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(54) Title: HIGH MANGANESE STEEL HAVING HIGH STRENGTH AND EXCELLENT DELAYED FRACTURE RESIS-
TANCE AND MANUFACTURING METHOD THEREOF

(57) Abstract: High manganese steel contains, by weight, 0.3% to 0.9% carbon (C), 15% to 25% manganese (Mn), 0.01% to 2.0%
silicon (Si), 0.01% to 4.0% aluminum (Al), 0.05% or less sulfur (S), 0.1% or less phosphor (P), inevitable impurities, and balance
iron (Fe). Al and Si have a relation of Al/Si > 2. The high manganese steel further contains one or two or more selected from
the group consisting of, by weight, 0.2% or less niobium (Nb), 0.5% or less vanadium (V), 0.3% or less titanium (Ti), 1.0% or less
tungsten (W), 1.0% or less molybdenum (Mo), and 1.0% or less chrome (Cr). The high manganese steel has tensile strength of 920
MPa or more and elongation of 55% or more, and thus can be safely and widely used for automotive members, structural members,
and so on.

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Description

HIGH MANGANESE STEEL HAVING HIGH STRENGTH AND EXCELLENT DELAYED FRACTURE RESISTANCE AND MANUFACTURING METHOD THEREOF

Technical Field

- [1] The present invention relates to high manganese steel having high strength, high elongation and excellent delayed fracture resistance and, more particularly, to high manganese steel having high strength, high elongation and excellent delayed fracture resistance, which can be applied to members such as automotive steel sheets and structural materials in which high formability as well as sufficient strength must be secured.

[2]

Background Art

- [3] In general, the field of automotive steel sheets requires steel having high formability and simultaneously excellent strength. Further, the automotive steel sheets are required to be sufficiently thin in order to reduce weight of an automotive body to increase fuel efficiency.
- [4] In order to meet this condition, ultra-low carbon steel having a ferrite structure has been used in former years. However, this ferritice ultra-low carbon steel can guarantee formability to some extent, but is insufficient in tensile and yield strength. As such, the ferritice ultra-low carbon steel has difficulty in reducing the weight of the automotive body, and cannot ensure automotive safety. Further, when carbon is further added in order to make up for strength, carbides or carbonoxides can be excessively formed in steel, and thus reduce the formability.
- [5] Multiphase steel capable of making up for the low strength of the ultra-low carbon steel is disclosed in US Patent No. 4,854,976. This multiphase steel has poor formability through the influence of bainite and martensite structures, and thus is restrictively used only for members that do not require high formability.
- [6] Furthermore, as disclosed in WO93/013233, high manganese steel containing 15 wt% to 35 wt% manganese (Mn) in steel appears to meet high strength and formability. This high manganese steel inhibits formation of an ϵ -martensite phase and slip deformation caused by dislocation by virtue of addition of a great deal of Mn, thereby having excellent strength and elongation (formability).
- [7] However, the teachings disclosed in WO93/013233 adopted only the strength and elongation as considerations, and did not refer to improvement of delayed fracture resistance, which refers to ability of members such as automotive steel materials to be

resistant to fracture caused by external stress or residual stress after formed.

[8]

Disclosure of Invention

Technical Problem

[9] Embodiments of the present invention provide high manganese steel, which has high strength, high formability and excellent delayed fracture resistance so as to be able to be widely used for automotive steel materials, structural members, and so on.

Technical Solution

[10] According to an aspect of the present invention, there is provided high manganese steel contains, by weight, 0.3% to 0.9% carbon (C), 15% to 25% manganese (Mn), 0.01% to 2.0% silicon (Si), 0.01% to 4.0% aluminum (Al), 0.05% or less sulfur (S), 0.1% or less phosphor (P), inevitable impurities, and balance of iron (Fe). Al and Si have relation of $Al/Si > 2$.

[11] According to another aspect of the present invention, there is provided a method of manufacturing high manganese steel, which includes: a reheating step of heating a steel slab at a temperature of 1200°C or less, the steel slab containing, by weight, 0.3% to 0.9% carbon (C), 15% to 25% manganese (Mn), 0.01% to 2.0% silicon (Si), 0.01% to 4.0% aluminum (Al), 0.05% or less sulfur (S), 0.1% or less phosphor (P), inevitable impurities, and balance iron (Fe), and Al and Si having relation of $Al/Si > 2$; a finish hot rolling step of finish hot rolling the steel slab into a steel sheet at a temperature of 950°C or less; a coiling step of cooling the finish-hot-rolled steel sheet with water and coiling the cooled steel sheet at a temperature of 550°C or less; a cold rolling step of pickling the hot-rolled steel sheet and cold rolling the pickled steel sheet at a rolling reduction of 40% or more; and an annealing step of continuously annealing the cold-rolled steel sheet at a temperature of 700°C to 830°C.

[12] According to another aspect of the present invention, there is provided a method of manufacturing a high manganese coated steel sheet, which includes: a reheating step of heating a steel slab at a temperature of 1200°C or less, the steel slab containing, by weight, 0.3% to 0.9% carbon (C), 15% to 25% manganese (Mn), 0.01% to 2.0% silicon (Si), 0.01% to 4.0% aluminum (Al), 0.05% or less sulfur (S), 0.1% or less phosphor (P), inevitable impurities, and a balance of iron (Fe), and Al and Si having relation of $Al/Si > 2$; a finish hot rolling step of finish hot rolling the steel slab into a steel sheet at a temperature of 950°C or less; a coiling step of cooling the finish-hot-rolled steel sheet with water and coiling the cooled steel sheet at a temperature of 550°C or less; a cold rolling step of pickling the hot-rolled steel sheet and cold rolling the pickled steel sheet at a rolling reduction of 40% or more; an annealing step of continuously annealing the cold-rolled steel sheet at a temperature of 700°C to 830°C; and

an electroplating step of electroplating the annealed steel sheet.

- [13] According to another aspect of the present invention, there is provided a method of manufacturing a high manganese coated steel sheet, which includes: a reheating step of heating a steel slab at a temperature of 1200°C or less, the steel slab containing, by weight, 0.3% to 0.9% carbon (C), 15% to 25% manganese (Mn), 0.01% to 2.0% silicon (Si), 0.01% to 4.0% aluminum (Al), 0.05% or less sulfur (S), 0.1% or less phosphorus (P), inevitable impurities, and a balance of iron (Fe), and Al and Si having relation of $Al/Si > 2$; a finish hot rolling step of finish hot rolling the steel slab into a steel sheet at a temperature of 950°C or less; a coiling step of cooling the finish-hot-rolled steel sheet with water and coiling the cooled steel sheet at a temperature of 550°C or less; a cold rolling step of pickling the hot-rolled steel sheet and cold rolling the pickled steel sheet at a rolling reduction of 40% or more; a hot dip coating step of heat-treating the cold-rolled steel sheet in a continuous hot dip coating line at a temperature of 700°C to 830°C and performing hot dip coating on the heat-treated steel sheet.

- [14] The high manganese steel and the high manganese coated steel sheet may further include one or two or more selected from the group consisting of, by weight, 0.2% or less niobium (Nb), 0.5% or less vanadium (V), 0.3% or less titanium (Ti), 1.0% or less tungsten (W), 1.0% or less molybdenum (Mo), and 1.0% or less chromium (Cr), and/or 0.005% or less antimony (Sb), and have tensile strength of 920 MPa or more and elongation of 55% or more.

Advantageous Effects

- [15] According to embodiments of the present invention, the high manganese steel has high strength and elongation as well as excellent delayed fracture resistance for use of automotive.

[16]

Mode for the Invention

- [17] Exemplary embodiments of the present invention provide high manganese steel, which has proper stacking fault energy by means of addition of carbon (C), manganese (Mn), aluminum (Al), etc. and thus uses twinning created during deformation. Since the created twins exert the same effect as the effect refining a grain size, the steel has high elongation and such strength as to be used for automotive members. Furthermore, exemplary embodiments of the present invention provide high manganese steel, in which an Al-Si component is controlled to improve delayed fracture resistance.

[18]

- [19] Hereinafter, the composition of the high manganese steel according to an exemplary embodiment of the present invention will be described in detail (on the basis of

weight).

[20]

[21] Carbon (C): 0.3% to 0.9%

[22] C is an element required to secure an austenite structure in steel, and is added at an amount of 0.3% or more in order to contribute to increasing strength of the steel. However, when an amount of C exceeds 0.9%, carbide is excessively precipitated to degrade workability and castability. Thus, the amount of C is limited to a range of 0.3% to 0.9%.

[23]

[24] Manganese (Mn): 15% to 25%

[25] Mn is an important component that serves to improve strength and stabilize an austenite phase, and must be added at an amount of 15% or more. When Mn is added at an amount less than 15%, an ϵ -martensite phase exists to reduce formability. In contrast, when Mn is added at an amount exceeding 25%, this is economically unfavorable, and internal oxidation sharply occurs during heating in a hot rolling process to thereby deteriorate surface quality. Thus, Mn is added at an amount of 15% to 25%.

[26]

[27] Silicon (Si): 0.01% to 2.0%

[28] Si is added at an amount of 0.01% or more in order to improve strength caused by means of deoxidation and solution hardening. However, when an added amount of Si exceeds 2.0%, Si can reduce delayed fracture resistance and deteriorate coatability. Thus, the added amount of Si is limited to a range of 0.01% to 2.0%.

[29]

[30] Aluminum (Al): 0.1 to 4.0%

[31] Al contributes to an increase in stacking fault energy for stabilizing an austenite phase and formation of twins during press forming. Further, Al acts as an important element for improving delayed fracture resistance in an embodiment of the present invention, and must be added at an amount of 0.1% or more. However, when the added amount of Al exceeds 4.0%, Al can deteriorate coatability. Thus, the added amount of Al is limited to a range of 0.1% to 4.0%.

[32]

[33] According an embodiment of the present invention, a ratio of Al and Si added to the steel must be 2 or more. A study of inventors of the present invention shows that Al and Si serve as elements for improving delayed fracture resistance in the high manganese steel. Particularly, a test shows that, only when an added amount of Al is twice as much as that of Si, stability of twins is secured, and the delayed fracture resistance shows a remarkable synergy effect. As such, the ratio of Al/Si is preferably set to 2 or more. When the ratio of Al/Si is less than 2, the delayed fracture resistance

is reduced, and coatability is deteriorated. Thus, it is necessary to control the added amounts of Al and Si within contents of Al and Si.

[34]

[35] Niobium (Nb) is an element added to improve strength through refinement of a grain size and precipitation strengthening. When an added amount of Nb exceeds 0.2%, Nb causes cracks during hot rolling. Thus, the added amount of Nb has an upper limit of 0.2%.

[36]

[37] Vanadium (V) is an added element for improving strength through precipitation strengthening. However, when an added amount of V exceeds 0.5%, V excessively forms coarse precipitates to fail to go far toward increasing strength, and increases manufacturing costs. Thus, the added amount of V has an upper limit of 0.5%.

[38]

[39] Titanium (Ti) is an element that reacts with nitrogen (N) in steel and thus precipitates nitride, and can be added to secure strength and formability. However, when an added amount of Ti exceeds 0.3%, Ti excessively forms precipitates to cause fine cracks during cold rolling, and deteriorates formability and weldability. Thus, the added amount of Ti has an upper limit to 0.3%.

[40]

[41] Sulfur (S) is required to be controlled at an amount of 0.05% or less in order to control inclusions. When an amount of S exceeds 0.05%, S causes hot shortness.

[42]

[43] Phosphor (P) is an element that is vulnerable to segregation, and promotes cracks during casting. In order to prevent the cracks, P must be controlled at an amount of 0.1% or less. When an amount of P exceeds 0.1%, P can deteriorate castability. Thus, the amount of P has an upper limit to 0.1%.

[44]

[45] Tungsten (W), molybdenum (Mo) and chrome (Cr) are elements added for precipitation strengthening, and each can be added up to 1%. When added amounts of W, Mo and Cr exceed 1%, the strengthening effect is not significantly increased, but manufacturing costs are increased.

[46]

[47] Antimony (Sb) can be added up to 0.05% in order to improve hot dip coating characteristics. When an added amount of Sb exceeds 0.05%, Sb degrades hot workability to cause cracks during hot rolling.

[48]

[49] Now, the high manganese steel containing the above-mentioned composition and a method of manufacturing a high manganese coated steel sheet using the high

manganese steel will be described in detail.

[50]

[51] The high manganese steel according to an embodiment of the present invention can be manufactured by performing continuous casting, hot rolling, cold rolling, etc. on a steel slab containing the above-mentioned composition.

[52]

[53] The slab is reheated at a temperature of 1200°C or less until it is uniformly heated on the whole. As the heating temperature is high, the hot rolling is easy. However, when steel having a high content of Mn like the high manganese steel of the embodiment of the present invention is heated at a high temperature, internal oxidation severely occurs to deteriorate superficial quality. In contrast, when the heating temperature is too low, a rolling load can be excessively applied during hot rolling. For this reason, the slab is preferably heated at a temperature of 1100°C or more.

[54]

[55] As a finish hot rolling temperature is high as well, deformation resistance becomes low to facilitate rolling. However, the higher the rolling temperature becomes, the lower the surface quality becomes. For this reason, it is necessary to carry out the finish hot rolling at a temperature of 950°C or less.

[56]

[57] After the finish hot rolling, the slab is cooled with water. Then, the cooled strip is wound in a coil shape. After the coiling, a cooling speed is typically slow in most cases. Thus, when a coiling start temperature is high, an oxide film on a surface of the slab reacts with a matrix of the slab during cooling after the coiling, and thereby a pickling characteristic is deteriorated. Thus, the slab must be coiled at a temperature of 550°C or less.

[58]

[59] During cold rolling, rolling reduction is generally determined depending on the thickness of a desired product. However, since the high manganese steel according to an embodiment of the present invention undergoes recrystallization during heat treatment after the cold rolling, it is necessary to well control driving force of the recrystallization. In detail, when the cold rolling reduction is too low, a recrystallization temperature is increased, so that high-temperature annealing is required. As a result, a thin oxide film is formed on the surface of the slab, and thus coatability, phosphatability, etc. can be deteriorated. Thus, the rolling reduction is controlled up to 40% during cold rolling, and the continuous annealing is also carried out at a temperature of 830°C or less. However, when an annealing temperature is too low, an annealing effect is insignificant. Thus, the annealing temperature is prevented from being lowered under 700°C.

[60]

[61] The high manganese steel according to an embodiment of the present invention can be manufactured through the above-mentioned processes. In addition to these processes, an electroplating process or a hot dip coating process can be additionally carried out to manufacture a high manganese electroplated steel sheet.

[62]

[63] An electroplating method that can be used in an embodiment of the present invention can be implemented with any electroplating method known in the related art can be applied and thus is not particularly limited. The electroplating process can be carried out after the continuous annealing is completed in the method of manufacturing the high manganese steel.

[64]

[65] Furthermore, the high manganese steel according to an embodiment of the present invention can be formed into a high manganese hot-dip coated steel sheet through a hot dip coating process. In this case, after the cold rolling, the high manganese steel can be introduced into a continuous hot dip coating line instead of the continuous annealing process. The high manganese steel is subjected to heat treatment at a temperature of 700°C to 830°C in the continuous hot dip coating line, and then hot dip coating again. Thereby, the high manganese hot-dip coated steel sheet can be manufactured. Similarly, the continuous hot dip coating line can perform the hot dip coating on the high manganese steel according to an embodiment of the present invention does not place special restrictions on typical hot dip coating equipment in which the heat treatment is possible.

[66]

[67] The high manganese steel and the method of manufacturing the same according to Examples of the present invention will be described below in detail.

[68]

[69] Example 1

[70] In this example, a composition of high manganese steel capable of securing high strength was set as follows. Tensile strength (TS, on the basis of MPa) and elongation (E, on the basis of %) were measured with respect to steel prepared with each composition, and the results were shown in Table 1 below.

[71]

[72] Table 1

[Table 1]

[Table]

	C	Mn	Al	Si	Nb	V	TS	El
Inventive Steel 1	0.6	20	1.5	0.01			940	60
Inventive Steel 2	0.6	18	2	0.5			990	60
Inventive Steel 3	0.5	18	1.5	0.15	0.03		1020	64
Inventive Steel 4	0.5	23	2	0.3		0.1	1050	62
Inventive Steel 5	0.7	18	1	0.3	0.03		1080	62
Inventive Steel 6	0.6	23	1	0.01	0.03	0.15	1100	60
Comparative Steel 1	0.15	18	1				950	45
Comparative Steel 2	0.5	6		0.4			960	47

[73]

[74] In Table 1, it could be found that 1) high strength (>800 MPa) was obtained from each C-Mn-Al steel alone, and 2) higher strength was secured when Si, Nb, V, etc. were added at a proper amount.

[75]

[76] Example 2

[77] In this example, a composition of high manganese steel capable of securing high strength and excellent delayed fracture resistance was set as follows. Tensile strength (TS, on the basis of MPa), elongation (E, on the basis of %), and delayed fracture resistance were tested with respect to each steel, and the results were shown in Table 2 below.

[78]

[79] Table 2

[Table 2]

[Table]

	C	Mn	Al	Si	Nb	V	TS	El	DFR*	Al/Si
IS* 7	0.6	20	0.5	0.01			980	55	Good	50
IS 8	0.6	18	2	0.8			1030	60	Good	2.5
IS 9	0.6	23	1	0.01	0.03	0.3	1140	62	Good	100
CS* 3	0.6	18	2	1.5			1070	65	Bad	1.33
CS 4	0.6	20	0.01	0.01			970	50	Bad	1

[80] Note) IS is short for Inventive Steel, CS is short for Comparative Steel, and DFR is short for Delayed Fracture Resistance.

[81]

[82] In Table 2, Al was added, Inventive Steels maintained the ratio of Al/Si to be 2 or more, whereas Comparative Steels set the ratio of Al/Si to 2 or less. In order to evaluate the delayed fracture resistance, a time which it takes the steels to cause delayed fracture was measured while the steels were formed in a cup shape at a drawing ratio of 2.0 and then were stored at room temperature. When the time was more than 300 days, the evaluation was good. When the time was less than 300 days, the evaluation was bad.

[83]

[84] As seen from Table 2, it could be found that Inventive Steels 7 through 9 exceeding the ratio of Al/Si of 2 were excellent in tensile strength, elongation and delayed fracture resistance.

[85]

[86] Accordingly, it can be seen from the principle of the present invention that, when Al and Si are properly added and process conditions are appropriately controlled, the automotive high manganese steel having high strength and elongation as well as excellent delayed fracture resistance can be manufactured.

Claims

- [1] High manganese steel comprising, by weight,
0.3% to 0.9% carbon (C),
15% to 25% manganese (Mn),
0.01% to 2.0% silicon (Si),
0.01% to 4.0% aluminum (Al),
0.05% or less sulfur (S),
0.1% or less phosphor (P),
inevitable impurities, and
balance iron (Fe),
wherein Al and Si have a relation of $Al/Si > 2$.
- [2] The high manganese steel of claim 1, further comprising one or two or more selected from the group consisting of, by weight, 0.2% or less niobium (Nb), 0.5% or less vanadium (V), 0.3% or less titanium (Ti), 1.0% or less tungsten (W), 1.0% or less molybdenum (Mo), and 1.0% or less chrome (Cr).
- [3] The high manganese steel of claim 1 or 2, further comprising, by weight, 0.05% or less antimony (Sb).
- [4] The high manganese steel of claim 1 or 2, wherein the high manganese steel has tensile strength of 920 MPa or more and elongation of 55% or more.
- [5] A method of manufacturing high manganese steel, the method comprising:
heating a steel slab at a temperature of 1200°C or less, the steel slab containing, by weight, 0.3% to 0.9% carbon (C), 15% to 25% manganese (Mn), 0.01% to 2.0% silicon (Si), 0.01% to 4.0% aluminum (Al), 0.05% or less sulfur (S), 0.1% or less phosphor (P), inevitable impurities, and balance iron (Fe), and Al and Si having a relation of $Al/Si > 2$;
finish hot rolling the steel slab into a steel sheet at a temperature of 950°C or less;
cooling the finish-hot-rolled steel sheet with water and coiling the cooled steel sheet at a temperature of 550°C or less;
pickling the hot-rolled steel sheet and cold rolling the pickled steel sheet at a rolling reduction of 40% or more; and
continuously annealing the cold-rolled steel sheet at a temperature of 700°C to 830°C.
- [6] The method of claim 5, wherein the steel slab further contains one or two or more selected from the group consisting of, by weight, 0.2% or less niobium (Nb), 0.5% or less vanadium (V), 0.3% or less titanium (Ti), 1.0% or less tungsten (W), 1.0% or less molybdenum (Mo), and 1.0% or less chrome (Cr).
- [7] The method of claim 5 or 6, the steel slab further includes, by weight, 0.05% or

- less antimony (Sb).
- [8] A method of manufacturing a high manganese coated steel sheet, the method comprising:
heating a steel slab at a temperature of 1200°C or less, the steel slab containing, by weight, 0.3% to 0.9% carbon (C), 15% to 25% manganese (Mn), 0.01% to 2.0% silicon (Si), 0.01% to 4.0% aluminum (Al), 0.05% or less sulfur (S), 0.1% or less phosphor (P), inevitable impurities, and balance iron (Fe), and Al and Si having a relation of $Al/Si > 2$;
finish hot rolling the steel slab into a steel sheet at a temperature of 950°C or less;
cooling the finish-hot-rolled steel sheet with water and coiling the cooled steel sheet at a temperature of 550°C or less;
pickling the hot-rolled steel sheet and cold rolling the pickled steel sheet at a rolling reduction of 40% or more;
continuously annealing the cold-rolled steel sheet at a temperature of 700°C to 830°C; and
electroplating the annealed steel sheet.
- [9] The method of claim 8, wherein the steel slab further includes one or two or more selected from the group consisting of, by weight, 0.2% or less niobium (Nb), 0.5% less vanadium (V), 0.3% or less titanium (Ti), 1.0% or less tungsten (W), 1.0% or less molybdenum (Mo), and 1.0% or less chrome (Cr).
- [10] The method of claim 8 or 9, the steel slab further includes, by weight, 0.05% or less antimony (Sb).
- [11] A method of manufacturing a high manganese coated steel sheet, the method comprising:
a reheating step of heating a steel slab at a temperature of 1200°C or less, the steel slab containing, by weight, 0.3% to 0.9% carbon (C), 15% to 25% manganese (Mn), 0.01% to 2.0% silicon (Si), 0.01% to 4.0% aluminum (Al), 0.05% or less sulfur (S), 0.1% or less phosphor (P), inevitable impurities, and balance iron (Fe), and Al and Si having a relation of $Al/Si > 2$;
finish hot rolling the steel slab into a steel sheet at a temperature of 950°C or less;
cooling the finish-hot-rolled steel sheet with water and coiling the cooled steel sheet at a temperature of 550°C or less;
pickling the hot-rolled steel sheet and cold rolling the pickled steel sheet at a rolling reduction of 40% or more;
heat-treating the cold-rolled steel sheet in a continuous hot dip coating line at a temperature of 700°C to 830°C and performing hot dip coating on the heat-treated steel sheet.
- [12] The method of claim 11, wherein the steel slab further includes one or two or

more selected from the group consisting of, by weight, 0.2% or less niobium (Nb), 0.5% less vanadium (V), 0.3% or less titanium (Ti), 1.0% or less tungsten (W), 1.0% or less molybdenum (Mo), and 1.0% or less chrome (Cr).

- [13] The method of claim 11 or 12, the steel slab further includes, by weight, 0.05% or less antimony (Sb).

INTERNATIONAL SEARCH REPORT

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Korean Utility models and applications for Utility models since 1975

Japanese Utility models and applications for Utility models since 1975

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

eKIPASS(KIPO internal) & keywords: high manganese steel, Al, Si, and similar terms

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2007-075006 A1(POSCO) 5 July 2007	1,2,4-6,8,9,11,12
Y	See the abstract; claims 1-13; tables 1, 2; and paragraph [85]	3,7,10,13
Y	WO 2007-074994 A1(POSCO) 5 July 2007 See the abstract; claims 1-24; and paragraph [90], [91]	3,7,10,13
A	US 5647922 A(TAI WOUNG KIM et al.) 15 July 1997 See the abstract; and claim 1	1
A	US 5810950 A(TAI WOUNG KIM et al.) 22 September 1998 See the abstract; and claim 1	1
A	WO 93-13233 A1(PO HANG IRON & STEEL and RES. INST. IND. SCIENCE & TECH) 8 July 1993 cited in the application See the abstract; and claims 9-12	1 - 7



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

13 JANUARY 2009 (13.01.2009)

Date of mailing of the international search report

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

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