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(54) NON-MAGNETIC AUSTENITIC STAINLESS STEEL HAVING IMPROVED STRENGTH AND SURFACE CONDUCTIVITY

(57) Disclosed is a non-magnetic austenitic stainless steel with improved strength and surface conductivity. An austenitic stainless steel according to an embodiment of the present disclosure includes, in percent (%) by weight of the entire composition, C: 0.07 to 0.2%, N: 0.15 to 0.4%, Si: 0.8 to 2%, Mn: 16 to 22%, S: 0.01% or less (excluding 0), Cr: 12.5 to 20%, Cu: 1 to 3%, the remainder of iron (Fe) and other inevitable impurities, and satisfies the following equation (1).

$$(1)\ Ni + 0.65Cr + 1.05Mn + 0.35Si + 12.6C + 33.6N \geq 40 \quad (1)$$

Ni, Cr, Mn, Si, C, N are % by weight of each element.

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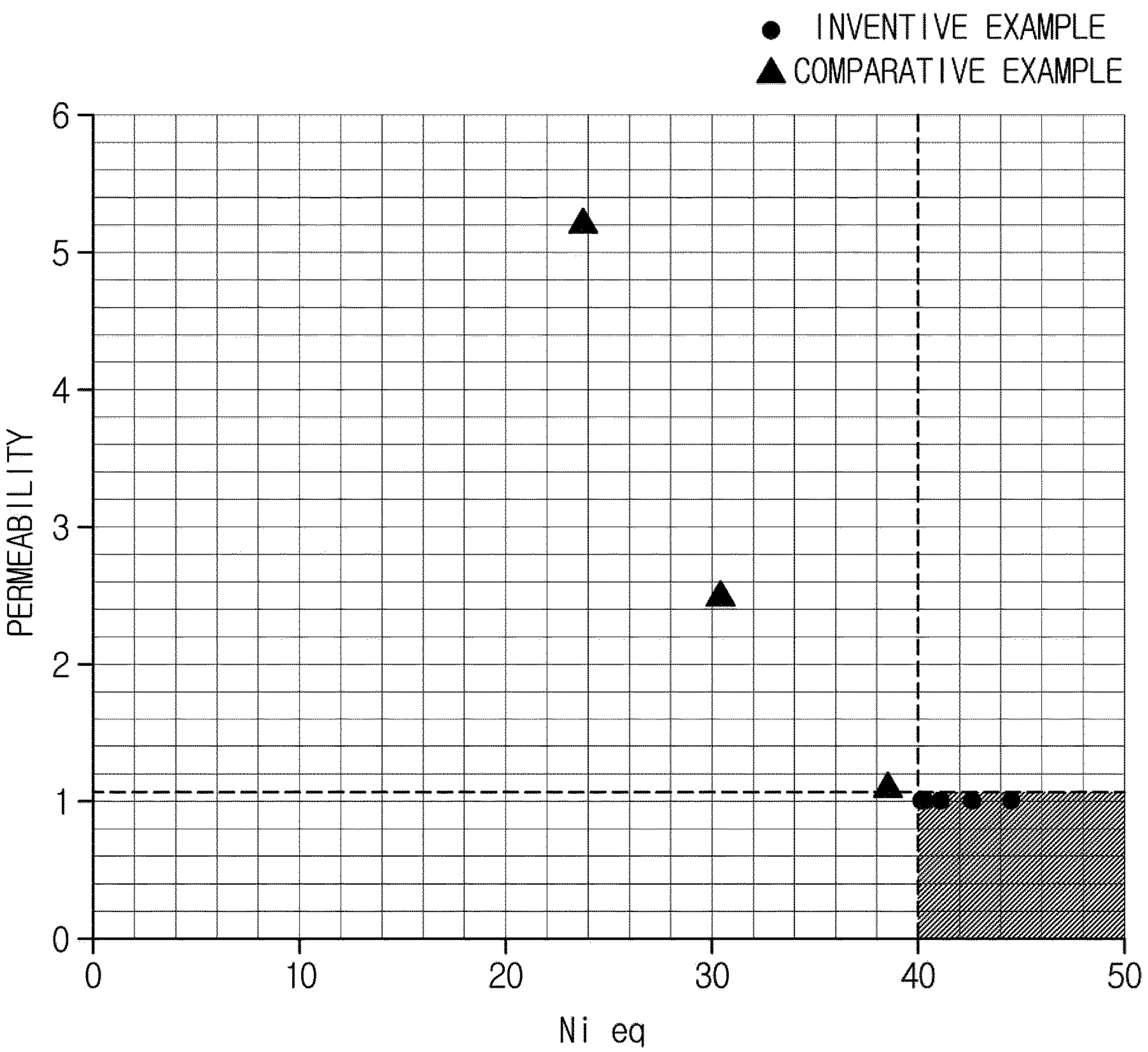
【FIGURE 1】


INVENTIVE EXAMPLE
COMPARATIVE EXAMPLE
PERMEABILITY
0
1
2
3
4
5
6
0
10
20
30
40
50
Ni eq

Description

[Technical Field]

[0001] The present disclosure relates to a non-magnetic austenitic stainless steel, and more particularly, to a non-magnetic austenitic stainless steel with improved strength and surface conductivity applicable to environments requiring strength and surface conductivity along with non-magnetic properties.

[Background Art]

[0002] Recently, according to industrial development in various fields, materials for electronic parts require austenitic stainless steel having excellent surface conductivity in addition to high strength and non-magnetic characteristics or high strength and non-magnetic characteristics. In general, a material for electronic parts contains a large amount of expensive Ni, which has a problem of increasing the raw material cost.

[0003] Austenitic stainless steel, represented by STS304, has good corrosion resistance, and exhibits a non-magnetic austenite structure in annealing heat treatment, and is used as a non-magnetic steel in various devices. However, there are cases where working is performed depending on the application, and when deep drawing and press working are applied to STS304 steel, due to the phase transformation to strain induced martensite structure, it is difficult to maintain non-magnetic properties, and there is a problem that delayed cracks occur.

[0004] Therefore, in order to compensate for this, it is necessary to develop a new steel type capable of securing strength and surface conductivity equal to or higher than that of a general austenitic stainless steel while lowering the Ni content.

[Disclosure]

[Technical Problem]

[0005] The embodiments of the present disclosure solve the above problems and provide non-magnetic austenitic stainless steel with improved strength and surface conductivity by controlling the content element without adding Ni to suppress strain induced martensite, and controlling δ-ferrite content during solidification.

[Technical Solution]

[0006] In accordance with an aspect of the present disclosure, an austenitic stainless steel includes, in percent (%) by weight of the entire composition, C: 0.07 to 0.2%, N: 0.15 to 0.4%, Si: 0.8 to 2%, Mn: 16 to 22%, S: 0.01% or less (excluding 0), Cr: 12.5 to 20%, Cu: 1 to 3%, the remainder of iron (Fe) and other inevitable impurities, and satisfies the following equation (1).

$$(1)\ \mathrm{Ni} + 0.65\mathrm{Cr} + 1.05\mathrm{Mn} + 0.35\mathrm{Si} + 12.6\mathrm{C} + 33.6\mathrm{N} \geq 40$$

Ni, Cr, Mn, Si, C, N are % by weight of each element.

[0007] The yield strength represented by the following equation (2) may be 450 MPa or more.

$$(2)\ \text{yield strength(MPa)} = 185 + 1977\mathrm{C} + 605\mathrm{N} + 3.65\mathrm{Cu} - 3.63\mathrm{Mn}$$

C, N, Cu, Mn are % by weight of each element.

[0008] The ferrite content measured after 70% cold working may be less than 0.1%.

[0009] The permeability may be 1.005 or less even at 70% cold working

The stacking fault energy (SFE) represented by the following equation (3) may be 41 mJ/m^2 or more.

$$(3)\ \mathrm{SFE}\ (\mathrm{mJ/m^2}) = 25.7+1.59(\mathrm{Ni}+\mathrm{Cu})-0.85\mathrm{Cr}+0.001\mathrm{Cr}^2+38.2\mathrm{N}^{0.5}-2.8\mathrm{Si}-1.34\mathrm{Mn}+0.06\mathrm{Mn}^2$$

Ni, Cu, Cr, N, Si, Mn are % by weight of each element.

[0010] The cold rolled material hardness (Hv) value may be 215 or more.

[0011] The Cu + Mn content in the region within 2nm of the passivation film may be 0.2% or more.

[0012] The surface resistance may be less than 10mΩcm^2.

[Advantageous Effects]

[0013] According to the disclosed embodiment, it is possible to provide a non-magnetic austenitic stainless steel with improved strength and surface conductivity by controlling the contained element without adding Ni to suppress strain induced martensite and controlling δ-ferrite content during solidification.

[0014] In addition, the non-magnetic austenitic stainless steel with improved strength and surface conductivity according to the disclosed embodiments can be used in various applications for non-magnetic components used in various devices.

[0015] In addition, according to the disclosed embodiment, an additional process of heat-treating the material for a long time in order to remove magnetism by δ-ferrite is unnecessary, and thus it is possible to provide a non-magnetic austenitic stainless steel with a simple manufacturing process.

[Description of Drawings]

[0016]

FIG. 1 is a graph showing the correlation between Ni equivalent and permeability.

FIG. 2 is a graph showing the correlation between the Ni equivalent and the yield strength prediction equation.

[Best Mode]

[0017] A non-magnetic austenitic stainless steel with improved strength and surface conductivity according to an embodiment of the present disclosure includes, in percent (%) by weight of the entire composition, C: 0.07 to 0.2%, N: 0.15 to 0.4%, Si: 0.8 to 2%, Mn: 16 to 22%, S: 0.01 % or less (excluding 0), Cr: 12.5 to 20%, Cu: 1 to 3%, the remainder of iron (Fe) and other inevitable impurities, and satisfies the following equation (1).

$$(1)\ Ni + 0.65Cr + 1.05Mn + 0.35Si + 12.6C + 33.6N \geq 40$$

Ni, Cr, Mn, Si, C, N are % by weight of each element.

[Modes of the Invention]

[0018] The following embodiments are provided to transfer the technical concepts of the present disclosure to one of ordinary skill in the art. However, the present disclosure is not limited to these embodiments, and may be embodied in another form. In the drawings, parts that are irrelevant to the descriptions may be not shown in order to clarify the present disclosure, and also, for easy understanding, the sizes of components are more or less exaggeratedly shown.

[0019] Also, when a part "includes" or "comprises" an element, unless there is a particular description contrary thereto, the part may further include other elements, not excluding the other elements.

[0020] An expression used in the singular encompasses the expression of the plural, unless it has a clearly different meaning in the context.

[0021] Hereinafter, it describes a non-magnetic austenitic stainless steel which can secure non-magnetic properties even if it is manufactured in a normal process without requiring an additional process for decomposing δ-ferrite by controlling the content of δ-ferrite present in the microstructure of the steel and has improved strength and surface conductivity compared to commonly used STS304 stainless steel.

[0022] Specifically, the present disclosure provides austenitic stainless steel that exhibits excellent non-magnetic properties only by controlling the alloying element, without the addition of expensive Ni, even without an additional heat treatment process.

[0023] An austenitic stainless steel according to an embodiment of the present disclosure includes, in percent (%) by weight of the entire composition, C: 0.07 to 0.2%, N: 0.15 to 0.4%, Si: 0.8 to 2%, Mn: 16 to 22%, S: 0.01% or less (excluding 0), Cr: 12.5 to 20%, Cu: 1 to 3%, the remainder of iron (Fe) and other inevitable impurities, and satisfies the following equation (1).

$$(1)\ Ni + 0.65Cr + 1.05Mn + 0.35Si + 12.6C + 33.6N \geq 40$$

[0024] Hereinafter, the reason for the numerical limitation of the content of the alloy component in the embodiment of the present disclosure will be described. In the following, unless otherwise specified, the unit is% by weight.

[0025] The content of C is 0.07 to 0.2%.

[0026] Carbon (C) is a strong austenite phase stabilizing element, and it is desirable to add 0.07% or more to increase the material strength by solid solution strengthening. However, when the content is excessive, it can be easily combined with a carbide-forming element such as Cr effective for corrosion resistance to lower the Cr content around the grain boundaries to lower the corrosion resistance, and the upper limit can be limited to 0.2%.

[0027] The content of N is 0.15 to 0.4%.

[0028] Nitrogen (N) is a strong austenite phase stabilizing element and is an essential element in steels that do not contain Ni. It is desirable to add 0.15% or more in the present disclosure. However, if the content is excessive, surface defects due to nitride precipitation and nitrogen pores may be generated, and the upper limit may be limited to 0.4%.

[0029] The content of Si is 0.8 to 2%.

[0030] Silicon (Si) is an element useful for deoxidation, and when Ni is not added, it has an effect of improving corrosion resistance, so it is preferable to add 0.8% or more. However, if the content is excessive, the mechanical properties related to impact toughness are reduced, and the upper limit can be limited to 2%.

[0031] The content of Mn is 16 to 22%.

[0032] Manganese (Mn) is a core element that is essential for stabilization of the austenite phase when Ni is not added, and it is preferable to add 16% or more. However, if the content is excessive, surface defects may occur, and the upper limit may be limited to 22%.

[0033] The content of S is 0.01% or less.

[0034] Sulfur (S) forms MnS, and this MnS becomes a starting point of corrosion and reduces corrosion resistance, so it is preferable to limit it to 0.01% or less.

[0035] The content of Cr is 12.5 to 20%.

[0036] Chromium (Cr) is the most contained element of the corrosion resistance improving element of stainless steel, and it is preferable to add 12.5% or more to express corrosion resistance. However, Cr is a ferrite stabilizing element. As the Cr content increases, the ferrite fraction increases to inhibit austenite stabilization. The upper limit can be limited to 20%.

[0037] The content of Cu is 1 to 3%.

[0038] Copper (Cu) is an essential element in the present disclosure, such as Mn, which increases the austenite phase stability and improves corrosion resistance. In addition, copper (Cu) is added together with Mn to be dissolved in the passivation film to increase the surface conductivity, so it is preferable to add 1% or more. However, if the content is excessive, the moldability is rather deteriorated, and the upper limit can be limited to 3%.

[0039] Nickel (Ni) is treated as an impurity in the present disclosure because its elution and formability are deteriorated when added in small amounts.

[0040] The remaining component of the present disclosure is iron (Fe). However, in the normal manufacturing process, impurities that are not intended from the raw material or the surrounding environment can be inevitably mixed, and therefore cannot be excluded. Since these impurities are known to anyone skilled in the ordinary manufacturing process, they are not specifically mentioned in this specification.

[0041] In general, austenitic stainless steel, which is used for electronic parts, requires processes such as plate forming and deep drawing. In the molded finished product, a deformed structure having a deformation amount of about 50% or more is formed, and non-magnetic properties must be maintained even in these deformed portions. For materials for electronic parts that use non-magnetic properties of steel, the permeability μ of the steel applied to the parts should be 1.005 or less for normal operation. To satisfy this, it is necessary to control the content of δ-ferrite formed during solidification of the steel.

[0042] In general, δ-ferrite present in the microstructure of austenitic stainless steel becomes magnetic due to the characteristics of the structure having a body-centered cubic structure, and austenite does not become magnetic due to the face-centered cubic structure. Therefore, it is possible to obtain a magnetic property of a desired size by controlling the fraction of δ-ferrite, and in the case of non-magnetic steel, it is necessary to make the fraction of δ-ferrite as low as possible or eliminate the fraction of δ-ferrite.

[0043] In particular, the fraction of δ-ferrite can be reduced by adding an austenite stabilizing element. In general, formation of δ-ferrite can be suppressed by controlling Ni content useful for stabilizing austenite without deteriorating other physical properties.

[0044] However, since Ni is a very expensive element, its range of use may be limited. Therefore, present disclosure attempted to secure the non-magnetic properties of austenitic stainless steel by controlling the content of Mn, Si, C, N without adding Ni. The non-magnetic property can be expressed as a Ni equivalent (Nieq) value indicating austenite stability.

[0045] Ni equivalent refers to the minimum Ni content that does not form δ-ferrite in a given compositional component, and can be expressed as follows.

$$Nieq = Ni + 0.65Cr + 1.05Mn + 0.35Si + 12.6C + 33.6N$$

[0046] Here, Ni, Cr, Mn, Si, C, and N are weight% of each element.

[0047] The inventors of the present disclosure discovered that when the Ni equivalent value is 40 or more, the ferrite content measured after 70% cold working by simulating the actual severe molding part should satisfy 0.1% or less, so that the permeability is 1.005 or less, so that non-magnetic properties can be satisfied..

[0048] FIG.1 is a graph showing the correlation of permeability according to Nieq. Referring to FIG. 1, it can be seen that permeability satisfies 1.005 or less after 70% cold deformation of austenite stainless steel when the Ni equivalent is 40 or more.

[0049] According to an embodiment of the present disclosure, the cold-rolled annealing plate of austenitic stainless steel may satisfy a yield strength of 450 Mpa or more and a hardness (Hv) value of 215 or more, expressed by the following equation (2).

$$(2)\ \text{yield strength(Mpa) prediction equation} = 185 + 1977C + 605N + 3.65Cu - 3.63Mn$$

[0050] Here, C, N, Cu, Mn are weight% of each element.

[0051] For materials for electronic parts, it is necessary to secure strength for various processing environments. In the present disclosure, without adding Ni, the contents of C, N, and Cu, which are effective for increasing yield strength, were controlled to realize high strength of austenitic stainless steel.

[0052] The inventors of the present disclosure have found that the yield strength prediction equation including C, N and Cu content, represented by equation (2), reflects the strength of the steel well, and have found that when the range of equation (2) is 450 or more, the desired strength can be secured.

[0053] FIG. 2 is a graph showing the correlation of yield strength (MPa) according to Nieq.

[0054] Referring to FIG. 2, it can be seen that when the Ni equivalent value is 40 or more, the yield strength of the cold rolled annealing plate of austenite stainless steel satisfies 450 Mpa or more.

[0055] According to an embodiment of the present disclosure, austenitic stainless steel may satisfy a stacking fault energy represented by the following equation (3) of 41 mJ/m^2 or more.

$$(3)\ SFE\ (mJ/m^2) = 25.7+1.59(Ni+Cu)-0.85Cr+0.001Cr^2+38.2N^{0.5}-2.8Si-1.34Mn+0.06Mn^2$$

[0056] It is necessary to secure the ductility of austenitic stainless steel considering the ease of processing such as plate forming and deep drawing along with high strength.

[0057] Stacking fault energy (SFE, mJ / m^2) of the austenite phase is known to control the deformation mechanism of the austenite phase. Typically, the stacking fault energy of the austenite phase indicates the degree to which the plastic deformation energy added from the outside contributes to the deformation of the austenite phase in the case of austenitic stainless steel in a single phase.

[0058] In general, the lower the stacking fault energy, the more the strain induced martensite phase that contributes to the work hardening of the steel increases after the formation of the epsilon martensite phase in the austenite phase.

[0059] When the stacking fault energy is moderate, mechanical twins are formed in the austenite phase. In the case of moderate stacking fault energy, a strain induced martensite phase is formed at the intersection of these twins, and the applied plastic deformation energy mechanically causes a phase change, resulting in transformation from the austenite phase to the martensite phase. Therefore, in the case of stainless steel, it is known that a strain induced martensite phase is formed in a fairly wide range, except for the difference between the intermediate phase (epsilon martensite phase or mechanical twin). Therefore, when the stacking fault energy is less than 41 mJ / m^2, a strain induced martensite phase is formed after the epsilon martensite phase is formed in the austenite phase, or a strain induced martensite phase is formed after mechanical twinning is formed in the austenite phase.

[0060] However, when the stacking fault energy is 41 mJ / m^2 or more, it is known that transformation from the austenite phase to the martensite phase does not occur well because the transformation proceeds by dislocation movement without the formation of a mechanical twin or epsilon martensite phase.

[0061] When the stacking fault energy of the austenite phase expressed by equation (3) is 41 mJ/m^2 or more, the inventors of the present disclosure, as a result of investigation using a transmission electron microscope, confirmed that formation of the martensite phase was not observed after plastic deformation.

[0062] According to an embodiment of the present disclosure, austenitic stainless steel may have a Cu + Mn content of 0.2% or more in a region within 2 nm from the surface layer.

[0063] In austenitic stainless steel used for electronic parts, surface conductivity is an important factor. In the present disclosure, it was confirmed that by controlling the content of Cu and Mn, the surface resistance was 10 mΩcm2 or less when Cu + Mn content was 0.2% or more within the region within 2 nm of the thickness of the passivation film. It was found that Cu and Mn were partially substituted and dissolved in the passivation film composed of the Cr oxide layer, thereby increasing the electron mobility and increasing the surface conductivity.

[0064] Hereinafter, it will be described in more detail through a preferred embodiment of the present disclosure.

Example

[0065] As shown in Table 1, stainless steel was produced through 50 kg ingot casting while changing the content of each component of the steel. After heating the ingot at 1250°C for 3 hours, hot rolling was performed to produce a 4 mm thick hot rolled material. The hot rolled material was cold rolled, processed to a final thickness of 2.5 mm, annealed at 1100°C for 30 seconds in the air, and pickled.

[0066] Yield strength (YS, Mpa) was measured through a tensile test on the specimen prepared in this way and compared with the yield strength prediction equation. In addition, hardness (Hv) was measured through a Vickers hardness test.

[Table 1]

	C	N	Si	Mn	S	Cr	Cu	Ni	Ni eq
Inventive steel 1	0.095	0.3	1.16	18	0.0075	14.9	2.04	-	40.268
Inventive steel 2	0.095	0.32	1.01	18.1	0.0066	13.5	1.03	-	40.0825
Inventive steel 3	0.095	0.36	1.05	17.9	0.0068	13.1	1.03	-	40.9705
Inventive steel 4	0.092	0.31	1.19	20	0.0067	17.6	2.08	-	44.4317
Inventive steel 5	0.093	0.36	0.82	18.1	0.0068	15.3	1.49	-	42.5048
Comparative steel 1	0.06	0.04	0.4	1.5	0.007	18.2	0.12	8.1	23.745
Comparative steel 2	0.1	0.1	0.8	17	0.008	18	0.5	4	38.45
Comparative steel 3	0.05	0.1	0.4	10	0.009	15	-	6	30.38

[0067] Inventive steel and comparative steel according to Table 1 were used in the experiment.

[0068] The 2.5 mm cold rolled specimen was cold rolled at a cold reduction ratio of 70% to simulate the non-magnetic and surface resistance properties of a molded article made of an actual electronic parts material, thereby producing a cold rolled sheet having a thickness of 0.75 mm. The ferrite content (%) of the manufactured cold rolled sheet was measured using a ferrite scope device, and permeability was measured using a permeability measurement device (FERROMASTER).

[0069] In addition, Mn + Cu (% by weight) in the passivation film at 2 nm from the surface layer of the cold rolled sheet was analyzed by using a Glow Discharge Spectrometer (GDS) analysis equipment.

[0070] The surface resistance was expressed as a surface resistance value by measuring the resistance with a DC 4 terminal method by placing a gold-plated Cu-plate (area 2cm^2) on the top / bottom of a cold rolled plate and applying a pressure of 10 N/cm^2. The surface resistance measurement criterion was evaluated as being good if the surface resistance was less than 10 mΩcm^2, and insufficient if it was 10mΩcm^2 or more.

[0071] The stacking fault energy (SFE), ferrite content, permeability, and yield strength estimated value and measured values, hardness, and Mn + Cu content and surface resistance evaluation results at 2 nm from the surface layer, of austenite stainless steel in each component are shown in Table 2 below.

[Table 2]

	ferrite content (%)	permeability	YS(Mpa) estimated value	YS(Mpa) measured value	hardness (Hv)	SFE (mJ/m^2)	Mn+Cu at 2 nm from the surface layer (wt%)	surface resistance ($m\Omega cm^2$)
Inventive Example 1	0	1.002	496.421	496	238	42.5	1.2	4.8(good)
Inventive Example 2	0	1.001	504.4715	498	234	43.3	0.8	6(good)
Inventive Example 3	0	1.001	529.3975	529	232	44.4	0.7	5.9(good)
Inventive Example 4	0	1.001	489.426	489	219	45.5	1.1	5(good)
Inventive Example 5	0.08	1.004	526.3965	526	229	44.4	0.5	6.8(good)
Comparative Example 1	50 or more	5.2	293.41	262	160	28.4	0.001	35 (insufficient)
Comparative Example 2	0.26	1.1	368.795	369	196	33.8	0.002	33 (insufficient)
Comparative Example 3	0.26	2.5	286.27	370	180	30.3	0.0001	45 (insufficient)

[0072] FIG. 1 is a graph showing the correlation of permeability according to Nieq.

[0073] Referring to FIG. 1 and Table 2, in the case of inventive examples, the Nieq value represented by equation (1) is greater than or equal to 40 and the permeability is 1.005 or less compared to comparative examples, and thus it can be confirmed that the non-magnetic property is satisfied.

[0074] FIG. 2 is a graph showing the correlation of yield strength (MPa) according to Nieq.

[0075] Referring to FIG. 1 and Table 2, in the case of inventive examples, it can be confirmed that the Nieq value represented by equation (1) is 40 or more, and the yield strength is 450 MPa or more and the hardness is 215 Hv or more, as compared with comparative examples. In addition, referring to Table 2, it can be seen that, in the case of inventive steels, the difference between the prediction equation of yield strength and the measured value of yield strength is minimal, so that equation (2) reflects the strength of austenitic stainless steel well.

[0076] In addition, in the case of Examples, the stacking fault energy (SFE) value was 41 mJ/m^2 or more as compared with Comparative Examples, and it was possible to suppress the formation of the martensite phase after plastic deformation, thereby ensuring ductility, and in the region within 2 nm from the surface layer, the Cu + Mn content is 0.2% or more and concentration of Cu and Mn occurs, so that the surface resistance is measured to be $10m\Omega cm^2$ or less. That is, it can be confirmed that the surface conductivity is improved.

[0077] On the other hand, in Comparative Example 1, Ni is contained 8.1%, but the Mn content was excessively low at 1.5%, and the Nieq value was less than 40. Specifically, referring to Table 1 and Table 2, in the case of Comparative Example 1, the Nieq value was 23.745, which was outside the present disclosure range, and the permeability is 5.2, it shows magnetism, so that high strength of 450 MPa or more and desired surface conductivity could not be secured.

[0078] Referring to Table 1 and Table 2, in the case of Comparative Example 2, C, Si, and Mn content satisfy the range of present disclosure, but the Nieq value is 38.45, which is less than 40. Therefore, permeability was not able to secure the desired non-magnetic property as 1.1, and it was not possible to secure the high strength of 450 MPa or more and the desired surface conductivity.

[0079] Referring to Table 1 and Table 2, even in Comparative Example 3, the Nieq value was 30.38, which is less than 40, and the permeability was 2.5, so that the desired non-magnetic property could not be secured, and high-strength properties of 450 MPa or more could not be secured.

[0080] In addition, in the case of Comparative Example 3, Cu dissolved in the passivation film together with Mn is not added, so that Cu + Mn content in the region within 2 nm from the surface layer is 0.0001%. Accordingly, the surface resistance was measured to be $45m\Omega cm^2$, so that the desired surface conductivity could not be secured.

[0081] The austenitic stainless steel according to an embodiment of the present disclosure controls the content element without adding Ni to suppress strain induced martensite, and controls the δ-ferrite content during solidification, thereby increasing strength and surface conductivity, while ensuring non-magnetic properties.

[0082] 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]

[0083] The non-magnetic austenitic stainless steel with improved surface conductivity according to embodiments of the present disclosure is applicable to materials for electronic parts.

Claims

1. An austenitic stainless steel comprising, in percent (%) by weight of the entire composition, C: 0.07 to 0.2%, N: 0.15 to 0.4%, Si: 0.8 to 2%, Mn: 16 to 22%, S: 0.01% or less (excluding 0), Cr: 12.5 to 20%, Cu: 1 to 3%, the remainder of iron (Fe) and other inevitable impurities, and satisfying the following equation (1).

$$(1)\ Ni + 0.65Cr + 1.05Mn + 0.35Si + 12.6C + 33.6N \geq 40$$

(Ni, Cr, Mn, Si, C, N are % by weight of each element)

2. The austenitic stainless steel of claim 1, wherein a yield strength represented by the following equation (2) is 450 MPa or more.

$$(2)\ \text{yield strength(MPa)} = 185 + 1977C + 605N + 3.65Cu - 3.63Mn$$

(C, N, Cu, Mn are % by weight of each element)

3. The austenitic stainless steel of claim 1, wherein a ferrite content measured after 70% cold working is less than 0.1%.

4. The austenitic stainless steel of claim 1, wherein a permeability is 1.005 or less even at 70% cold working

5. The austenitic stainless steel of claim 1, wherein a stacking fault energy (SFE) represented by the following equation (3) is 41 mJ/m^2 or more.

$$(3)\quad SFE\ (mJ/m^2) = 25.7+1.59(Ni+Cu)-0.85Cr+0.001Cr^2+38.2N^{0.5}-2.8Si-1.34Mn+0.06Mn^2$$

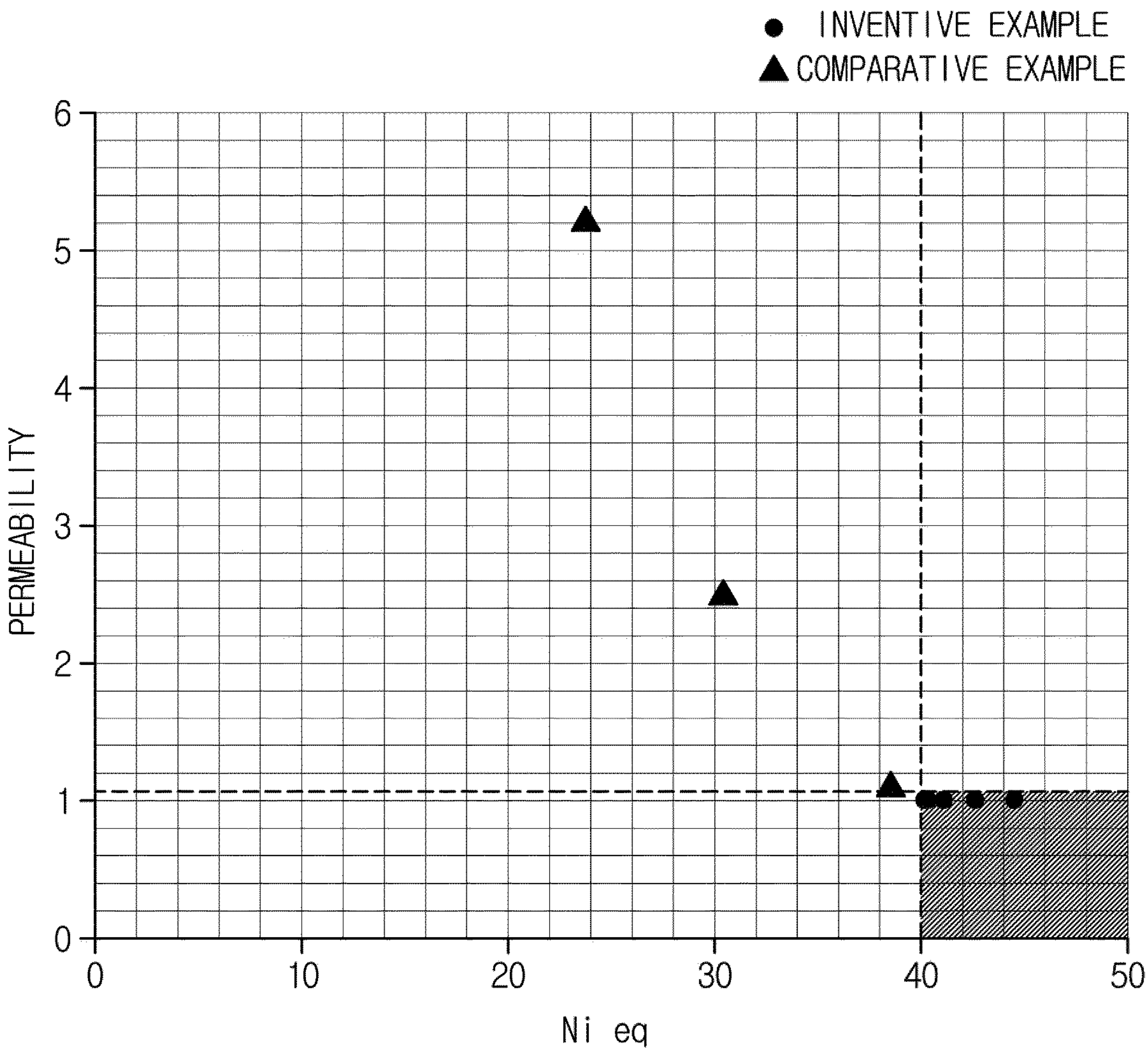
(Ni, Cu, Cr, N, Si, Mn are % by weight of each element)

6. The austenitic stainless steel of claim 1, wherein a cold rolled material hardness (Hv) value is 215 or more.

7. The austenitic stainless steel of claim 1, wherein a Cu + Mn content in the region within 2nm of the passivation film is 0.2% or more.

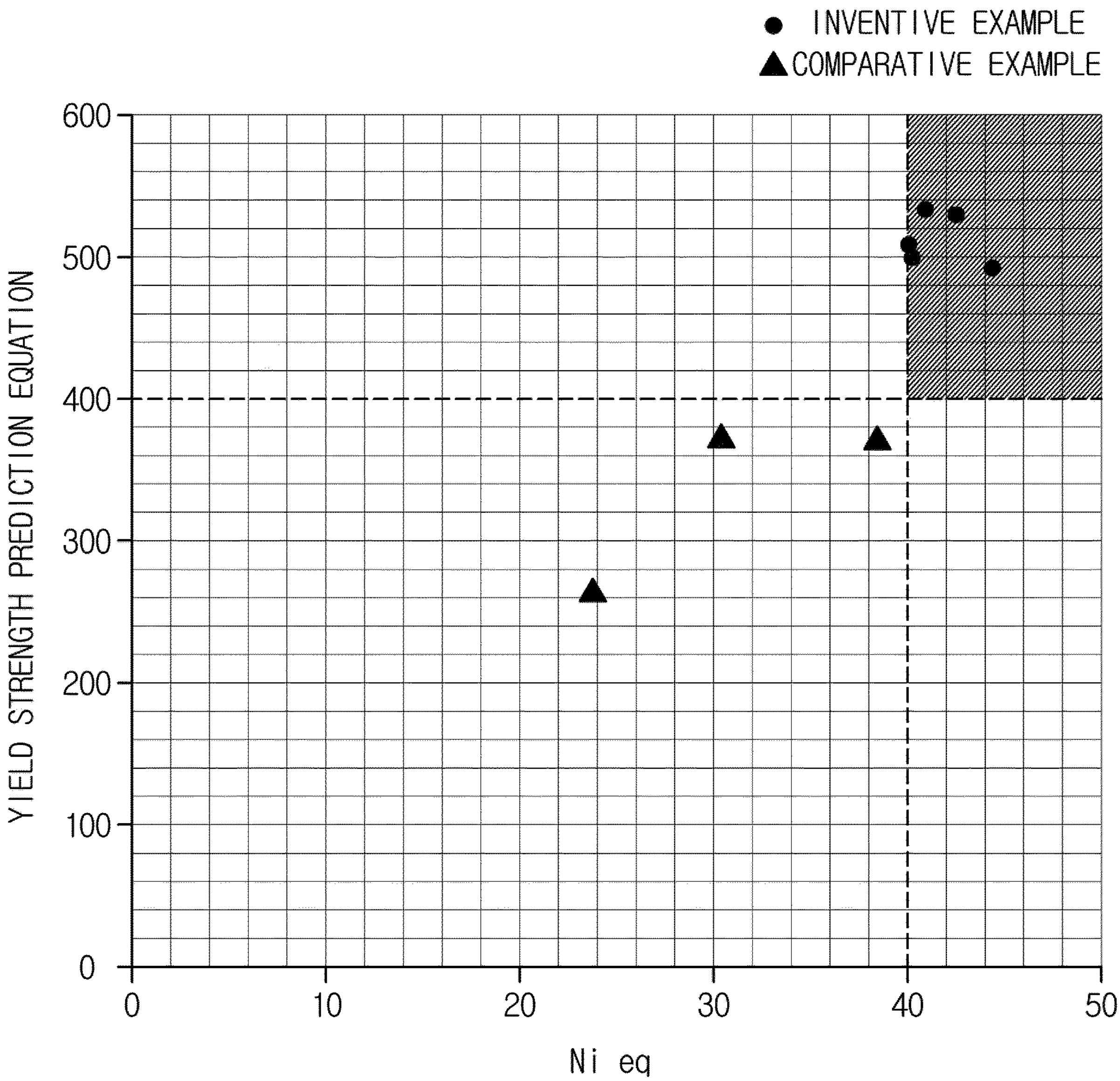
8. The austenitic stainless steel of claim 7, wherein a surface resistance is less than 10mΩcm^2.

【FIGURE 1】



INVENTIVE EXAMPLE
COMPARATIVE EXAMPLE
PERMEABILITY
0
1
2
3
4
5
6
0
10
20
30
40
50
Ni eq

【FIGURE 2】


INVENTIVE EXAMPLE
COMPARATIVE EXAMPLE
600
500
400
300
200
100
0
YIELD STRENGTH PREDICTION EQUATION
0
10
20
30
40
50
Ni eq

INTERNATIONAL SEARCH REPORT

International application No. **PCT/KR2018/011762**

A. CLASSIFICATION OF SUBJECT MATTER

C22C 38/38(2006.01)i, C22C 38/20(2006.01)i, C22C 38/00(2006.01)i, C21D 7/02(2006.01)i

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
C22C 38/38; A44B 1/02; B23P 15/00; C22C 38/00; C22C 38/58; C22C 38/20; C21D 7/02

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: stainless steel, austenite, nonmagnetic, C, N, Si, Mn, S, Cr, Cu, Ni

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	CN 101148740 A (JIANGSU FANGTONG NEW TYPE STAINLESS STEEL PRODUCTS CO., LTD.) 26 March 2008 See page 9 and claim 1.	1-8
X	US 05094812 A (DULMAINE et al.) 10 March 1992 See column 6, lines 63-66 and claim 1.	1-8
X	KR 10-1345048 B1 (NIPPON YAKIN KOGYO CO., LTD.) 26 December 2013 See abstract and claim 1.	1-8
A	JP 09-195007 A (KAWASAKI STEEL CORP.) 29 July 1997 See paragraph [0019] and claims 1-3.	1-8
A	KR 10-2009-0035710 A (ACTECH GMBH.) 10 April 2009 See paragraph [0031] and claims 1, 2.	1-8
A	JP 2017-061741 A (SWATCH GROUP RESEARCH & DEVELOPMENT LTD.) 30 March 2017 See paragraph [0045] and claim 1.	1-8
A	CN 103667947 A (JIANGYIN HENGRUN HEAVY INDUSTRY CO., LTD.) 26 March 2014 See paragraphs [0050], [0058] and claim 1.	1-8

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

* Special categories of cited documents:
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"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"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	Date of mailing of the international search report
29 JANUARY 2019 (29.01.2019)	**30 JANUARY 2019 (30.01.2019)**

Name and mailing address of the ISA/KR	Authorized officer
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Form PCT/ISA/210 (second sheet) (January 2015)

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Information on patent family members

International application No.
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