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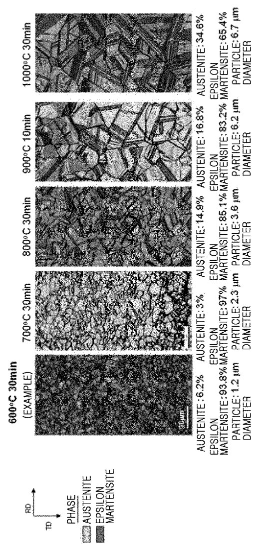
(54) **HIGH MANGANESE STEEL SHEET HAVING EXCELLENT VIBRATION-PROOF PROPERTY, AND MANUFACTURING METHOD THEREFOR**

(57) The present invention relates to a high Mn steel sheet and a manufacturing method therefor, the steel sheet comprising, by wt%: 0-0.1% or less of C; 8-30% of Mn; 0.1% or less of P; 0.02% or less of S; 0.1% or less of N; 0-1.0% of Ti; and Fe and inevitable impurities, wherein a microstructure has epsilon martensite and austenite, and the average particle diameter of the martensite and the austenite is 2 μm or less.

【Fig. 1】



EP 3 395 978 A1

Description

[Technical Field]

[0001] The present disclosure relates to a high Mn steel sheet having excellent damping properties, provided as a steel sheet for a vehicle or construction equipment and used in a location requiring damping properties for noise reduction.

[Background Art]

[0002] In recent years, noise reduction in vehicle manufacturing and building materials is a problem which manufacturers have needed to solve. In the case of vehicle manufacturers, it is particularly necessary to have damping properties in addition to excellent mechanical properties in components such as engine parts, oil pans, and the like, in which a significant noise is generated. In the case of building materials, recently, due to the strengthening of regulations relating to noise between floors, the development of a damping steel sheet as a floor plate of a duplex building including an apartment building is required.

[0003] High Mn damping steel is steel having good damping properties and excellent mechanical properties, since noise energy may be converted to thermal energy due to interface sliding of epsilon martensite when an external impact is applied.

[Disclosure]

[Technical Problem]

[0004] An aspect of the present disclosure may provide a high Mn steel sheet having excellent damping properties and a method for manufacturing the same.

[Technical Solution]

[0005] According to an aspect of the present disclosure, a high Mn steel sheet, having excellent damping properties, includes: 0 wt% to 0.1 wt% of carbon (C), 8 wt% to 30 wt% of manganese (Mn), 0.1 wt% or less of phosphorus (P), 0.02 wt% or less of sulfur (S), 0.1 wt% or less of nitrogen (N), 0 wt% to 1.0 wt% of titanium (Ti), and iron (Fe) and inevitable impurities, wherein a microstructure contains epsilon martensite and austenite, and an average particle diameter of each of the martensite and the austenite is 2 μm or less.

[0006] According to another aspect of the present disclosure, a method for manufacturing a high Mn steel sheet, having excellent damping properties, includes: heating a steel sheet, satisfying the composition range described above, to a heat treatment temperature of Ac1°C to Ac3+50°C at a heating rate of 0.01°C/s to 200°C/s; maintaining the steel sheet for 0.01 second to 24 hours at the heat treatment temperature; and cooling the steel sheet to room temperature at a cooling rate of 0.01°C/s or more.

[Advantageous Effects]

[0007] According to an exemplary embodiment in the present disclosure, a high Mn steel sheet having excellent damping properties is provided, and is used for structural components for a vehicle and building materials such as a flooring material, in which a noise reduction is required.

[Description of Drawings]

[0008]

FIG. 1 is a view illustrating the microstructures of the Example heat treated at 600°C and the Comparative Example heat treated at 700°C to 1000°C.
FIG. 2 is a drawing illustrating a dilatometer cycle of the heat treatment illustrated in FIG. 1.
FIG. 3 is a graph illustrating the results of specific damping capacity (SDC) measured by the internal resistance method with respect to the Example and the Comparative Example (4) .

[Best Mode for Invention]

[0009] Hereinafter, the present disclosure will be described in detail.

[0010] The present disclosure relates to a high Mn steel sheet having excellent damping properties and a method for manufacturing the same. The high Mn steel sheet includes 0 wt% to 0.1 wt% or less of carbon (C), 8 wt% to 30 wt% of manganese (Mn), 0.1 wt% or less (including 0%) of phosphorus (P), 0.02 wt% or less (including 0%) of sulfur (S), 0.1 wt% or less (including 0%) of nitrogen (N), 0 wt% to 1.0 wt% (excluding 0%) of titanium (Ti), and iron (Fe) and inevitable impurities. A microstructure of the steel sheet has epsilon martensite and austenite, and an average particle diameter of each of the martensite and the austenite is 2 μm or less.

[0011] A specific steel composition of the steel sheet according to the present disclosure and the reasons for restricting the steel composition thereof are as follows.

[0012] If the addition amount of carbon (C) exceeds 0.1%, carbides may be excessively precipitated, and the hot workability and elongation are lowered, and the damping capability may be significantly reduced. Thus, the addition amount of C is limited to 0.1% or less.

[0013] Manganese (Mn) is an element essential for stably securing an austenite structure and is an element for increasing the stacking fault energy. If an addition amount of Mn is less than 8%, martensite, degrading formability, is formed. Thus, strength increases but ductility significantly decreases. Moreover, the stacking fault energy is lowered, so austenite, partially formed, may be easily transformed into epsilon martensite. Thus, a lower limit of Mn is limited to 8%. On the other hand, if the addition amount of Mn exceeds 30%, manufacturing costs may be increased due to a large amount of Mn, and slab cracking may be caused by an increase in an amount of phosphorus (P) in steel. Moreover, as the addition amount of Mn increases, internal grain boundary oxidation significantly occurs when a slab is reheated. Thus, an oxide defect on a surface of a steel sheet is caused. Moreover, surface properties are degraded in hot dip galvanizing. Thus, an upper limit of the addition amount of Mn is limited to 30%.

[0014] Phosphorus (P) and sulfur (S) are inevitably included when steel is produced. The content of P is preferably limited to 0.1% or less (including 0%), and the content of S is preferably limited to 0.02% or less (including 0%) . In detail, in the case of P, segregation occurs, so the workability of steel may be reduced. In the case of S, coarse manganese sulfide (MnS) is formed, so a defect such as flange cracking may be generated, and the hole expansion of a steel sheet may be reduced. Thus, an addition amount thereof should be significantly suppressed as much as possible.

[0015] Nitrogen (N) is an element, inevitably contained during the production, so an addition range of N is preferably limited to 0.1% or less (including 0%).

[0016] Titanium (Ti) is a strong carbide forming element, combined with carbon to form a carbide. The carbide formed at this time is an element effective in refining a grain size by inhibiting crystal grain growth. Moreover, when Ti is added in combination with boron, a high temperature compound is formed in a columnar-grained boundary to prevent grain boundary cracking from occurring. In addition, Ti has a scavenging effect in which a fraction of each of C and N is lowered by forming a compound with C and N. Thus, Ti is an essential element for improving damping capabilities. However, if an addition amount of Ti exceeds 1.00%, an excessive amount of Ti may be segregated in a crystal grain boundary and grain boundary embrittlement may be caused, or a precipitation phase may be excessively coarse. Thus, a grain growth effect may be lowered. Therefore, the addition amount of Ti is limited to being 1.0% or less.

[0017] The high Mn steel sheet according to another aspect to the present disclosure additionally includes one, two, or more among 0 wt% to 3 wt% of silicon (Si), 0.005 wt% to 5.0 wt% of chromium (Cr), 0.005 wt% to 2.0 wt% of nickel (Ni), 0.005 wt% to 0.5 wt% of niobium (Nb), 0.0001 wt% to 0.01 wt% of boron (B), 0.005 wt% to 0.5 wt% of vanadium (V), and 0.005 wt% to 1 wt% of tungsten (W).

[0018] Silicon (Si) is a solid solution strengthening element, and is an element for increasing yield strength by reducing a grain size by a solid solution effect. Thus, Si is necessary to secure strength. However, if an addition amount of Si is increased, during hot rolling, silicon oxide is formed on a surface of a steel sheet. Thus, pickling properties are deteriorated, so surface qualities of a steel sheet may be deteriorated, as a disadvantage. Moreover, due to addition of a large amount of Si, the weldability of steel may be significantly lowered. Thus, an upper limit of the addition amount of Si may be limited to 3%.

[0019] Chromium (Cr) reacts with external oxygen during a hot rolling or annealing operation, and a Cr-based oxide film (Cr_2O_3) having a thickness of 20 μm to 50 μm is preferentially formed on a surface of a steel sheet, so Mn and Si, contained in the steel, are prevented from being eluted into a surface layer. Thus, Cr may act as an element for contributing to stabilization of a structure of a surface layer and improving plating surface properties.

[0020] However, if Cr is included in an amount less than 0.005%, the effect described above is insignificant. If Cr is included in an amount exceeding 5.0%, chromium carbide is formed, so workability and delayed fracture properties are deteriorated. Thus, an upper limit of the content of Cr may be limited to 5.0%.

[0021] Nickel (Ni) contributes to the stabilization of the austenite, which is not only advantageous for improving the elongation but also contributing effectively to the high temperature ductility. If the content of Ni, a strong high temperature toughness improving element, is less than 0.005%, an effect on high temperature toughness is insignificant. If an added content of Ni increases, Ni has a significant effect on prevention of delayed fracture and slab cracking. However, material costs may be high, so production costs may be increased. Thus, the content of Ni may be limited to 0.005% to 2.0%.

[0022] Niobium (Nb) is a carbide forming element for forming carbide by being combined with carbon in the steel. In the present disclosure, Nb may be added for the purpose of increasing the strength and refining the grain size. According to the related art, Nb forms a precipitate at a lower temperature as compared to Ti, so Nb is an element having significant effects of refining a crystal grain size and strengthening precipitation by formation of a precipitate. Thus, Nb may be added in an amount of 0.005% to 0.5%. However, if an addition amount of Nb is less than 0.005%, the effect described above is insignificant. On the other hand, if Nb is added in an amount exceeding 0.5%, an excessive amount of Nb is segregated in a grain boundary, thereby causing grain boundary embrittlement, or a precipitate may be excessively coarse, thereby lowering a growth effect of a crystal grain. Moreover, in a hot rolling process, recrystallization is delayed, so rolling load may be increased. Thus, the addition amount of Nb may be limited to 0.005% to 0.5%.

[0023] Vanadium (V) and tungsten (W) are elements for forming carbonitride by being combined with C and N together with Ti. In the present disclosure, since a fine precipitate is formed at a low temperature, a precipitation strengthening effect may be obtained. Moreover, V and W may be important elements for securing austenite. However, if two elements are added in small amounts, less than 0.005%, the effect described above is insignificant. On the other hand, if V is added in an amount exceeding 0.5% and W is added in an amount exceeding 1.0%, a precipitate is excessively coarse, so a grain growth effect may be lowered, which may cause hot brittleness. Thus, the addition amount of V may be limited to 0.005% to 0.5%, while the addition amount of W may be limited to 0.005% to 1%.

[0024] Boron (B) is added with Ti, and thus a high-temperature compound is formed in a grain boundary, so grain boundary cracking may be prevented. However, if B is added in a small amount of 0.0001% or less, there may be no effect. If B is added in an amount of 0.01%, a boron compound is formed, so surface properties may be deteriorated. Thus, a range of B may be limited to 0.0001% to 0.01%.

[0025] Hereinafter, a method for manufacturing a high Mn steel sheet having excellent damping properties will be described.

[0026] In the method for manufacturing a high Mn steel sheet according to the present disclosure, steel, which has the composition and composition range, and in which a microstructure is comprised of a austenite as main phase, is heated at a heating rate of 0.01°C/s to 200°C/s, and maintained at a heat treatment temperature of Ac1°C to Ac3+50°C for 0.01 second to 24 hours, and is then cooled to room temperature at a cooling rate of 0.01°C/s or more.

[0027] The high Mn steel sheet may be a cold rolled steel sheet or a hot rolled steel sheet.

[0028] A microstructure of the high Mn steel sheet has epsilon martensite and austenite.

[0029] In the heating, if a heating rate exceeds 200°C/s, Ac1 and Ac3 temperatures are raised. Thus, even when heat treatment is performed in the range of the present disclosure, there is a problem in which an average particle diameter of a microstructure exceeds 2 μm. Therefore, an upper limit of a heating rate is limited to 200°C/s. If the heating rate is 0.01°C/s or less, during an operation, coarse carbides may be generated due to phase instability. Therefore, the heat treatment should be performed at a rate of 0.01°C/s or more.

[0030] If the heat treatment is performed at a temperature less than Ac1, transformation does not proceed, so there may be a problem in which a heat treatment effect can not be obtained. If a heat treatment temperature exceeds Ac3+50°C, there may be a problem in which an average particle diameter of a microstructure exceeds 2 μm. Thus, the heat treatment temperature is limited to Ac1°C to Ac3+50°C.

[0031] If the heat treatment time is less than 0.01 second, the application of recrystallization and recovery is insignificant, so an effect of heat treatment may be not obtained. If the heat treatment time exceeds 24 hours, there may be a problem in a process in which excessive oxidation occurs, so base iron is removed, and excessive heat treatment costs are consumed, as well as a problem in a microstructure in which a microstructure significantly grows, so an average particle diameter thereof is greater than a target particle diameter.

[0032] If the cooling is performed at a cooling rate less than 0.01°C/s, there may be problems in which an average particle diameter of a microstructure is increased during the cooling, and coarse carbides are generated due to phase instability. Thus, a lower limit of a cooling rate is limited to 0.01°C/s. There is no upper limit of a cooling rate. As the cooling rate is increased, it may be more advantageous to secure epsilon martensite and secure a fine average particle size.

[Mode for Invention]

[0033] Hereinafter, an Example of the present disclosure will be described in detail. The following example is for the purpose of understanding the present disclosure and is not intended to limit the present disclosure.

[0034] A cold rolled steel sheet, including 0.02 wt% of C, 17 wt% of Mn, 0.01 wt% of N, 0.008 wt% of P, 0.008 wt% of S, 0.03 wt% of Ti, and Fe and inevitable impurities, was heated at a heating rate of 5°C/s, and was then maintained for the heat treatment time at a heat treatment temperature illustrated in Table 1. Then, the heat treated steel sheet was cooled to room temperature at a cooling rate of 5°C/s.

[0035] Regarding the steel sheet, having been heat-treated and cooled, an average particle diameter of a microstructure and the fraction of epsilon martensite were investigated, and a result thereof is illustrated in Table 1 and FIG. 1.

[Table 1]

Classification	Heat Treatment Temperature (°C)	Heat Treatment Temperature (min)	Particle Diameter (μm)	Area Fraction (%) of Epsilon Martensite
Example	600	30	1.23	6.2
Comparative Example 1	700	30	2.3	3
Comparative Example 2	800	30	3.6	14.9
Comparative Example 3	900	10	6.7	16.8
Comparative Example 4	1000	30	6.7	34.6

[0036] As disclosed in Table 1 and FIG. 1, the Example, heat treated at 600°C, is compared with the Comparative Examples (1 to 4), heat treated at 700°C to 1000°C. In Comparative Example (1), in which a heat treatment temperature was 700°C, the area fraction of epsilon martensite was lower, and a particle diameter was greater, as compared to the Example, heat treated at 600°C.

[0037] Moreover, in the case of Comparative Examples (2 to 4) in which heat treatment temperatures were 800°C, 900°C, and 1000°C, respectively, the area fraction of epsilon martensite was greater, as compared to the Example, heat treated at 600°C. However, a particle diameter of the Example, heat treated at 600°C, was smaller than a particle diameter of the Comparative Examples (2 to 4), heat treated at 700°C to 1000°C.

[0038] Meanwhile, in the case of Example, heat treated at 600°C according to the present disclosure, an average particle diameter of a microstructure was 2 μm or less.

[0039] FIG. 2 is a drawing illustrating a dilatometer cycle of heat treatment illustrated in FIG. 1.

[0040] In FIG. 2, Ac1 and Ac3 are confirmed, and the Example is a result in which a heat treatment was performed at Ac3 + 30°C.

[0041] In FIG. 3, the Example, heat treated at 600°C, and Comparative Example (4), heat treated at 1000°C, were measured using a friction coefficient method. A result of measuring Specific Damping Capacity (SDC) is illustrated therein.

[0042] Here, SDC indicates the damping capacity (a property in which an object absorbs vibrations).

[0043] Referring to FIGS. 1 and 3, a room temperature SDC value of damping steel having a microstructure according to the Example, heat treated at 600°C, is a value 2.5 times that of damping steel according to Comparative Example (4). In other words, a SDC value of Example, heat treated at 600°C, is 0.00025, and a SDC value of Comparative Example (4), heat treated at 1000°C, was measured as 0.0001.

[0044] The area fraction of epsilon martensite of the Example, heat treated at 600°C, was relatively low. However, a particle diameter thereof was small, so a structure may be finely and uniformly distributed. In this case, when a steel sheet, in which residual dislocation and an interface together with epsilon martensite are present, was affected by an external shock, a rate of conversion from energy to thermal energy was increased. Thus, damping capacity is improved, so damping properties may be excellent.

[0045] According to the related art, when a room temperature SDC value is 0.00015 or more, damping properties are excellent.

[0046] Through comprehensive results, when heat treatment is performed according to the present disclosure, an average particle diameter of 2 μm or less is secured. Thus, it can be seen that excellent damping properties may be secured.

[0047] In the case of the Comparative Examples, except for a Comparative Example heat treated at 700°C, the area fraction of epsilon martensite is high, as compared to the Example. On the other hand, an average particle diameter of a microstructure is great. Thus, the damping performance is inferior.

[0048] While exemplary embodiments have been shown and described above, it will be apparent to those skilled in the art that modifications and variations could be made without departing from the scope of the present invention as defined by the appended claims.

Claims

1. A high Mn steel sheet having excellent damping properties, comprising

   0.1 wt% or less of carbon (C), 8 wt% to 30 wt% of manganese (Mn), 0.1 wt% or less of phosphorus (P), 0.02 wt% or less of sulfur (S), 0.1 wt% or less of nitrogen (N), 0 wt% to 1.0 wt% of titanium (Ti), and iron (Fe) and inevitable impurities,
   wherein a microstructure contains epsilon martensite and austenite, and an average particle diameter of each of the martensite and the austenite is 2 μm or less.

2. The high Mn steel sheet having excellent damping properties of claim 1, wherein the steel sheet additionally comprises one, two, or more among 0 wt% to 3 wt% of silicon (Si), 0.005 wt% to 5.0 wt% of chromium (Cr), 0.005 wt% to 2.0 wt% of nickel (Ni), 0.005 wt% to 0.5 wt% of niobium (Nb), 0.0001 wt% to 0.01 wt% of boron (B), 0.005 wt% to 0.5 wt% of vanadium (V), and 0.005 wt% to 1 wt% of tungsten (W).

3. The high Mn steel sheet having excellent damping properties of claim 1, wherein a room temperature specific damping capacity (SDC) value of the steel sheet is 0.00015 or more.

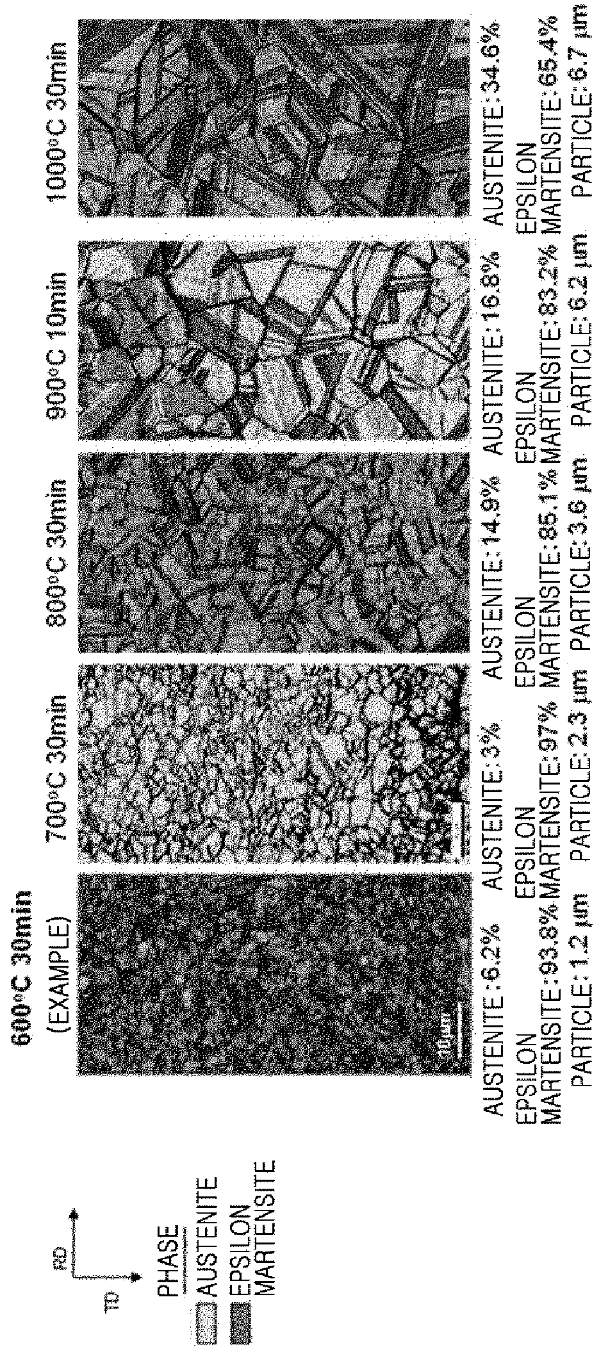
4. A method for manufacturing a high Mn steel sheet having excellent damping properties, comprising:

   heating a high Mn steel sheet, including 0 wt% to 0.1 wt% or less of carbon (C), 8 wt% to 30 wt% of manganese (Mn), 0.1 wt% or less of phosphorus (P), 0.02 wt% or less of sulfur (S), 0.1 wt% or less of nitrogen (N), 0 wt% to 1.0 wt% of titanium (Ti), and iron (Fe) and inevitable impurities to a heat treatment temperature of Ac1°C to Ac3+50°C at a heating rate of 0.01°C/s to 200°C/s;
   maintaining the high Mn steel sheet for 0.01 second to 24 hours at the heat treatment temperature; and
   cooling the high Mn steel sheet to room temperature at a cooling rate of 0.01°C/s or more.

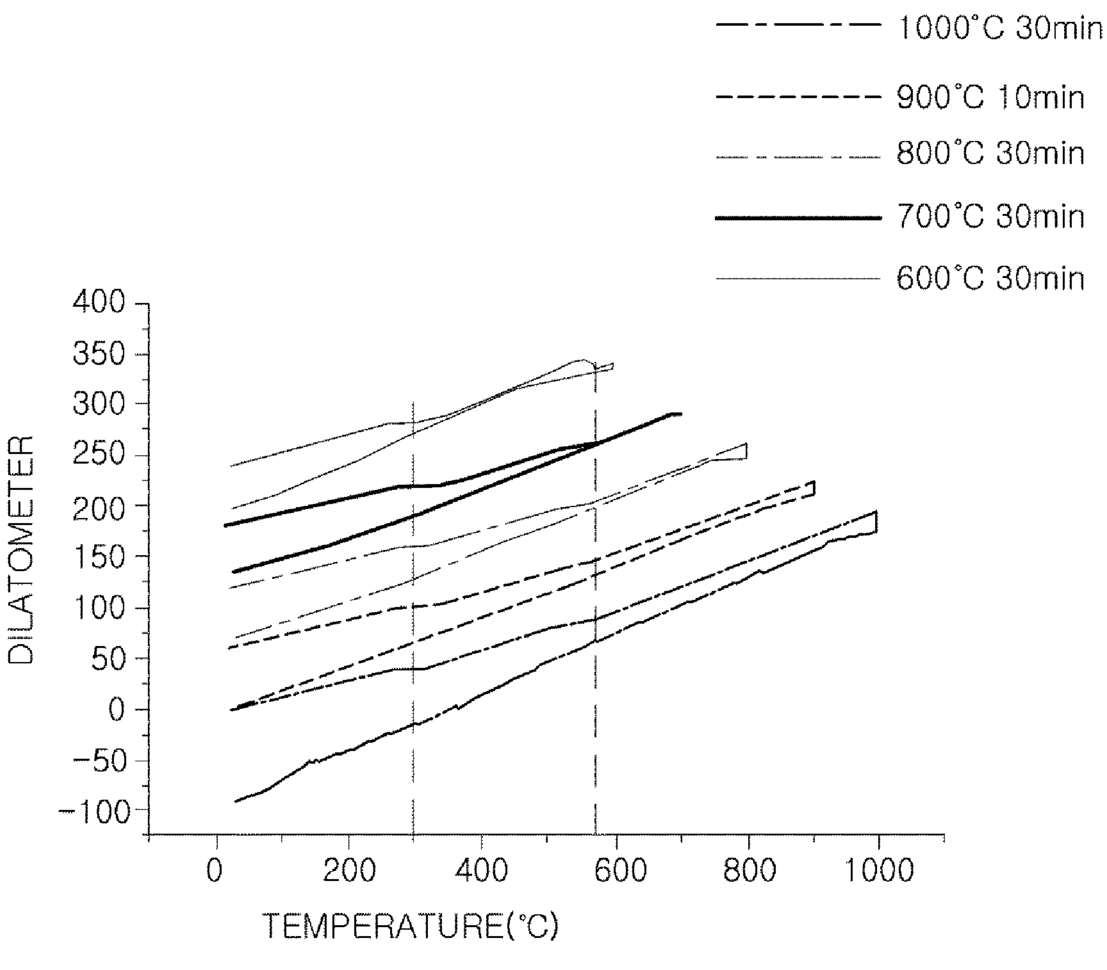
5. The method for manufacturing high Mn steel sheet having excellent damping properties of claim 4, wherein a microstructure of the high Mn steel sheet has epsilon martensite and austenite.

6. The method for manufacturing high Mn steel sheet having excellent damping properties of claim 4, wherein the steel sheet additionally comprises one, two, or more among 0 wt% to 3 wt% of silicon (Si), 0.005 wt% to 5.0 wt% of chromium (Cr), 0.005 wt% to 2.0 wt% of nickel (Ni), 0.005 wt% to 0.5 wt% of niobium (Nb), 0.0001 wt% to 0.01 wt% of boron (B), 0.005 wt% to 0.5 wt% of vanadium (V), and 0.005 wt% to 1 wt% of tungsten (W).

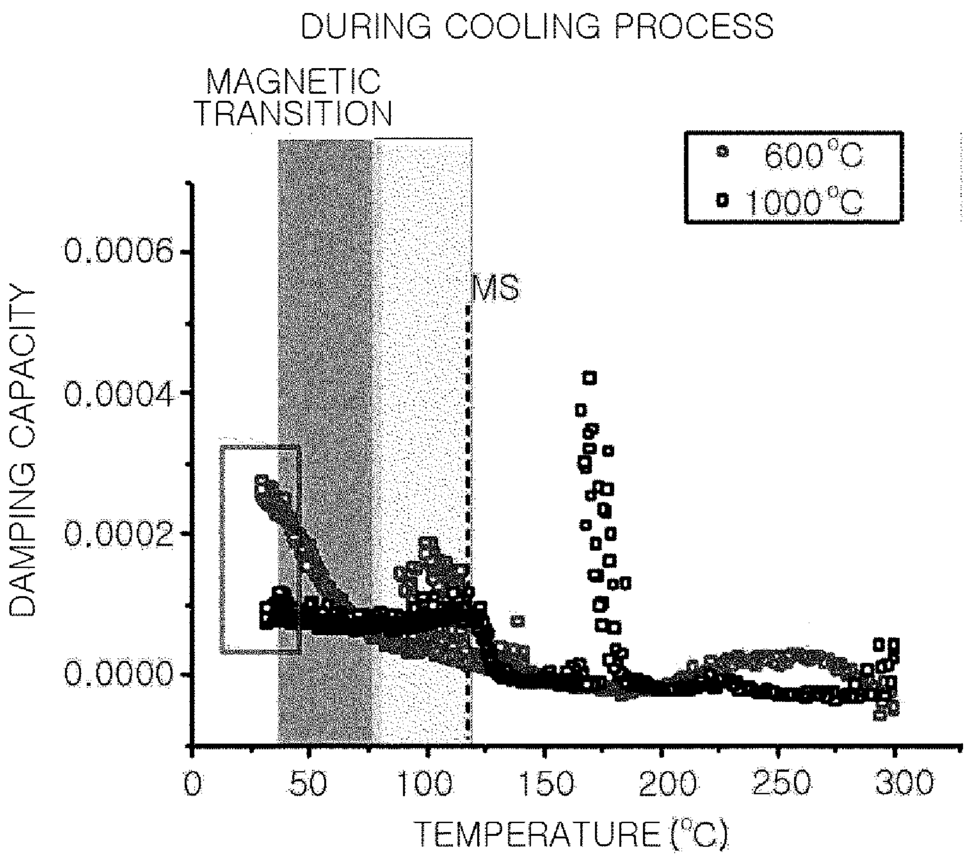
【Fig. 1】


600°C 30min (EXAMPLE)
AUSTENITE : 6.2%
EPSILON MARTENSITE : 93.8%
PARTICLE DIAMETER : 1.2 μm
700°C 30min
AUSTENITE : 3%
EPSILON MARTENSITE : 97%
PARTICLE DIAMETER : 2.3 μm
800°C 30min
AUSTENITE : 14.9%
EPSILON MARTENSITE : 85.1%
PARTICLE DIAMETER : 3.6 μm
900°C 10min
AUSTENITE : 16.8%
EPSILON MARTENSITE : 83.2%
PARTICLE DIAMETER : 6.2 μm
1000°C 30min
AUSTENITE : 34.6%
EPSILON MARTENSITE : 65.4%
PARTICLE DIAMETER : 6.7 μm
RD
TD
PHASE
AUSTENITE
EPSILON MARTENSITE

【Fig. 2】


1000°C 30min
900°C 10min
800°C 30min
700°C 30min
600°C 30min
DILATOMETER
400
350
300
250
200
150
100
50
0
-50
-100
0
200
400
600
800
1000
TEMPERATURE(°C)

【Fig. 3】


DURING COOLING PROCESS
MAGNETIC TRANSITION
600°C
1000°C
MS
DAMPING CAPACITY
0.0006
0.0004
0.0002
0.0000
0
50
100
150
200
250
300
TEMPERATURE (°C)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/KR2016/015040

A. CLASSIFICATION OF SUBJECT MATTER

C22C 38/04(2006.01)i, C22C 38/00(2006.01)i, C22C 38/14(2006.01)i, C22C 38/58(2006.01)i, C22C 38/54(2006.01)i, C22C 38/48(2006.01)i, C22C 38/46(2006.01)i, C22C 38/44(2006.01)i, C21D 6/00(2006.01)i

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

C22C 38/04; C21D 8/02; B22D 11/00; C22C 38/00; B22D 11/20; C21D 8/00; C22C 38/14; C22C 38/58; C22C 38/54; C22C 38/48; C22C 38/46; C22C 38/44; C21D 6/00

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: manganese, epsilon-martensite, austenite, anti-dust, titanium, heat treatment, cooling

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	KR 10-2014-0085225 A (POSCO) 07 July 2014 See paragraph [0062] and claims 1-3, 11, 13.	1-6
X	KR 10-0840287 B1 (POSCO) 20 June 2008 See paragraphs [0036]-[0039] and claims 1, 3.	1-6
A	KR 10-2014-0119216 A (WOOJIN INC.) 10 October 2014 See paragraphs [0040]-[0049] and claims 1-7.	1-6
A	JP 2004-137579 A (NISSHIN STEEL CO., LTD.) 13 May 2004 See paragraph [0029] and claim 1.	1-6
A	JP 2011-230182 A (SUMITOMO METAL IND. LTD.) 17 November 2011 See paragraphs [0037], [0040] and claim 1.	1-6

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

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"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
27 FEBRUARY 2017 (27.02.2017)	**03 MARCH 2017 (03.03.2017)**

Name and mailing address of the ISA/KR	Authorized officer
Korean Intellectual Property Office Government Complex-Daejeon, 189 Seonsa-ro, Daejeon 302-701, Republic of Korea Facsimile No. 82-42-472-7140	Telephone No.

Form PCT/ISA/210 (second sheet) (January 2015)

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/KR2016/015040

Patent document cited in search report	Publication date	Patent family member	Publication date
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		CN 104884655 A	02/09/2015
		EP 2940171 A1	04/11/2015
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