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(54) MANUFACTURE METHOD OF ORIENTED SILICON STEEL HAVING GOOD MAGNETIC PERFORMANCE

(57) A method for manufacturing a grain-oriented silicon steel having excellent magnetic performance, comprising steps as follows 1) conventionally melting and casting into a steel blank; 2) heating the steel blank and hot rolling the same into a strip of steel; 3)normalizing process; carrying out the normalizing process having two stages, wherein the strip is firstly heated to 1100~1200°C, then cooled to 900~1000 °C within 50-200s; and next, the strip is rapidly cooled in water having a temperature of 10~100; in this period, a tension force is applied to the strip of steel, the strip of steel in the temperature range of 900°C~500°C has a stress of 1~200N/mm^2; 4)cold rolling, i.e. carrying out a primary cold rolling, or a double cold rolling with intermediate annealing; 5)carrying out primary recrystallizing annealing, then coating an annealing separator, whose main composition is MgO, to carry out final product annealing comprising secondary recrystallizing annealing and purifying annealing. The invention optimizes the content and distribution of martensite in the steel plate after normalization by adjusting the tension force applied to the steel plate while normalization transformation, so as to make the content of martensite in the range ensuring a better magnetic performance of the final product and to optimize the magnetic performance of final products.

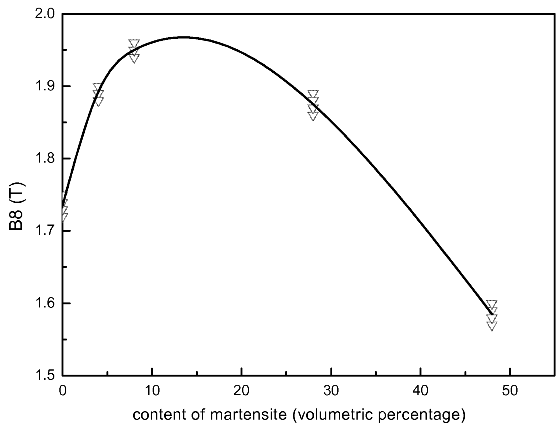

FIG. 1

EP 2 644 715 A1

Description

Field of the Invention

[0001] The present invention relates to a method for manufacturing a grain-oriented silicon steel, especially to a method for manufacturing a grain-oriented silicon steel with excellent magnetic performance.

Description of the Prior Art

[0002] Oriented silicon steel is an indispensable and important soft magnetic alloy in electric, electronic and military industries, which is mainly utilized for the iron core for transformer, as well as the electric generator and large electric machine and like. It is desired that the grain-oriented silicon steel has excellent magnetic performance, especially degradation of iron loss.

[0003] Oriented silicon steel may have excellent magnetic performance in a rolling direction by utilizing a secondary re-crystallizing technology, making Goss texture (Goss texture: {110} means that crystal face is parallel to rolling plane, <001> means that crystal direction is parallel to rolling direction) to undergo an abnormal grain growth so as to merge grains in other orientations.

[0004] A traditional method for manufacturing a grain- oriented silicon steel having high magnetic induction is as follows. A steel blank is heated to a temperature of 1350 °C to 1400 °C in a special high temperature heating furnace, then the temperature is maintained for more than 1h, so as to facilitate the sufficient solid solution of impurities of AlN, MnS or MnSe, and then the steel blank is rolled, the roll- finishing temperature is over 950 °C , the hot- rolled steel strip is coiled after being rapidly splashed and cooled with water.In the following normalizing process, fine and diffusive second phase particles (namely, a grain growth inhibitor) are separated out from the body of the steel, pickling is carried out to the hot- rolled steel after normalization to remove a ferric oxide skin from its surface. After being further cold rolled to a thickness of a final product, the steel sheet is subjected to decarburizing and annealing process to reduce [C] content in steel sheet to the extent that will not affect the magnetic property of the final product (≤30ppm), and then an annealing separator, whose main composition is MgO, is coated on the steel sheet to carry out high temperature annealing, and the steel sheet is subjected to a secondary recrystallization to form an under coating of Mg_2SiO_4 as well as purify the steel, and finally, the steel sheet is coated with an insulation coating, stretched and annealed, and thus the product of the grain- oriented silicon steel with high performance that has high magnetic induction, low iron loss and good insulation is obtained.

[0005] The following problems come with the above manufacturing method.

1. heating temperature is high, and burning loss of the steel blank is great;
2. the heating furnace shall be repaired frequently, and the production efficiency would be low;
3. hot rolling temperature is high, and flange creak of hot rolling is large.

[0006] In order to solve these problems, some foreign companies grope and develop some methods for manufacturing grain-oriented silicon steels at a relatively low temperature for heating the steel blanks, for example:

1.a method for manufacturing grain-oriented silicon steel at an intermediate temperature

[0007] Some steel mills, such as Russian Novolipetsk Iron & Steel Corporation (NLMK), and VIZ etc., utilize an intermediate temperature oriented silicon steel manufacturing technology, the steel-blank-heating temperature is 1200 - 1300 °C, chemical composition contains a relatively high content of Cu (0.4% - 0.7%), while AlN and CuS are used as inhibitors. This method can avoid several problems due to heat steel blank in high temperature, the disadvantage is that only general oriented silicon steels can be manufactured.

2. A method of heating steel blank and nitriding at low temperature

[0008] When cold rolled sheets pass a decarburizing and annealing furnace, NH_3 is induced to nitride the interior of the steel sheets to form an acquired obtained type inhibitor. By utilizing this method, the steel-blank-heating temperature can be reduced to be lower than 1250 °C, and the method can be utilize to produce not only general oriented silicon steel but also oriented silicon steel with high magnetic.

3. A method of manufacturing grain-oriented silicon steels without inhibitors

[0009] When in smelting, materials are controlled to be highly purified, the contents of Se, S, N, O are controlled to be lower than 30ppm to eliminate any influence due to segregation of Se, S, N, O etc.. Thus, the grain-oriented silicon steel can be manufactured by utilizing difference between travel speeds of high energy grain boundary and other grain boundaries.

[0010] M. Barisoni et al. propose that steel sheet is cooled to 800 ~ 850 °C at a speed of 20 °C/s after being normalized, then the steel sheet is quenched at a cooling speed of 100 °C/s, so as to form dispersed martensite phase whose volumetric percentage is about 8%, and hardness $H_v \geq 600$ (the hardness of steel plate matrix $H_v \geq 230$), as well as to segregate out a great amount of AlN of about 10nm.Martensite is formed to make stored energy increased, and accordingly the stored energy after cold rolling is increased, while the stored energy will make {110} grain to recrystallize and grow more easily in decarburizing and annealing process, and {110} composition after subjected to decarburizing and annealing is strengthened, and thus the magnetic performance of the final product is improved.

[0011] Martensite phase transition can be induced by rapidly cooling (quenching), which is named as thermally induced martensite phase transition. Also, Martensite phase transition can be induced due to stress or strain, which is named as stress or strain induced martensite phase transition. In view of free energy of phase transition, work by which stress induces the martensite phase transition is identical to the free energy variation by which the phase transition is driven. Therefore, the driving force of martensite phase transition is composed of two parts, i.e., a chemical driving force and a mechanical driving force.

[0012] In a status of stress, the temperature of martensite phase transition decreases. When at or below Curie temperature (770 °C), the grain-oriented silicon steel presents spontaneous ferromagnetic elongation, which can partly counteract automatic contraction in volume when cooling, so as to increase the decrease of the temperature of martensite phase transition.

[0013] Martensite phase transition goes through two phases of nucleation and growth.

[0014] As can be seen in accordance with the solid state phase transition theory, by importing deformation stored energy, nucleation rate of martensite is greatly increased, whose extent may reach tens of order of magnitude to hundreds of order of magnitude.stored energy does not greatly influence the growing speed of crystal nucleus of martensite.

[0015] In US Patent No.3959033, an amount of martensite is controlled by controlling normalizing process after hot rolling, especially by controlling the cooling speed from 700 ~ 900 °C to the room temperature in the normalizing process, and finally, the magnetic performance of the final product is improved.The disadvantage of this patent is that it is difficult to achieve consistency in cooling speed in a direction of plate thickness, which results in inhomogeneous of distribution of martensite in a direction of plate thickness; because there exists this inhomogeneous, it is difficult to achieve an effective control to the amount of martensite. Further, in this patent, water is utilized to control a cooling speed from 700 ~ 900 °C to the room temperature, firstly the control is likely to be limited by site conditions, for example air temperature, damage or obstruction of nozzle , which may render cooling speed unstable; and secondly, the temperature of steel sheets cannot be accurately measured due to artificial factors, it is difficult to achieve an accurate control, and accordingly it is difficult to achieve a fine tuning of cooling speed.

Summary of the Invention

[0016] The object of the present invention is to provide a method for manufacturing a grain-oriented silicon steel with excellent magnetic performance, in which the content of martensite in steel plate and distribution thereof after normalizing can be optimized by adjusting the stress in the steel sheet in normalizing phase transition, so as to enable the content of martensite is in the range that a better magnetic performance of the final product can be obtained, and an optimization in the magnetic performance of the final product is realized.

[0017] In order to obtain the above-described object, the technical solution of the present invention is that

[0018] A method for manufacturing oriented silicon steels with good magnetic performance, comprising steps as follows:

1) conventionally melting, casting to form a steel blank;
2) heating the steel blank being heated and hot rolling the steel blank to a strip of steel;
3) normalizing process
carrying out the normalizing process having two stages, wherein the strip is firstly heated to 1100~1200°C, then is cooled to 900~1000 °C in 50-200s, next, the strip is rapidly cooled in water having a temperature of 10~100°C, in this period, a tension force is applied to the strip of the steel, the strip of steel in a temperature range of 900 °C~500°C has a stress of 1~200N/mm^2;
4) cold rolling;
carrying out a primary cold rolling, or a double cold rolling with an intermediate annealing;
5) carrying out primary recrystallizing annealing, then coating an annealing separator, whose main composition is MgO to carry out annealing to a final product which annealing comprises secondary recrystallizing annealing and purifying annealing.

[0019] Further, the tension force can be applied to the strip of steel by disposing a tension roller within a normalizing furnace or varying front and rear tension rollers.

[0020] In accordance with the present invention, by adjusting the stress in the steel sheet in the normalizing phase transition, the stress or strain induces the martensite phase to be transited, so as to achieve reasonable and effective control on the amount of the martensite in the steel sheet after normalizing, and finally, the magnetic performance of the final product is improved. In accordance with the present invention, a relatively homogeneous martensite structure can be derived in the direction of the thickness of the steel sheet. Due to utilize a tension control, limit due to the site conditions is fewer, for a sample sheet with same thickness, the desired amount of martensite can be obtained stably, while the tension control is quantified with a little human factor, so that it is more easy to control accurately, and fine tuning can be achieved.

[0021] By controlling the stress in the hot rolled sheet in the normalizing phase transition, the amount of martensite after normalizing is optimized so as to make the content of the martensite in normalized steel sheet in a range that a better magnetic performance of the final product can be obtained, and finally, a better magnetic performance of the final product is obtained.

[0022] The reasons why an appropriate content of martensite will be helpful to improve magnetic performance B_8 of the final product are as follows.

(1) Because there exists the martensite, which makes the stored energy improved, after cold rolling, the stored energy is increased, which facilitates the recrystallization and growth of the (110) grain in decarburizing and annealing process, the content of (110) composition increases, the magnetic performance can be improved.
(2)Because there exists the martensite, after cold rolling as well as decarburizing and annealling, the amount of high angle grain boundary increases, which assists the Goss texture to merge grains in other orientations, which facilitates the secondary recrystallization.
(3) After the martensite is cold rolled as well as decarburized and annealed, γ fiber texture is formed in the material, which facilitates the process of the secondary recrystallization. Because of the above-analyzed relative factors, improvement in degree of grain orientation of the final product can be achieved, the magnetic performance B_8 of the final product is improved.

[0023] If the composition of steel sheets is identical, conditions of manufacturing processes are identical and methods for measuring martensite amount are identical, the amounts of martensite in the sheets are identical. So, the relation between the martensite amount and the magnetic performance of the final product can be calculated in advance in accordance with the amount of martensite in the steel sheet after normalizing and before cold rolling measured by the same measuring method in the sample sheet that is produced in advance, a target range of the amount of martensite in the steel sheet after normalizing and before cold rolling can be calculated.

[0024] As the means for controlling the amount of martensite, there are the following three ways.

(1) The content of martensite is varied by varying the stress in the steel sheet in the phase transition so as to vary the nucleation number of martensite in the phase transition.
(2) The content of martensite is varied by varying a highest temperature of normalizing to vary the amount of austenite at the highest temperature.
(3) The content of martensite is varied by varying a speed of secondary cooling when normalizing. The measured value of the amount of martensite in the steel sheet after normalizing is compared with a target value, according to the difference therebetween, the stress (1 ~ 200N/mm^2) of the steel plate in the normalizing phase transition (in a range of 900 °C to 500 °C) is varied by at least one of adjusting the tension roller disposed within the furnace or varying winding tension, a purpose of optimization of the content and distribution of martensite in the steel sheet after normalizing can be achieved, the amount of martensite is in the range that a better magnetic performance of the final product can be obtained.

[0025] The steps (1), (2), (3) and (4) in the method in accordance with the present invention are all general technical means for manufacturing the grain-oriented silicon steel, and the description thereof will be omitted.

[0026] The advantages of the present invention are as follows:

In accordance with the present invention, a reasonable and effective control on the amount of martensite in the steel sheet after normalizing is realized, which finally improves the magnetic performance of the final product, by adjusting the stress in the steel sheet in normalizing phase transition so that the tension force or strain induces the phase of martensite to transit.

[0027] The present invention can obtain relatively homogeneous martensite texture in the direction of plate thickness, and can perform the fine tuning with respect to the content of martensite as desired.

[0028] The present invention utilizes the tension control with few limits due to the site condition, and with respect to the sample plates having the same thickness, the desired amount of martensite can be obtained stably; the tension control is more quantified, influence of artificial factors is few, it is easy to conduct an accurate control, and the fine tuning can be realized.

Brief Description of Drawings

[0029]

Fig.1 is a view showing relation between the content of martensite (vol %) with magnetic performance B_8 of a final product with respect to a grain-oriented silicon steel, which is normalized, in accordance with the present invention.

Fig.2 is a schematic view showing the distribution of martensite vs. sheet thickness at a transverse section of oriented silicon steel in accordance with the present invention.

Detailed Description of the Invention

[0030] Hereinafter, the present invention will be described in connection with embodiments.

Embodiment 1

[0031] Steel sheets, which contain a variety of compositions, are normalized. The main compositions of steel sheet are as shown in Table 1.

Table 1 (% by weight)

NO.	Si	C	Als	N	Mn	S
1	3.03	0.0456	0.0264	0.0078	0.12	<0.0060
2	3.22	0.0507	0.0261	0.0081	0.12	<0.0060
3	3.41	0.0542	0.0269	0.0083	0.12	<0.0060

[0032] The steel sheet, which comprises the above-described compositions, is heated to 1200°C, which temperature is held preserved for 180 minutes. Then, the steel sheet is directly rolled to 2.0mm. Two-stage normalizing process is carried out to the sheet which is hot rolled. Firstly, the steel sheet is heated to 1200 °C, then cooled to 900 °C within 200s, and next, the steel sheet is rapidly cooled in water having the temperature of 100 °C. Stress (1 ~ 200N/mm^2) in the steel sheet at the normalizing phase transition (in a range of 900 °C to 500 °C) can be varied by at least one of adjusting a tension roller disposed within the furnace or varying front and rear tension rollers, so as to optimize of the content and distribution of martensite in the normalized sheet within a range that a better magnetic performance range can be achieved.

[0033] After being pickled, a single-stage cold rolling is carried out to the steel sheet for 5 rolling passes, wherein the third and fourth passes are at 220 °C, and the steel sheet is pressed to have a thickness of 0.30mm. Decarburization and nitride annealing is carried out to the cold rolled sheet at 850 °C. After nitriding, an annealing separator, whose main composition is MgO, is coated on the surface of the sheet, being heated to 1220°C in an atmosphere of 25% N_2 and 75% H_2, then the atmosphere is changed to pure H_2, and the sheet is preserved in this temperature for 30 hours.

[0034] The content of martensite after normalization, tension force applied to the steel sheet in phase transition and magnetic performance are shown in Table 2.

Table 2

Applied Tension Force and Magnetic Performance of the final Product				
composition		Content of martensite (% by area)	Applied tension force (N/mm^2)	B_8(T)
NO.1	Comparative Example 1	2.9	0	1.87
	Embodiment 1	8.8	30	1.93

(continued)

Applied Tension Force and Magnetic Performance of the final Product				
composition		Content of martensite (% by area)	Applied tension force (N/mm^2)	B_8(T)
NO.2	Comparative Example 2	3.2	0	1.87
	Embodiment 2	10.7	40	1.92
NO.3	Comparative Example 3	25	60	1.86
	Embodiment 3	9.2	20	1.92

Embodiment 2

[0035] The main chemical compositions of the steel sheet are Si 3.05% by weight, C 0.060% by weight, Als 0.0290% by weight, N 0.0077% by weight, Mn 0.13% by weight and S<0.006% by weight.

[0036] The steel sheet, which contains the above-described compositions, is heated to 1200 °C, which temperature is held for 180 minutes.Then, the steel sheet is directly rolled to 2.0mm. Two-stage normalizing process is carried out to the hot rolled sheet, firstly, the steel sheet is heated to 1100 °C , and then cooled to 1000°C in 50s, and next, the steel sheet is rapidly cooled in water having the temperature of 50°C.Stress (1 ~ 200N/mm^2) in steel sheet in the normalizing phase transition (in 900 °C to 500 °C) can be varied by at least one of adjusting a tension roller disposed within furnace or varying a winding tension, so as to optimize the content and distribution of martensite in the normalized sheet within a range that a better magnetic performance range can be achieved.

[0037] After being pickled, a single-stage cold rolling is carried out to the steel sheet for 5 rolling passes, wherein the third and fourth passes are at 220 °C, and the steel sheet is pressed to have a thickness of 0.30mm.Decarburization and nitride annealing is carried out to the cold rolled strip at 850 °C. After nitriding, an annealing separator, whose main composition is MgO, is coated on the surface of the sheet, being heated to 1220°C in an atmosphere of 25% N_2 and 75% H_2, then the atmosphere is changed to pure H_2, and the sheet is preserved in this temperature for 30 hours.

[0038] The content of martensite after normalization, tension force applied to the steel sheet in phase transition and magnetic performance are shown in Table 3.

Table 3

Applied Tension Force and Magnetic Performance of the final Product			
	Content of martensite	Applied tension force (N/mm^2)	B_8(T)
Comparative Example	20	50	1.86
Embodiment	8	15	1.92

Embodiment 3

[0039] The main chemical compositions of the steel sheet are Si 2.9wt%, C 0.048wt%, Als 0.0255wt%, N 0.0073wt%, Mn 0.10wt% and S<0.006wt%.

[0040] The steel sheet, which contains the above-described compositions, is heated to 1200 °C, which temperature is held for 180 minutes. Then, the steel sheet is directly rolled to 2.0mm. Two-stage normalizing process is carried out to the hot rolled sheet, firstly, the steel sheet is heated to 1100 °C , and then cooled to 900 °C in 100s. Next, the steel sheet is quick cooled in water having the temperature of 80 °C. Stress (1 ~ 200N/mm^2) in the steel sheet in the normalizing phase transition (in the range of 900 °C to 500 °C) can be varied by at least one of adjusting a tension roller disposed within furnace or varying a winding tension, so as optimize the content and distribution of martensite in the normalized sheet within a range that a better magnetic performance range can be achieved.

[0041] After the steel sheet is pickled, a single-stage cold rolling is carried out to the sheet for 5 rolling passes, wherein the third and fourth passes are at 220 °C, and the steel sheet is pressed to have a thickness of 0.30mm. Decarburization and nitride annealing is carried out to the cold rolled sheet at 850 °C. After nitriding, an annealing separator, whose main composition is MgO, is coated on the surface of the sheet, being heated to 1220°C in an atmosphere of 25% N_2 and 75% H_2, then the atmosphere is changed to pure H_2, and the sheet is preserved in this temperature for 30 hours.

[0042] The content of martensite after normalization, the tension force applied to the steel sheet in the phase transition and magnetic performance are shown in Table 4.

Table 4

Applied Tension Force and Magnetic Performance of the final Product			
	Content of martensite	Applied tension force (N/mm^2)	B_8(T)
Comparative Example	1.5	0	1.85
Embodiment	9	18	1.93

Embodiment 4

[0043] The main chemical compositions of the steel sheet are Si 3.41% by weight, C 0.0542% by weight, Als 0.0269% by weight, N 0.0083% by weight, Mn 0.12% by weight and S<0.006% by weight.
[0044] The steel sheet, which contains the above-described compositions, is heated to 1200 °C, which temperature is held for 180 minutes. Then, the steel sheet is directly rolled to 2.0mm. Normalizing annealing is carried out by means of the method described below, respectively.
[0045] Firstly, the steel sheet is heated to 1180°C, and then cooled to 920 °C in 200s, and next, the steel sheet is rapidly cooled in water having a temperature of 100 °C.

(1) a tension force of 60N/mm^2 is applied to the steel sheet during the cooling period (Comparative Example);
(2)a tension force of 20N/mm^2 is applied to the steel sheet during a cooling period (900 °C -500 °C), so as to keep the content of normalized martensite in a range that the excellent magnetic performance of the final product can be obtained (Embodiment).

[0046] After the steel sheet pickled, the single-stage cold rolling is carried out to the sheet for 5 rolling passes, wherein the third and fourth passes are at 220 °C, the steel sheet is pressed to have a thickness of 0.30mm. Decarburization and nitride annealing are carried out to the cold rolled strip at 850 °C. After nitriding, an annealing separator, whose main composition is MgO, is coated on the surface of the sheet, being heated to 1220°C in an atmosphere of 25% N_2 and 75% H_2, then the atmosphere is changed into pure H_2, and the sheet is preserved in the temperature for 30 hours.
[0047] Results are shown in Table 5.

Table 5

Applied Tension Force and Magnetic Performance of the final Product			
	Content of martensite	Applied tension force (N/mm^2)	B_8(T)
Comparative Example	25	60	1.86
Embodiment	9.2	20	1.92

[0048] The distributions of martensite vs. the sheet thickness in the transverse section of Comparative Example and Embodiment are shown in Fig.2.
[0049] As can be seen from the figure, a relatively homogeneous martensite texture in the sheet-thickness direction can be obtained by means of the tension control. For a sample plate with the same thickness, the desired amount of martensite can be obtained stably; a better magnetic performance of the final product can be obtained.

Claims

1. A method for manufacturing a grain-oriented silicon steel having excellent magnetic performance, comprising steps as follows:

1) conventionally melting and casting to form a steel blank;
2) heating the steel blank and hot rolling the steel blank to a strip of steel;
3) normalizing process
carrying out the normalizing process having two stages, wherein the strip is firstly heated to 1100~1200 °C , and then cooled to 900~1000 °C in 50-200s; and next, the strip is rapidly cooled in water having a temperature of 10~100 °C; in this period, a tension force is applied to the strip of steel, the strip of steel in a temperature

range of 900°C~500°C has a stress of 1~200N/mm^2;
4) cold rolling;
carrying out a primary cold rolling, or a double cold rolling with intermediate annealing;
5) carrying out a primary recrystallizing annealing, then coating an annealing separator, whose main composition is MgO to carry out annealing to a final product, which annealing comprises secondary recrystallizing annealing and purifying annealing.

2. The method for manufacturing a grain-oriented silicon steel having excellent magnetic performance according to claim 1, **characterized in that** the tension force is applied to the strip of steel by disposing a tension roller in a normalizing furnace or varying front and rear tension rollers.

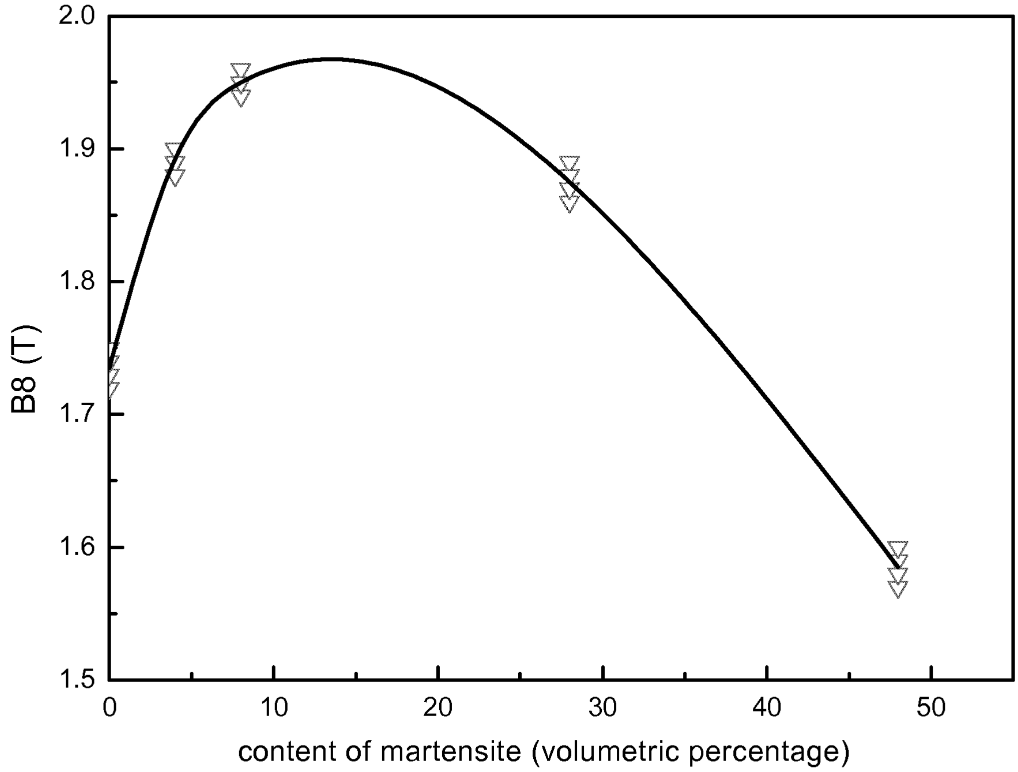
2.0
1.9
1.8
1.7
1.6
1.5
B8 (T)
0
10
20
30
40
50
content of martensite (volumetric percentage)

FIG. 1

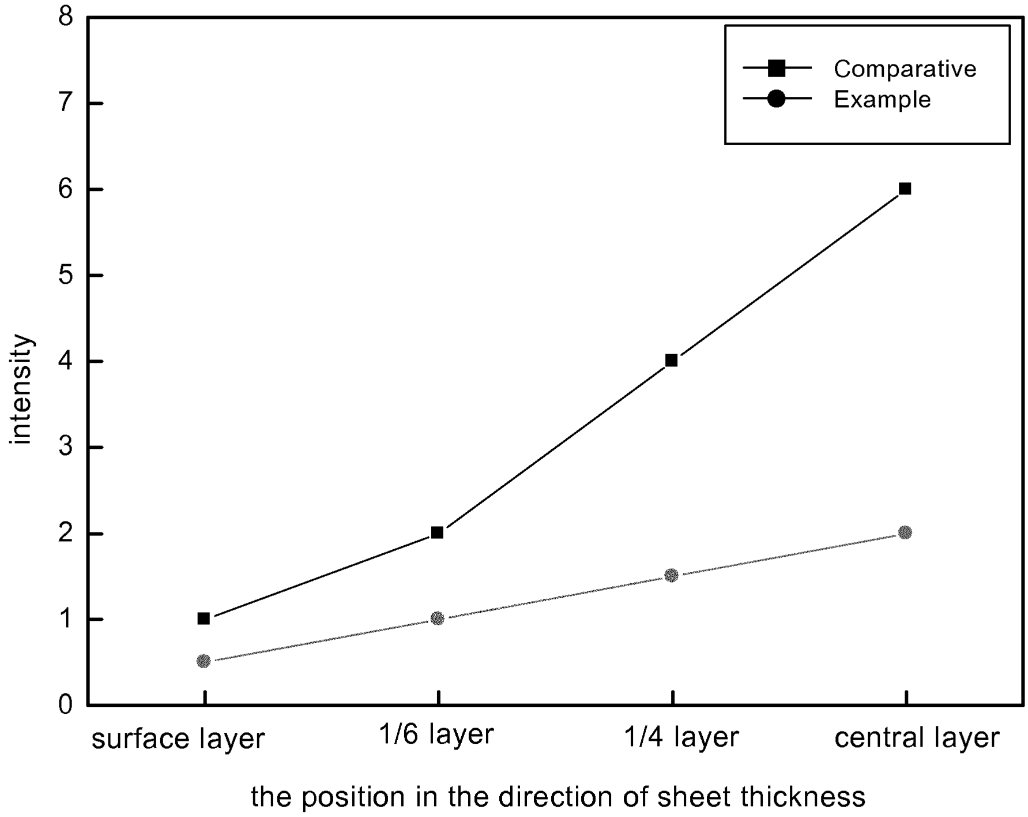
8
7
6
5
4
3
2
1
0
intensity
Comparative
Example
surface layer
1/6 layer
1/4 layer
central layer
the position in the direction of sheet thickness

FIG. 2

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2011/073419

A. CLASSIFICATION OF SUBJECT MATTER

See extra sheet

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)

IPC: C21D8/-, B21B37/-

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

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

WPI, EPODOC, CN-PAT, CNKI: anneal+, hot roll+, cold roll+, normalizing, oriented, directional, electrical steel, electric steel, magnetic steel, silicon steel, si steel, stress, force, tensile force, tension, transformation, martensite, martensitic

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	CN1743127A(UNIV DONGBEI)08 Mar.2006(08.03.2006) Claim 1	1-2
Y	US2005/0115643A1(THYSSENKRUPP ACCIAI SPECIALI TERNI SPA)02 Jun.2005 (02.06.2005) Paragraphs [0028], [0029],Table 5 No. D	1-2
A	US3959033A(CENT SPERIMENTALE METALL SPA et al.)25 May 1976 (25.05.1976) whole document	1-2
A	XU Zuyao, Martensite Transformation and Martensite, SCIENCE PRESS, Mar. 1980, page 407	1-2

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

* Special categories of cited documents:

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"&"document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
20 Aug.2011 (20.08.2011)	**08 Sep. 2011 (08.09.2011)**

Name and mailing address of the ISA/CN
The State Intellectual Property Office, the P.R.China
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INTERNATIONAL SEARCH REPORT

International application No.
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Continuation of: second sheet, A. CLASSIFICATION OF SUBJECT MATTER

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Form PCT/ISA /210 (extra sheet) (July 2009)

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