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(54) Title: THE METHOD FOR MANUFACTURING THIN STEEL SHEET FOR DEEP DRAWING HAVING EXCELLENT WORKABILITY

(57) Abstract: There is provided a method for manufacturing a thin steel sheet for deep drawing having excellent workability that is generally used for inner and outer panels of an automobile body. A method includes reheating steel slabs containing, by weight%, C: 0.010% or less, Si: 0.4% or less, Mn: 0.06-1.5%, P: 0.03-0.15%, S: 0.020% or less, Sol. Al: 0.40% or less, N: 0.010% or less, Ti: 0.003-0.05%, Nb: 0.003-0.05%, Mo: 0.10% or less, B: 0.0002-0.0030%, one or both of Sb: 0.005-0.10% and Sn: 0.005-0.10%, the balance Fe, and unavoidable impurities, completing finish rolling the reheated steel slabs at the single phase austenite region while a reduction ratio of rough rolling and finish rolling is in the range of 1.0 (50%:50%)-4.0 (80%:20%), and strip- cooling rate of final three pass is 30°C/sec or more during finish rolling, coiling the finish rolled steel sheet, cold rolling the coiled hot-rolled steel sheet at a cold rolling reduction ratio of 60% or more, and continuously annealing the cold-rolled steel sheet at a temperature of a range of 780-8600C, in which the average size of precipitates satisfies 20-60 nm. As described above, according to the embodiment of the present invention, it is possible to provide a thin steel sheet for deep drawing having tensile strength of 28-50 kg/mm and more excellent workability and galvanizing properties than a thin steel sheet for deep drawing according to the related art.

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Description

THE METHOD FOR MANUFACTURING THIN STEEL SHEET FOR DEEP DRAWING HAVING EXCELLENT WORKABILITY

Technical Field

[1] The present invention relates to a method for manufacturing a thin steel sheet for deep drawing having excellent workability that is generally used for inner and outer panels of an automobile body, and more particularly, to a method for manufacturing a thin steel sheet for deep drawing having tensile strength of 28-50 kg/mm^2, excellent galvanizing properties, and more excellent formability than high-strength steel for deep drawing according to the related art.

[2]

Background Art

[3] In recent years, as components of an automobile have had more complicated structures and integrated into a single body, steel sheets having excellent formability are required for the automobile. Further, taking into account the use of the automobile, the steel sheets have also been required to have good galvanizing appearance.

[4] However, in order to improve the formability of the steel sheets, a so-called IF steel may be used. In the IF steel, high-purity steel, in which impurity elements, such as, carbon, nitrogen, and sulfur, hardly exist in steel, is used as a basic constituent, and Ti, Nb, and the like are added thereto. In general, solid solution strengthening elements, such as Si, Mn, and P, are added to obtain the target strength.

[5] However, the elements, such as Ti, Mn, and Si, are segregated to the surface during annealing, which results in deterioration of hot-dip galvanizing properties. That is, re-crystallization annealing is performed at the temperature of 760°C or more to soften structures that are work-hardened after cold rolling. Since most of the added elements have a higher affinity to oxygen than Fe, the elements are grown to surface ag-glomerates in singular or composite forms, such as MnO, SiO_2, Al_2O_3, and TiO, during annealing.

[6] Further, since the high-purity IF steel hardly has impurity elements, grain boundary embrittlement is much more likely to occur. In order to prevent this, B, which is known as a grain boundary strengthening element, is generally added. However, the element B is also segregated to the surface. As the amount of surface agglomerates increases, the wettability of a galvanizing bath is decreased during hot dipping, and an alloying reaction is prevented. Therefore, surface defects, such as non-plated parts, are likely to occur.

[7] Further, when coarsening of the surface agglomerates occurs, the coarsened surface

agglomerates are attached to a hearth roll of a continuous furnace to form fine dents on the surface of the plated steel sheet, which results in poor surface quality.

[8] In general, when a thin steel sheet for deep drawing is manufactured, ultra-low carbon IF (Interstitial Free) steel is used. In the ultra-low carbon IF steel, in order to ensure good formability, the amount of interstitial solid elements, such as C and N, is reduced to 50 ppm or less during steelmaking, and carbonitride forming elements Ti and Nb are separately added in singular or composite forms.

[9] Parent patents disclose the above-described technique for manufacturing a thin steel sheet for deep drawing using the IF steel. Examples of the parent patents include Ti-containing steel (Japanese Patent No.564385) to Yawata, the predecessor of NSC in Japan that applied for the patent for the first time around the world, Nb-containing steel to Armco Steel Corporation in USA, improved Ti-containing steel(Japanese Patent No.1278670) of NSC, and Ti-Nb containing steel of KSC. In addition to the parent patents, a great number of related patents, which have slightly different conditions that define a method of composing components and manufacturing conditions, have been applied around the world. According to the these patents, the carbonitride forming elements Ti and Nb of 0.01 to 0.07% are generally added to the ultra-low carbon steel so as to ensure workability.

[10] However, since interstitial solid elements that strengthen the grain boundaries do not exist in the steel, it is difficult to avoid secondary work embrittlement. This problem is worsened in the case of high-strength steel for deep drawing, where solid solution strengthening elements, such as P and Mn, are added. To solve this problem, the grain boundary strengthening element B may be added, or the carbon content in steel may be limited to 60 ppm or more. In this case, poor workability is caused, and the galvanizing properties are deteriorated when manufacturing galvannealed (GA) products.

[11] In order to solve the above-described galvanizing problems, methods including a method of preventing the formation of agglomerates on the surface during cold annealing by performing pre-oxidation on hot-rolled coils before the cold annealing (Japanese Laid-open Publication No. 2001-288550) have been proposed. However, according to the methods, the effect of the addition of predetermined elements is unclear. Further, since the methods cannot be performed in a general hot rolling-cold rolling-continuous annealing line, they have not been put into commercial production.

[12] A method of improving galvanizing properties by adding predetermined elements, such as Sb, (Korean Application No. 2005-0078433) has also been proposed. According to the method, it is difficult to reliably ensure workability, which is required as an essential characteristic of a product according to an exemplary embodiment of the present invention.

Disclosure of Invention

Technical Problem

[13] An aspect of the present invention provides a method for manufacturing a thin steel sheet for deep drawing having tensile strength of 28-50 kg/mm^2 and more excellent workability and galvanizing properties than a thin steel sheet for deep drawing according to the related art by controlling alloy components and precipitates by controlled rolling during hot rolling.

[14]

Technical Solution

[15] According to an aspect of the present invention, there is provided a manufacturing a thin steel sheet for deep drawing having excellent hot-dip galvanizing properties, the method including reheating steel slabs containing, by weight%, C: 0.010% or less, Si: 0.4% or less, Mn: 0.06-1.5%, P: 0.03-0.15%, S: 0.020% or less, Sol. Al: 0.40% or less, N: 0.010% or less, Ti: 0.003-0.05%, Nb: 0.003-0.05%, Mo: 0.10% or less, B: 0.0002-0.0030%, one or both of Sb: 0.005-0.10% and Sn: 0.005-0.10%, the balance Fe, and unavoidable impurities, completing finish rolling the reheated steel slabs at the single phase austenite region while a reduction ratio of rough rolling and finish rolling is in the range of 1.0 (50%:50%)-4.0 (80%:20%), and strip-cooling rate of final three pass is 30℃/sec or more during finish rolling, coiling the finish rolled steel sheet, cold rolling the coiled hot-rolled steel sheet at a cold rolling reduction ratio of 60% or more, and continuously annealing the cold-rolled steel sheet at a temperature of a range of 780-860℃. Here, in which the average size of precipitates satisfies 20-60 nm.

[16]

Advantageous Effects

[17] According to the embodiment of the present invention, it is possible to provide a thin steel sheet for deep drawing having tensile strength of 28-50 kg/mm^2 and more excellent workability and galvanizing properties than a thin steel sheet for deep drawing according to the related art.

[18]

Best Mode for Carrying Out the Invention

[19] Hereinafter, exemplary embodiments of the present invention will be described in detail.

[20] The present inventors have proposed exemplary embodiments of the present invention on the basis of research results that it is possible to ensure more excellent workability and galvanizing properties than a thin steel plate for deep drawing according to the related art by controlling alloy components and the grain size of precipitates by controlled rolling during hot rolling in a thin steel sheet for deep drawing

having tensile strength of 28-50 kg/mm^2.

[21] A composition range of steel components according to an exemplary embodiment of the present invention will now be described.

[22] Preferably, the C content is 0.010% or less.

[23] The carbon in steel serves as an interstitial solid element to prevent formation of the {111} texture, which is advantageous for workability, when the texture of a steel sheet is formed during cold rolling and annealing. Further, if the C content in steel is high, the contents of carbonitride forming elements Ti and Nb need to be increased, which increases manufacturing costs. Therefore, it is preferable that the C content be 0.010% or less.

[24] Preferably, the Si content in steel is 0.4% or less.

[25] Si is an element that can be used to improve the strength of the steel. However, Si also causes the surface scale in terms of surface characteristics, and generates temper colors during annealing and non-plated parts during galvanizing. In general, the Si content is limited to 0.1% or less. However, in recent years, with the development of galvanizing techniques, it is possible to manufacture a steel sheet with the Si content of approximately 0.4% without forming non-plated parts. Therefore, it is preferable that the Si content be less than 0.4% or less.

[26] Preferably, the Mn content is in the range of 0.06-1.5%.

[27] The Mn in steel is added as a substitutional solid solution strengthening element to ensure the strength in the steel. However, when the Mn content exceeds 1.5%, segregation toward the center of thickness may occur, and an r-value together with elongation may be rapidly decreased. On the other hand, when the Mn content is less than 0.06%, embrittlement may occur in the steel due to S in steel. Therefore, it is preferable that the Mn content be in the range of 0.06-1.5%.

[28] Preferably, the P content is in the range of 0.03-0.15%.

[29] P in steel as well as Mn is one of representative solid solution strengthening elements that are added to improve the strength. In a case of Ti-Nb steel according to the exemplary embodiment of the present invention, P may result in development of the {111} texture, which is advantageous for the r-value, by grain refinement and grain boundary segregation as well as the increase in strength. In order to obtain the above-described effects, P of 0.03% or more needs to be added. However, when the P content exceeds 0.15%, elongation may be rapidly reduced and embrittlement of the steel may be significantly increased. Therefore, it is preferable that the maximum value of the P content be limited to 0.15%.

[30] Preferably, the S content is 0.020% or less.

[31] In general, when steel for deep drawing is manufactured, the S content in steel is limited to a low value of 0.005% or less. However, since the steel according to the

exemplary embodiment of the present invention contains Mn, all the S in steel is precipitated as MnS, and thus it is possible to avoid deterioration in workability due to the solid solution of S. Therefore, it is preferable that the S content be 0.020% or less while avoiding a region where an edge crack may occur during rolling.

[32] Preferably, the Sol.Al content is 0.40% or less.

[33] When Sol.Al in steel is put into the steel as a deoxidizer, dissolved oxygen in steel is maintained at a low enough level, and in terms of economic efficiency, the Sol.Al content is generally in the range of 0.02-0.07%. In this way, steel is manufactured. However, when Sol.Al is put into the steel as an alloy component, Sol.Al causes the coarsening of precipitates in steel, prevents the effect of suppressing recrystallization by P so as to promote the recrystallization, and improves the development of the {111} texture. However, when the Sol.Al content exceeds 0.40%, it may cause an increase in the manufacturing costs and deterioration in continuous casting operation. Therefore, it is preferable that the Sol.Al content be 0.40% or less.

[34] Preferably, the N content is 0.010% or less.

[35] When nitrogen in steel exists in a solid solution state, N significantly reduces workability. Further, when the N content is high, the Ti and Nb contents need to be increased to fix N as precipitates in the steel. Therefore, it is preferable that the N content be 0.010% or less.

[36] Preferably, each of the Ti and Nb content is in the range of 0.003-0.05%.

[37] Ti and Nb are very important elements in order to ensure workability. It is preferable that each of the Ti and Nb contents be in the range of 0.003-0.05% in consideration of minimum and optimum amounts to reliably ensure the enhancement of workability (particularly, r-value).

[38] Preferably, the Mo content is 0.10% or less.

[39] Even though Mo in steel is added as an element that improves the secondary work embrittlement resistance and the galvanizing properties. However, when the Mo content exceeds 0.10%, the improving effect by Mo is greatly reduced and manufacturing costs are increased. Therefore, it is preferable that the Mo content be 0.10% or less.

[40] Preferably, the B content is in the range of 0.0002-0.0030%.

[41] B in steel is a grain boundary strengthening element that improves the fatigue properties of spot welded joints, and prevents grain boundary embrittlement of the IF steel with high purity. In order to obtain these effects, the B content needs to be 0.0002% or more. On the other hand, when the B content exceeds 0.0030%, this causes poor workability and reduces the surface quality of the plated steel sheet. Therefore, it is preferable that the B content be in the range of 0.0002-0.003%.

[42] Further, in the exemplary embodiment of the present invention, at least one kind of

Sb: 0.005-0.10% and Sn: 0.005-0.10% may be additionally contained.

[43] Preferably, the Sb content is in the range of 0.005-0.10%.

[44] Sb concentrates at the grain boundaries of the steel. When elements Mn, Si, Al, and B in steel diffuse through the grain boundaries during recrystallization annealing, Sb prevents agglomeration of oxides on the surface. Since large surface agglomerates may cause formation of dents in the furnace, the average size of agglomerates needs to be 1.0 □ or less.

[45] In order to obtain the above-described effects by the addition of Sb in the steel, the Sb content needs to be 0.005% or more. However, when the Sb content is more than a predetermined level, the desired effects cannot be obtained, and workability is significantly reduced. Therefore, it is preferable that a maximum value of the Sb content be limited to 0.10%.

[46] Preferably, the Sn content is in the range of 0.005-0.10%.

[47] Sn in steel as well as the Sb is an element that may cause grain boundary segregation, and has similar effects to Sb. In order to obtain the effects, the Sn content needs to be 0.005% or more. However, when the Sn content is more than a predetermined level, desired effects cannot be obtained, and workability is reduced. Therefore, it is preferable that the maximum value of Sn content be limited to 0.10%.

[48] The steel according to the exemplary embodiment of the present invention contains the balance Fe and unavoidable impurities in addition to the above-described components.

[49] According to the exemplary embodiment of the present invention, the average size of precipitates of the thin steel sheet is controlled to be in the range of 20-60 nm in order to ensure workability.

[50] Ti and Nb that are added to the steel according to the embodiment of the present invention are combined with the impurity elements, the solid solution elements in steel, such as N, S, and C, to thereby form precipitates. The size and distribution of precipitates affect workability of final cold-rolled and plated products.

[51] That is, when all of the impurity elements C, N and S of the hot-rolled steel sheet are fixed as precipitates, if ultra-fine precipitates of tens of Å or less hardly exist, but precipitates of hundreds of Å or more are evenly distributed, an r-value of the cold-rolled and plated steel sheet is significantly improved.

[52] Among the precipitates, coarsened precipitates of hundreds of nanometers or more that are formed in a reheating zone slightly affect the quality of material of the steel, while the size and distribution of precipitates that are formed during rolling greatly affects the workability. The size and distribution of precipitates greatly depend on hot rolling temperature, rolling reduction, and cooling rate during rolling.

[53] That is, the formation of the precipitates is promoted by dynamic precipitation

during rolling. As the rolling reduction and the cooling rate are increased at a temperature where the formation of precipitation is actively performed, it is easier to form the precipitates. Therefore, the higher the rolling reduction during finish rolling, the easier it is to form the precipitates. Further, since the formed precipitates are dynamic precipitates, the average size of precipitates containing Nb, Ti, Al, N, C, and S in steel are 20-60 nm, that is, the relatively coarsened precipitates are formed. When the precipitates are 20 nm or less, the quality of material may be deteriorated due to the ultra-fine precipitates. On the other hand, when the precipitates exceed 60 nm, the precipitates are separated from each other by large intervals. Thus, a small amount of an interstitial solid solution element is not precipitated but may exist in the steel.

[54] Hereinafter, a method for manufacturing a thin steel sheet having the above-described composition will be described in detail.

[55] First, steel slabs having the above-described composition are reheated. Then, the steel slabs are subjected to finish rolling at the single phase austenite region while a reduction ratio of rough rolling and finish rolling is in the range of 1.0 (50%:50%)-4.0 (80%:20%), and strip-cooling rate of final three pass is 30℃/sec or more during finish rolling.

[56] As described above, the reduction ratio of rough rolling and finish rolling has a minimum value of 1.0. This is because high rolling reduction in finish rolling causes a significant increase in rolling load. Further, the reason the reduction ratio thereof has a maximum value of 4.0 is that the r-value is hardly increased at the reduction ratio exceeding 4.0.

[57] Further, when the strip-cooling rate of final three pass is set to 30℃/sec or less during finish rolling, very fine precipitates of 10 nm or less can be formed in the steel.

[58] The reheated steel slabs are subjected to the finish rolling at the single phase austenite region according to the above-described reduction method. Then, the finish-rolled steel sheet is coiled, and the hot-rolled steel sheet is subjected to cold rolling at a cold rolling reduction ratio of 60%.

[59] When the cold rolling reduction ratio is less than 60%, it may be difficult to obtain a high r-value, which is required in the exemplary embodiment of the present invention.

[60] Then, the cold-rolled steel sheet is subjected to continuous annealing at a temperature of 780-860℃.

[61] When the continuous annealing temperature is less than 780℃, it is difficult to obtain the high r-value, which is required according to the exemplary embodiment of the present invention. Meanwhile, when the annealing temperature exceeds 860℃, a problem may occur in passing properties of the steel strip due to the high-temperature annealing. Therefore, it is preferable that the steel sheet be subjected to the continuous annealing at the temperature of 780-860℃.

Mode for the Invention

[62] Hereinafter, an exemplary embodiment of the present invention will be described in detail.

[63] [Embodiment]

[64] As can be seen in Table 1, steel slabs containing high-strength steel for deep drawing (DDQ, 35E, 40E, and 45E grades) having tensile strength of 28, 35, 40, and 45 kg/mm^2, respectively, are reheated at the temperature of 1200℃, and then heat rolled under the condition that the finish-rolling temperature is 900℃. As shown in Table 2 below, a reduction ratio of rough rolling and finish rolling, and strip-cooling rate of final three pass during finish rolling are controlled. After the cold rolling and continuous annealing, a galvanizing process is performed in a Zn bath of 0.12-0.19Al%, and alloying heat treatment is performed on Zn galvanizing at the temperature of 540-560℃. In this way, galvannealed steel sheets are manufactured. In Table 2, mechanical characteristics of inventive steel and comparative steel, the size of precipitates, powdering rate, and the like are shown.

[65] In Table 2, powdering is determined in such a manner that a plated steel sheet is cut 20×50 mm, a bending test is performed at an angle of 60°, and tape is applied to a region where the plated steel sheet is unbent. The width of a plated layer removed from the plated steel sheet is determined as follows.

[66] 1: no galvanizing removed or width of plated layer removed is within 1 mm

[67] 2: width of plated layer removed is in the range of 1-3 mm

[68] 3: width of plated layer removed is in the range of 3-5 mm

[69] 4: width of plated layer removed is 5 mm or more

[70]

[71] Table 1

The Type of Steel	Chemical composition (weight%, ppm for B)													Remark	
	C	Si	Mn	P	S	S. Al	N	Ti	Nb	B	Mo	Sb	Sn		
1	0.003	0.02	0.12	0.008	0.007	0.11	0.003	0.008	0.015	3	-	0.02	-	Inventive steel	Tensile strength 28 kg/mm² grade
2	0.001	0.02	0.09	0.005	0.008	0.09	0.002	0.008	0.014	4	-	0.03	-	Inventive steel	
3	0.003	0.02	0.08	0.008	0.012	0.04	0.002	0.02	0.019	-	-	-	-	Comparative steel	
4	0.004	0.02	0.58	0.038	0.01	0.21	0.003	0.007	0.024	5	0.02	0.04	-	Inventive steel	Tensile strength 35kg/mm² grade
5	0.002	0.02	0.54	0.042	0.008	0.08	0.002	0.008	0.009	8	0.02	0.04	-	Inventive steel	
6	0.003	0.02	0.38	0.058	0.012	0.04	0.003	0.048	-	4	-	-	-	Comparative steel	
7	0.003	0.02	0.76	0.084	0.007	0.24	0.002	0.007	0.028	11	0.03	0.04		Inventive steel	Tensile strength 40kg/mm² grade
8	0.003	0.02	0.84	0.091	0.008	0.34	0.003	0.006	0.01	7	0.03	-	0.03	Inventive steel	
9	0.003	0.02	0.78	0.094	0.01	0.05	0.002	0.049	-	9	-	-	-	Comparative steel	
10	0.002	0.02	1.12	0.091	0.007	0.14	0.003	0.006	0.028	10	0.03	0.03	0.01	Inventive steel	Tensile strength 45kg/mm² grade
11	0.003	0.02	1.15	0.087	0.012	0.05	0.002	0.008	0.026	11	0.03	0.04	-	Inventive steel	
12	0.004	0.02	0.83	0.095	0.009	0.04	0.003	0.043	-	7	-	-	-	Comparative steel	

[72] Table 2

The Type of Steel	Reduction ratio of rough rolling /finish rolling	Cooling rate during finish rolling (℃ /sec)	Cold rolling reduction ratio (%)	Continuous annealing temperature (℃ /sec)	Tensile strength (kg/ mm^2)	Elongation (%)	R-value	Average size of precipitates (nm)	Plating properties (powdering resistance)	Remark	
1	2.8	32	73	835	29.7	50.7	2.24	40	1	Inventive steel	Tensile strength 28kg grade
2	2.8	34	73	835	28.9	49.8	2.32	42	1		
3	5.2	20	73	830	29.9	47.9	1.92	12	2	Comparative steel	
4	3.2	38	75	815	36.1	45.0	2.20	51	1	Inventive steel	Tensile strength 35kg grade
5	3.2	38	75	810	36.8	44.3	2.35	54	1		
6	5.2	15	75	830	35.4	45.3	1.84	23	3	Comparative steel	
7	3.5	35	73	798	41.6	37.0	2.26	49	1	Inventive steel	Tensile strength 40kg grade
8	3.5	33	73	825	42.1	36.7	2.41	52	1		
9	4.5	16	73	830	41.4	37.2	1.81	18	4	Comparative steel	
10	3.7	38	68	793	45.5	33.9	2.10	52	1	Inventive steel	Tensile strength 45kg grade
11	3.7	39	68	812	46.3	33.2	2.13	55	2		
12	4.5	17	68	840	45.2	34.2	1.78	21	4	Comparative steel	

[73]

[74] As shown in Table 2, inventive steel that satisfies the composition range and the manufacturing method according to the exemplary embodiment of the present invention has precipitates, of which the average size is in the range of 40-55 nm. As compared with the general comparative steel, such as thin steel sheets for deep drawing of 28, 35, 40, and 45 kg/mm^2 grades, the inventive steel can ensure good mechanical characteristics (tensile strength and elongation), and has excellent workability (r-value) and galvanizing properties (powdering resistance).

[75] However, the comparative steel that has been manufactured using steel slabs, which do not contain Nb or B, and does not comply with the manufacturing method according to the exemplary embodiment of the present invention, has poor workability and galvanizing properties as compared with the inventive steel.

Claims

[1] A method for manufacturing a thin steel sheet for deep drawing having excellent hot-dip galvanizing properties, the method comprising:
reheating steel slabs containing, by weight%, C: 0.010% or less, Si: 0.4% or less, Mn: 0.06-1.5%, P: 0.03-0.15%, S: 0.020% or less, Sol. Al: 0.40% or less, N: 0.010% or less, Ti: 0.003-0.05%, Nb: 0.003-0.05%, Mo: 0.10% or less, B: 0.0002-0.0030%, one or both of Sb: 0.005-0.10% and Sn: 0.005-0.10%, the balance Fe, and unavoidable impurities;
completing finish rolling the reheated steel slabs at the single phase austenite region while a reduction ratio of rough rolling and finish rolling is in the range of 1.0 (50%:50%)-4.0 (80%:20%), and strip-cooling rate of final three pass is 30℃/sec or more during finish rolling;
coiling the finish rolled steel sheet;
cold rolling the coiled hot-rolled steel sheet at a cold rolling reduction ratio of 60% or more; and
continuously annealing the cold-rolled steel sheet at a temperature of a range of 780-860℃,
wherein the average size of precipitates satisfies 20-60 nm.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/KR2007/006628

A. CLASSIFICATION OF SUBJECT MATTER

C21D 8/02(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)
IPC 8: C21D, C22C, C23C

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 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)
e-KIPASS (KIPO internal) & keywords: Zinc, plating, Tin, Stibium 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.
P, A	KR 10-2007-0023995 A (POSCO) 2 March 2007, cited in the application. See the abstract; page 2, line 37 - page 4, line 21; and claims 1-8.	1
A	US 06911268 B (YOSHIHISA TAKADA et al.) 28 June 2005 See the abstract; column 2, line 65 - column 4, line 51; and claims 1-9.	1
A	US 06517955 B (YOSHIHISA TAKADA et al.) 11 February 2003 See the abstract; column 3, line 4 - column 5, line 32; and claims 1-15.	1
A	JP 2002-294397 A (NIPPON STEEL CORP.) 9 October 2002 See the abstract; paragraphs 11- 63; and claims 1-15.	1
A	JP 02-163346 A (NISSHIN STEEL CO., LTD.) 22 June 1990 See the abstract; and claims 1-2.	1
A	JP 06-057337 A (NIPPON STEEL CORP.) 1 March 1994 See the abstract; paragraphs 5-16; and claims 1-2.	1

☐ 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 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
20 MARCH 2008 (20.03.2008)	**20 MARCH 2008 (20.03.2008)**

Name and mailing address of the ISA/KR

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KIM, Seong Kon

Telephone No. 82-42-481-5526

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
KR 10-2007-0023995 A	02.03.2007	WO2007024114A1	01.03.2007
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		EP1354970A4	01.12.2004
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