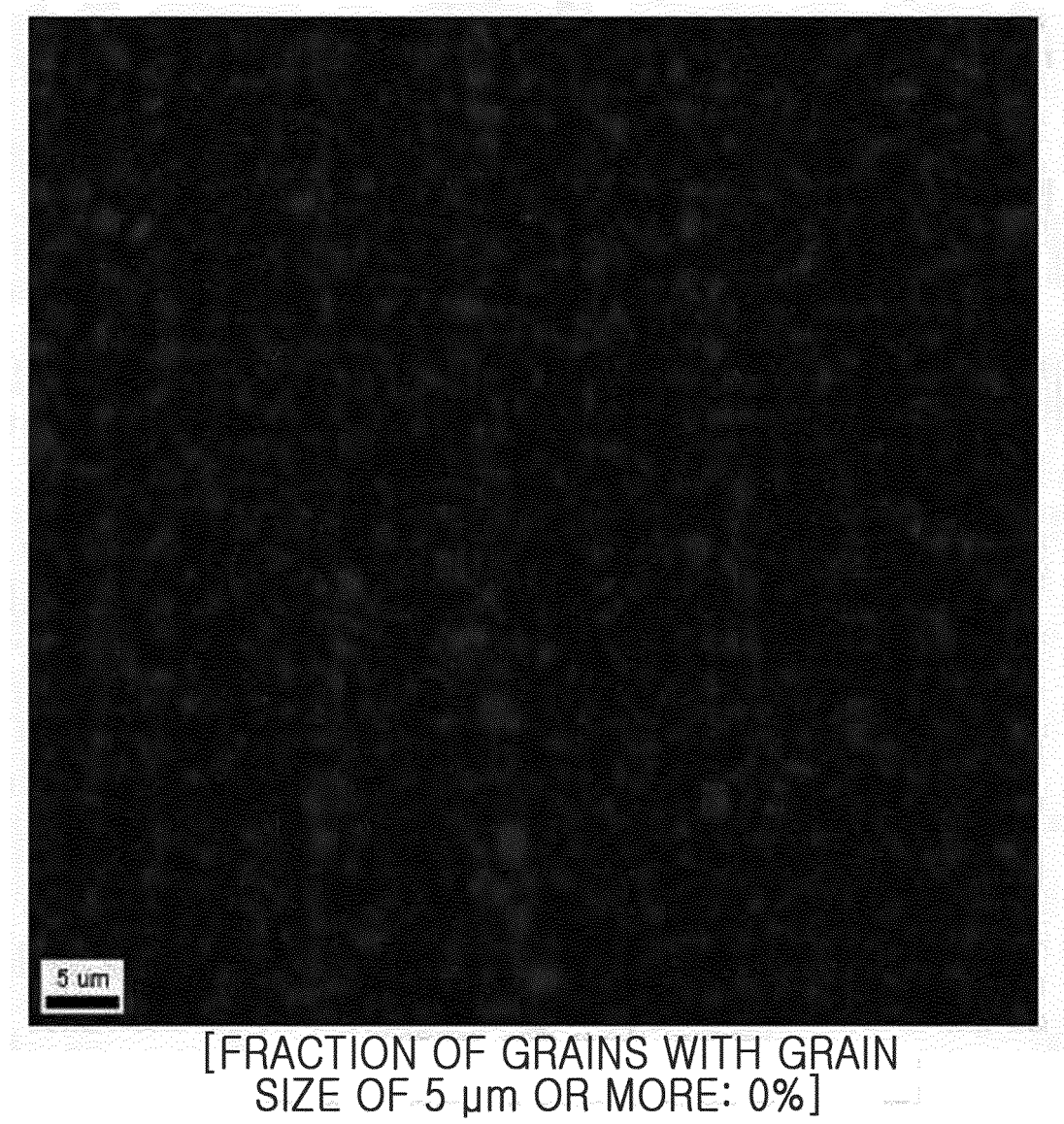
preparing a slab by casting an austenitic stainless steel including, in percent by weight (wt%), 0.005 to 0.03% of C, 0.1 to 1% of Si, 0.1 to 2% of Mn, 0.01 to 0.4 of Cu, 0.01 to 0.2 of Mo, 6 to 9% of Ni, 16 to 19% of Cr, 0.01 to 0.2% of N, and the balance of Fe and inevitable impurities,
wherein an austenitic stability parameter (ASP) value calculated by $551-462(C+N)-9.2Si-8.1Mn-13.7Cr-29(Ni+Cu)-18.5Mo$ is from 30 to 60, a $[100*N]/[Ni+Cu]$ value is 1.4 or more, an average grain size is less than 5 μm , and a fraction (%) of grains with a grain size of 5 μm or more is less than 10%;
hot rolling, annealing, and acid pickling the slab, and cold-rolling a resultant steel sheet with a cold rolling reduction ratio of 60% or more; and
annealing the steel sheet in a temperature range of 800 to 850°C.

6. The method according to claim 5, wherein the austenitic stainless steel has a tensile strength of 850 MPa or more.

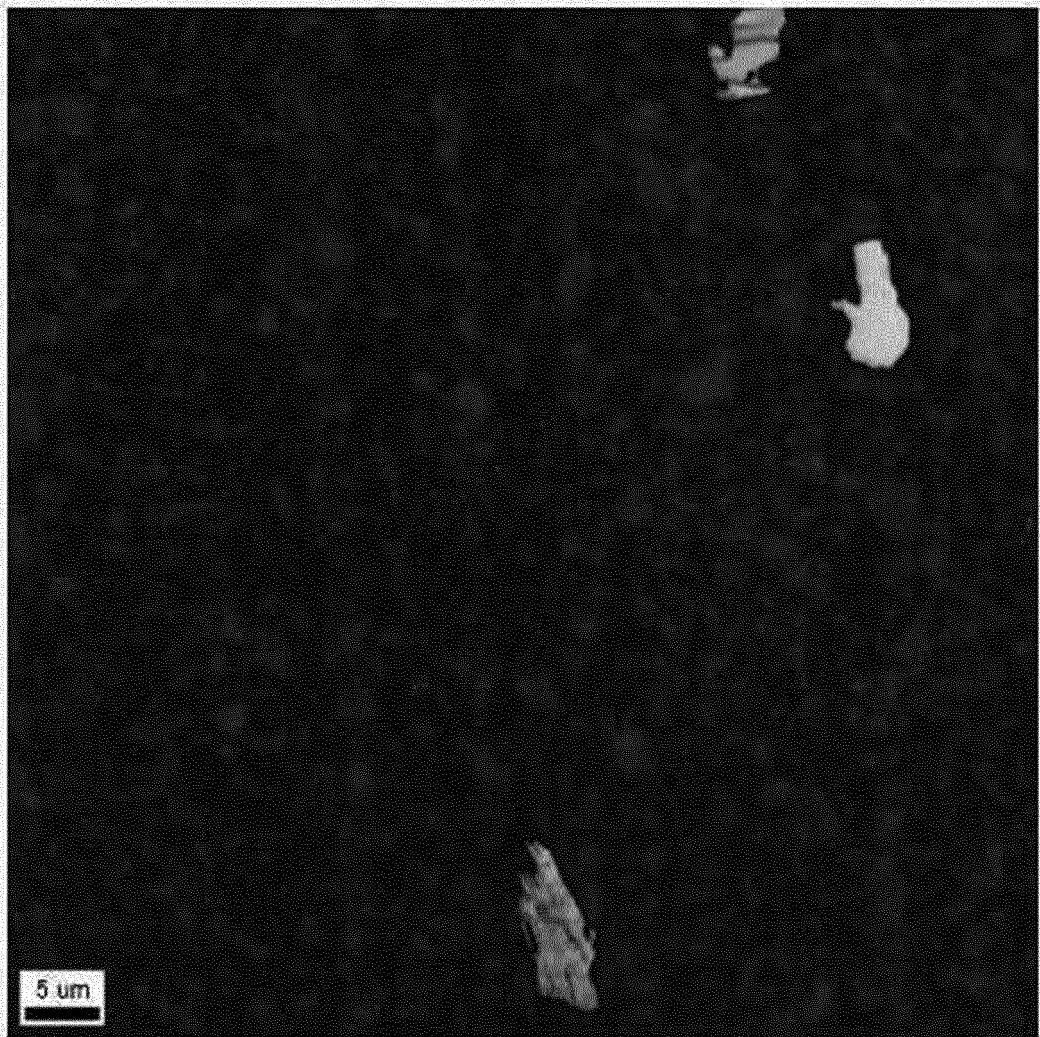
7. The method according to claim 5, wherein the austenitic stainless steel has a yield strength of 500 MPa or more.

8. The method according to claim 5, wherein the austenitic stainless steel has an elongation of 25% or more.

[FIG. 1]

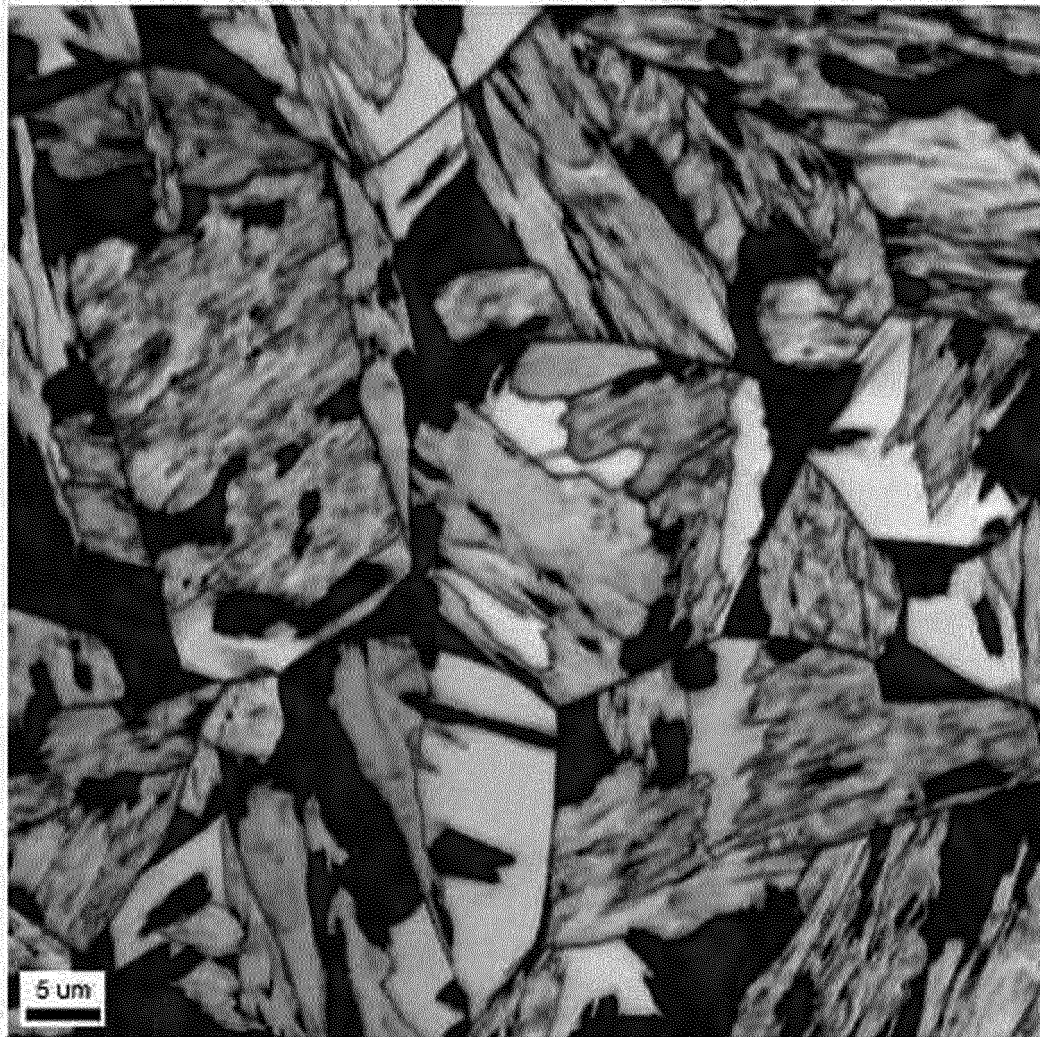


[FIG. 2]



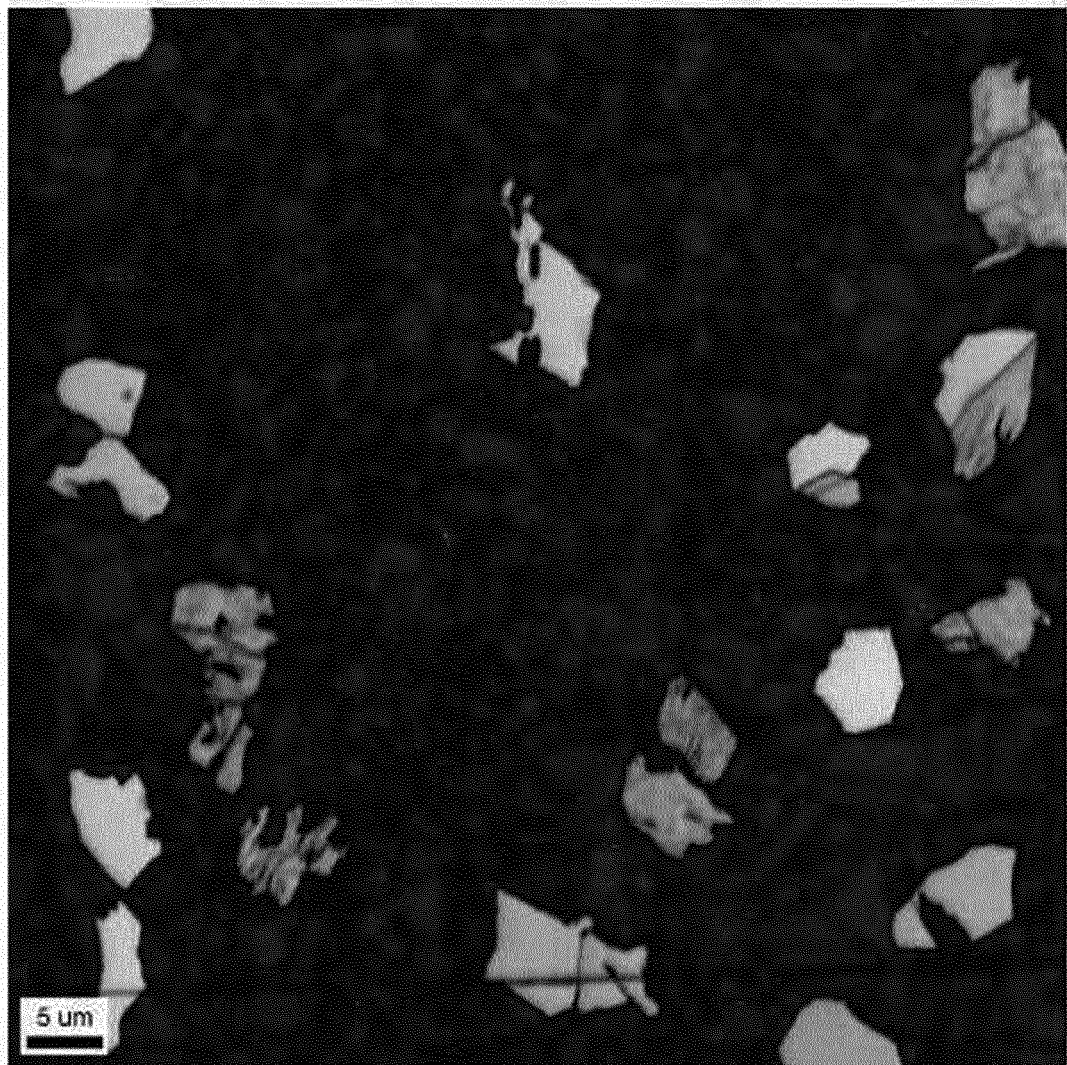
[FRACTION OF GRAINS WITH GRAIN
SIZE OF 5 μm OR MORE: 7%]

[FIG. 3]



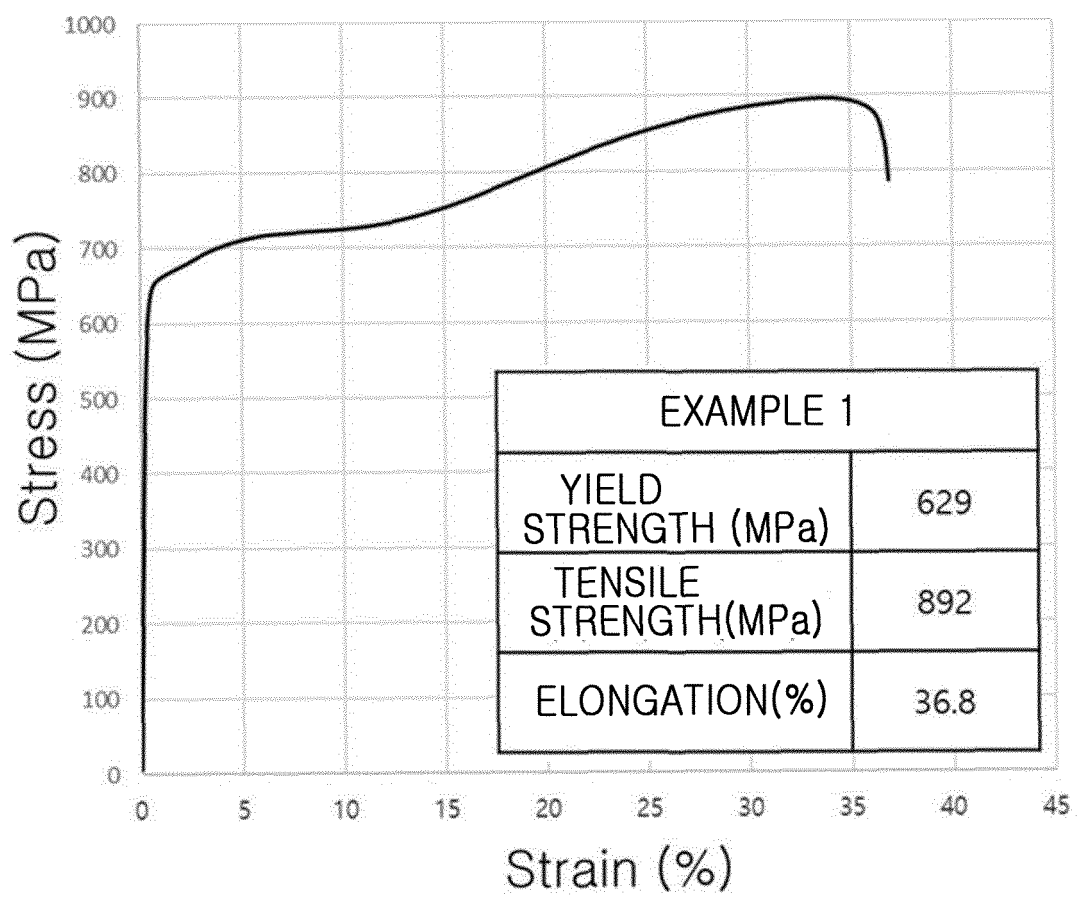
[FRACTION OF GRAINS WITH GRAIN
SIZE OF 5 μm OR MORE: 85%]

[FIG. 4]

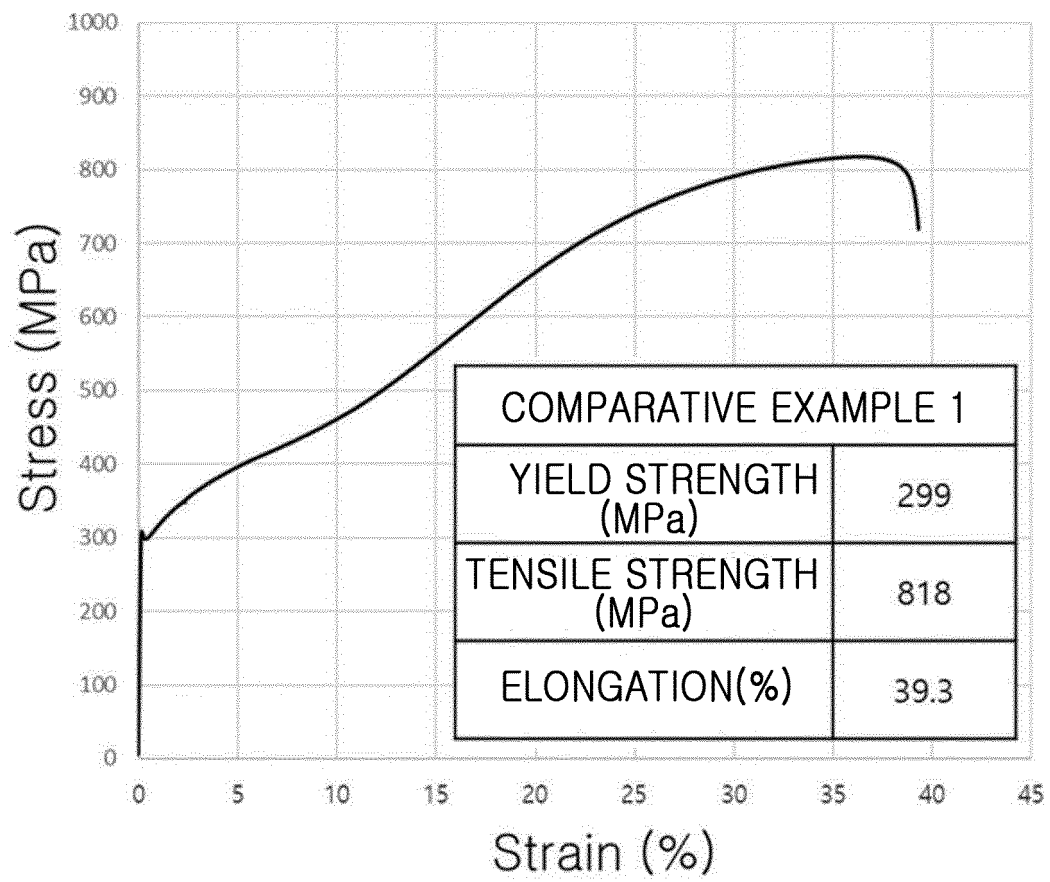


[FRACTION OF GRAINS WITH GRAIN
SIZE OF 5 μm OR MORE: 14%]

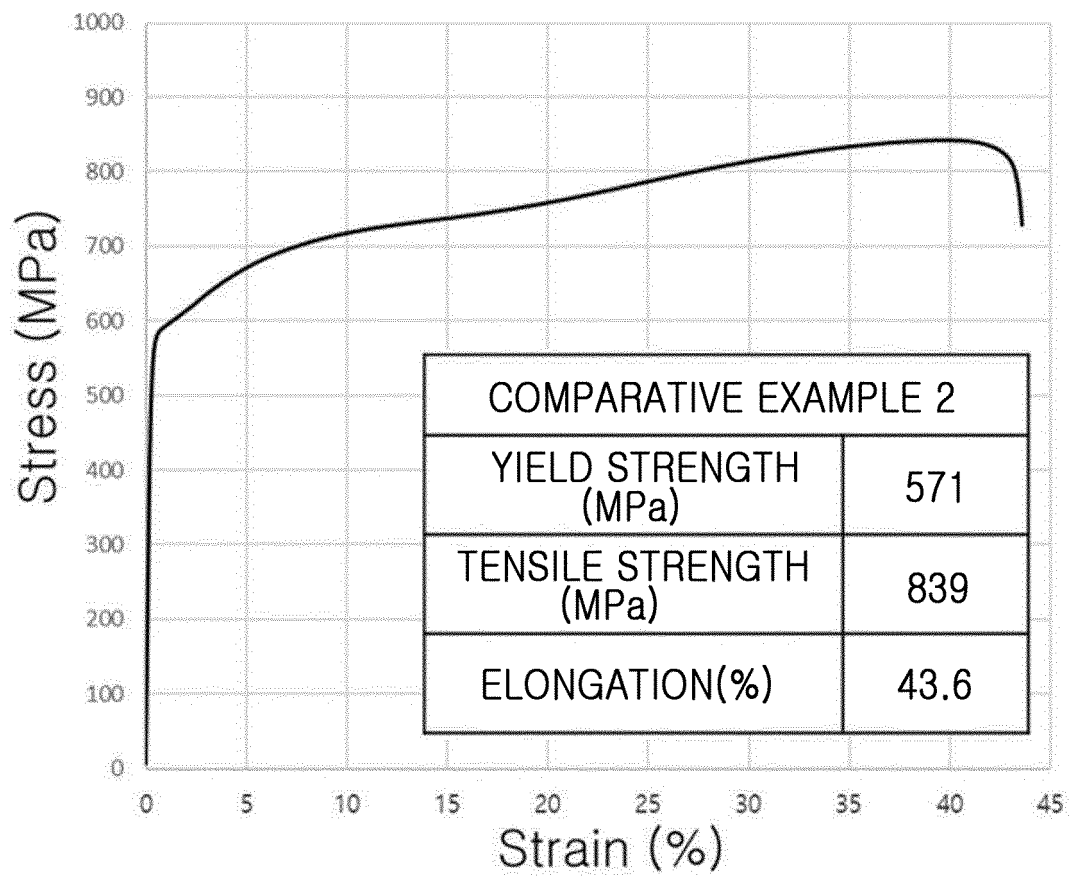
[FIG. 5]



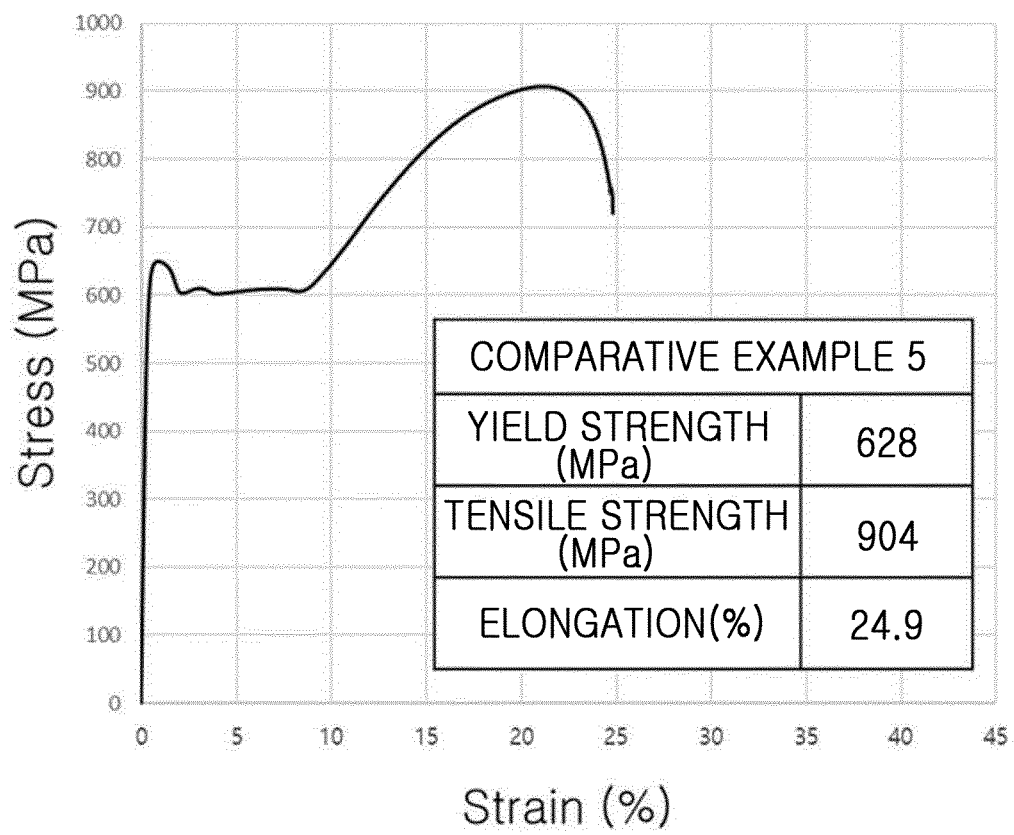
[FIG. 6]



[FIG. 7]



[FIG. 8]



INTERNATIONAL SEARCH REPORT

International application No.

PCT/KR2022/008906

A. CLASSIFICATION OF SUBJECT MATTER

C22C 38/58(2006.01)i; C22C 38/44(2006.01)i; C22C 38/00(2006.01)i; C21D 8/02(2006.01)i; C23G 1/02(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 38/58(2006.01); C21D 8/02(2006.01); C21D 9/46(2006.01); C22C 38/00(2006.01); C22C 38/40(2006.01);
C22C 38/42(2006.01); C22C 38/44(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), 소둔(annealing), 압하율(reduction rate), 인장강도(tensile strength), 항복강도(yield strength), 연신율(elongation)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	KR 10-2021-0052502 A (NIPPON STEEL CORPORATION) 10 May 2021 (2021-05-10) See paragraphs [0058]-[0062], [0081], [0099], [0119]-[0125], [0137]-[0144], [0152] and [0153]; and table 1.	1-8
A	KR 10-2017-0056007 A (NIPPON STEEL & SUMITOMO METAL CORPORATION) 22 May 2017 (2017-05-22) See entire document.	1-8
A	JP 2003-193202 A (NISSHIN STEEL CO., LTD.) 09 July 2003 (2003-07-09) See entire document.	1-8
A	KR 10-2020-0075656 A (POSCO) 26 June 2020 (2020-06-26) See entire document.	1-8
A	KR 10-2021-0078228 A (POSCO) 28 June 2021 (2021-06-28) See entire document.	1-8

☒ Further documents are listed in the continuation of Box C.☒ See patent family annex.

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"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

04 October 2022

Date of mailing of the international search report

04 October 2022

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/KR2022/008906

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
PX	KR 10-2022-0030722 A (POSCO) 11 March 2022 (2022-03-11) See paragraphs [0075], [0076], [0083] and [0102]; and table 1.	1-8

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.

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REFERENCES CITED IN THE DESCRIPTION

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