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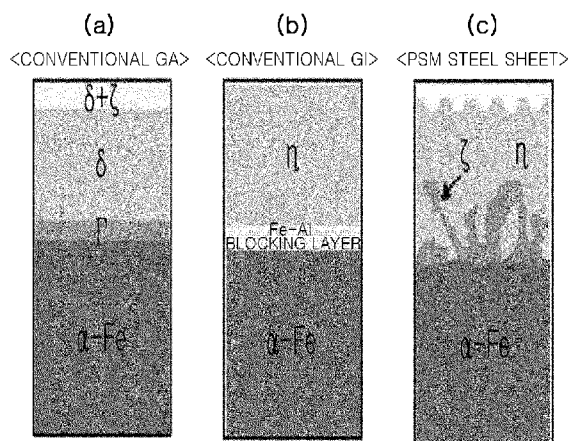
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(54) Title: GALVANNEALED STEEL SHEET HAVING SUPERIOR ADHESIVENESS OF PLATED FILM AND METHOD
FOR MANUFACTURING THE SAME

[Fig. 1]



(57) Abstract: There are provided a galvanized steel sheet used in an inner plate or an outer plate of an automobile, and a method for manufacturing the same. The galvanized steel sheet having excellent adhesiveness to zinc coating layer has a galvanized coating layer formed in at least one surface thereof, wherein a Fe content of the galvanized coating layer is in a range from 5 to 9%, and has an eta phase and a zeta phase as a Zn-Fe phase. Also, the method for manufacturing a galvanized steel sheet includes: galvanizing a steel sheet, and alloying the galvanized steel sheet at a temperature of 470 to 530°C so that an alloyed coating layer has a Fe content of 5 to 9% and has an eta phase and a zeta phase as a Zn-Fe phase. The hybrid galvanized steel sheet having advantages of both a galvanizing steel sheet (GI) and a galvanized steel sheet (GA) may be useful to improve general physical properties such as weldability, powdering resistance, adhesion to a bond, etc.

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Description

GALVANNEALED STEEL SHEET HAVING SUPERIOR ADHESIVENESS OF PLATED FILM AND METHOD FOR MANUFACTURING THE SAME

Technical Field

- [1] The present invention relates to a galvanized steel sheet used in an inner plate or an outer plate of an automobile and a method for manufacturing the same, and more particularly, to a galvanized steel sheet capable of solving the film peeling problem caused due to the low interfacial adhesion that is one of disadvantages of a galvanized steel sheet (GA), and also improving the poor weldability that is one of disadvantages of a galvanizing steel sheet (GI), and a method for manufacturing the same.

[2]

Background Art

- [3] Recently, as attentions have been taken to environment-friendly issues, high-strength galvanized steel sheets tends to be increasingly used in the field of automobiles in aspect of the safety, light weight and light duty of the automobiles.
- [4] However, a galvanizing steel sheet (GI steel sheet) has a problem that life span of electrodes in a welding rod may be reduced and paintability may be poor in a welding procedure from automobile manufacturers since a coating layer of the steel sheet is composed of pure zinc. As a result, a GA steel sheet, prepared by alloying a GI steel sheet, has been increasingly used. However, the GA steel sheet has problems of powering and flaking in which a coating layer is peeled off upon press forming since the coating layer is composed of brittle Fe-Zn intermetallic compounds.
- [5] Meanwhile, since the galvanizing steel sheet is processed in the assembly into automobile parts from automobile clients using a bond in addition to the conventional spot welding, there has been a demand for the development of a novel high-strength steel sheet that satisfies the solution of the film peeling problem of the galvanized steel sheet (GA) and the improvement of the poor weldability of the galvanizing steel sheet (GI) at the same time.
- [6] A Fe content means a numerical value representing the content (%) of Fe in a coating layer, and the Fe content in conventional GA steel sheets is in a range of about 9 to 11%. When the coating layer has a high Fe content, delta and gamma phases grow suddenly through the brittle reaction of Fe and Zn, which leads to the easy peeling of

zinc coating layers between an iron interface and a coating layer. For these steel sheets, it is difficult to use an adhesive to process the steel sheets. Meanwhile, the conventional GI steel sheets does not have process-induced defects caused by the peeling between the interface and the coating layer since the alloying reaction is not induced in the conventional GI steel sheets. However, the conventional GI steel sheets have problems that, since a surface of the coating layer is composed of pure zinc for the GA steel sheet, the life span of a copper welding rod is significantly reduced and the weldability is poor in the welding procedure from automobile manufacturers.

[7]

Disclosure of Invention

Technical Problem

[8] The present invention is designed to solve the problems of the prior art, and therefore it is an object of the present invention to provide a hybrid galvanized steel sheet capable of solving the film peeling problem caused due to the low interfacial adhesion that is one of disadvantages of a galvanized steel sheet (GA), and also improving the poor weldability that is one of disadvantages of a galvanizing steel sheet (GI).

[9] Also, it is another object of the present invention to provide a method for manufacturing the same.

[10]

Technical Solution

[11] According to an aspect of the present invention, there is provided a galvanized steel sheet having excellent adhesiveness to zinc coating layer, the steel sheet having a galvanized coating layer formed in at least one surface thereof, wherein a Fe content of the galvanized coating layer is in a range from 5 to 9%, and having an eta phase and a zeta phase as a Zn-Fe phase. In this case, the eta phase may be present as the Zn-Fe phase at contents of 90% or more, and the zeta phase may be present as the Zn-Fe phase at contents of 10% or less.

[12] Also, oil pockets having a diameter of 20 to 50 μm may be formed in a surface of the galvanized coating layer.

[13] According to another aspect of the present invention, there is provided a method for manufacturing a galvanized steel sheet including: galvanizing a steel sheet, and alloying the galvanized steel sheet at a temperature of 470 to 530°C so that an alloyed coating layer has a Fe content of 5 to 9% and has an eta phase and a zeta phase as a Zn-Fe phase.

- [14] In this case, the eta phase may be present as the Zn-Fe phase at contents of 90% or more, and the zeta phase may be present as the Zn-Fe phase at contents of 10% or less. Also, oil pockets may be formed in a surface of the alloyed coating layer by performing a temper rolling process on the alloyed steel sheet using an embossing roll.
- [15] Also, the galvanizing process may be performed in a galvanizing bath containing Al of 0.12 to 0.2% by weight and the balance of Zn and other inevitable impurities. And, oil pockets having a diameter of 20 to 50 μm (micrometer) may be formed in a surface of the galvanized coating layer.
- [16] The steel sheets used in the present invention may be possible if they may be galvanized or galvanized. As one of the most preferred examples, the galvanized steel sheet may include, by weight: 0.005% or less of carbon (C); 0.003 to 0.02% of sulfur (S); at least one selected from the group consisting of 0.2% or less of manganese (Mn) and 0.2% or less of copper (Cu); and the balance of Fe and other inevitable impurities. As another of the most preferred examples, the galvanized steel sheet may include, by weight: 0.01% or less of C; 0.005 to 0.02% of S; 0.0001 to 0.002% of boron (B); at least one compound of 0.01 to 0.2% of Cu and 0.01 to 0.3% of Mn; at least one compound of 0.002 to 0.04% of niobium (Nb) and 0.005 to 0.15% of titanium (Ti); and the balance of Fe and other inevitable impurities. Also, the galvanized steel sheet may include at least one compound selected from the group consisting of compounds A, B and C:
- [17] A: at least one selected from the group consisting of 0.1 to 0.8% of silicon (Si), 0.03 to 0.2% of phosphorus (P) and 0.2 to 1.2% of chromium (Cr),
- [18] B: at least one selected from the group consisting of 0.01 to 0.2% of molybdenum (Mo) and 0.01 to 0.2% of vanadium (V), and
- [19] C: 0.01 to 0.1% of aluminum (Al) and 0.02% or less of nitrogen (N).
- [20]

Advantageous Effects

- [21] According to the present invention, provided is the galvanized steel sheet having excellent adhesion to a bond, as well as excellent spot weldability and powdering resistance. Also, provided also is the galvanized steel sheet having improved press workability when oil pockets are formed in the galvanized steel sheet.
- [22]

Brief Description of the Drawings

- [23] FIG. 1 is a schematic view illustrating a Zn-Fe phase formed in a galvanized

coating layer. In FIG. 1, (a) shows a conventional galvanized steel sheet (GA), (b) shows a conventional galvanizing steel sheet (GI), and (c) shows a galvanized steel sheet (GA) according to the present invention.

[24] FIG. 2 is a scanning electron microscopic (SEM) diagram illustrating a galvanized coating layer. In FIG. 2, (a) shows a galvanized steel sheet (GA) according to the present invention, (b) shows a conventional galvanized steel sheet (GA), and (c) shows a conventional galvanizing steel sheet (GI).

[25] FIG. 3 is photographic diagram illustrating the test results of steel sheets for adhesion to a bond. In FIG. 3, (a), (b) and (c) shows inventive galvanized steel sheets, and (d) shows a conventional galvanized steel sheet (GA).

[26]

Best Mode for Carrying Out the Invention

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

[28] According to the present invention, a hybrid galvanized steel sheet having the advantages of both a galvanizing steel sheet (GI) and a galvanized steel sheet (GA) is provided. Hereinafter, exemplary embodiments of the present invention will be described in detail with reference to the accompanying drawings. In the drawings, the shapes and sizes may be exaggerated for more clear descriptions, and the same components in the drawings have the same reference numerals.

[29] The hybrid galvanized steel sheet according to the present invention may ensure both of the weldability and powder resistance at the same time by adjusting a Fe content of the galvanized steel sheet to a suitable Fe content range with the attempts to improve the weldability of a galvanizing steel sheet (GI), as well as to improve the powdering resistance of a galvanized steel sheet (GA). According to the present invention, a Fe content in a galvanized coating layer is in a range from 5 to 9%, and an eta phase and a zeta phase are present as a Zn-Fe phase. Preferably, the eta phase and the zeta phase are present at contents of 90% or more and 10% or less in the galvanized steel sheet, respectively.

[30] In FIG. 1, (a) and (b) show Zn-Fe phases that may be seen in coating layers of the conventional GA steel sheet and GI steel sheet, respectively. A delta phase (δ) and a capital gamma phase (Γ) are present in the coating layer of the GA steel sheet, and the presence of the phases adversely affects the powdering resistance. And, the GI steel sheet has poor weldability since the eta phase (η) is mainly present in the steel sheet. The GA steel sheet according to the present invention mainly has a zeta phase (ζ) and

an eta phase (η), as shown in FIG. 1(c). The GA steel sheet according to one exemplary embodiment of the present invention may ensure the weldability and powdering resistance at the same time when the GA steel sheet has an eta phase and a zeta phase while satisfying a Fe content of 5 to 9%. More preferably, the GA steel sheet according to the present invention has a Fe content of 5 to 7%. When the Fe content is less than 9%, only the powdering property is ensured in the GA steel sheet. In addition, the powdering property is further improved when the Fe content is reduced to 7% or less. In this case, the weldability of the GA steel sheet may be ensured only when the Fe content exceeds 5%. In the case of the GA steel sheet, a zeta phase (ζ) and an eta phase (η) are mainly present as the Zn-Fe phase. However, the GA steel sheet according to one exemplary embodiment of the present invention may have both the powdering resistance and weldability for sure when the eta phase (η) is present at contents of 90% or more and the zeta phase (ζ) is present at contents of 10% or less.

[31] Kinds of various steel sheets that may be used in a galvanizing process may be used in the present invention, but the present invention is not particularly limited thereto. For example, there are steel sheets proposed in International Publication Nos. WO05/045085 and WO05/061748 by the present inventors. That is to say, one example of the galvanized steel sheet may include a steel sheet including, by weight: 0.005% or less of carbon (C); 0.003 to 0.02% of sulfur (S); at least one selected from the group consisting of 0.2% or less of manganese (Mn) and 0.2% or less of copper (Cu); and the balance of Fe and other inevitable impurities. Also, another example of the galvanized steel sheet may include a steel sheet including, by weight: 0.01% or less of C; 0.005 to 0.02% of S; 0.0001 to 0.002% of boron (B); at least one compound of 0.01 to 0.2% of Cu and 0.01 to 0.3% of Mn; at least one compound of 0.002 to 0.04% of niobium (Nb) and 0.005 to 0.15% of titanium (Ti); and the balance of Fe and other inevitable impurities. A kind of the galvanized steel sheets may include at least one compound selected from the group consisting of compounds A, B and C:

[32] A: at least one selected from the group consisting of 0.1 to 0.8% of silicon (Si), 0.03 to 0.2% of phosphorus (P) and 0.2 to 1.2% of chromium (Cr),

[33] B: at least one selected from the group consisting of 0.01 to 0.2% of molybdenum (Mo) and 0.01 to 0.2% of vanadium (V), and

[34] C: 0.01 to 0.1% of aluminum (Al) and 0.02% or less of nitrogen (N).

[35] Oil pockets having a diameter of 20 to 50 μm are preferably formed in a surface of the coating layer having a low Fe content according to the present invention. The term oil pocket means a groove that is formed in a surface of a steel sheet to carry oils. The oil

pockets may be formed using a pre-texture roll whose surface has embossing projections. The galvanizing steel sheet may ensure lubricant properties due to the presence of the oil pockets during the press-forming of the galvanizing steel sheet.

[36] The method for manufacturing a steel sheet with a low Fe content according to the present invention will be described in more detail.

[37] First, a steel sheet is galvanized and alloyed. The galvanizing process is performed in a conventional galvanizing bath. In this case, the galvanizing bath contains, for example, 0.12~0.2% of Al and the balance of Zn and other inevitable impurities.

[38] The alloying process on the galvanized steel sheet is carried out at an alloying temperature of 470 to 530°C, so that the galvanized steel sheet can have a Fe content of 5 to 9% and an eta phase and a zeta phase as the Zn-Fe phase. For the galvanized steel sheet having a low Fe content, a zeta phase (ζ) and an eta phase (η) are mainly present as the Zn-Fe phase. According to one exemplary embodiment of the present invention, the galvanized steel sheet may have both the powdering resistance and weldability for sure when the eta phase (η) is present at contents of 90% or more, and the zeta phase (ζ) is present at contents of 10% or less.

[39] In this case, the optimum alloying temperature is in a range from 500 to 520°C in the case of the galvanized steel sheet according to one exemplary embodiment of the present invention that includes, % by weight: 0.005% or less of C, 0.003-0.02% of S, at least one compound selected from the group consisting of 0.2% or less of Mn and 0.2% or less of Cu, and the balance of Fe and other inevitable impurities. Also, the optimum alloying temperature is also in a range from 420 to 440°C in the case of the galvanized steel sheet that includes, by weight: 0.01% or less of C; 0.005 to 0.02% of S; 0.0001 to 0.002% of B; at least one compound of 0.01 to 0.2% of Cu and 0.01 to 0.3% of Mn; at least one compound of 0.002 to 0.04% of niobium (Nb) and 0.005 to 0.15% of titanium (Ti); and the balance of Fe and other inevitable impurities. It is preferred to alloy the steel sheet under the alloying temperature range in aspect of the powdering property.

[40] The alloyed steel sheet is subject to a temper rolling process. The temper rolling process may also be used to form oil pockets using a pre-texture roll whose surface has embossing projections. The pre-texture roll is selected and the temper rolling process is then suitably carried out, so that the oil pockets can have a diameter of 20 to 50 μm .

[41] For the galvanized steel sheet having a low Fe content according to the present invention, its corrosion resistance is enhanced and craters caused by outbursts are not formed in a surface of the coating layer. Therefore, it is possible to manufacture a steel

sheet whose surface is made smooth by removing surface ununiformity that is one of the disadvantages of the conventional GA steel sheets. The surface of the steel sheet is formed with an eta phase or a zeta phase, other than the delta phase, that has weak hardness. When the press formability (lubricity) is adversely affected due to the presence of the Zn-Fe phase having weak hardness, it is recommended to form oil pockets.

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

[43] [Examples]

[44] A 0.7mm-thick cold-rolled steel sheet that satisfies component systems as listed in Table 1 was galvanized, and then alloyed under the conditions as listed in Table 2, thus to form coating layers in the front and rear of the cold-rolled steel sheet. Here, the coating layers had a thickness of about 45g/mm².

[45] In the galvanizing process, a pot temperature was in a range from about 450 to 460°C, and concentration of Al was 0.128%. Dross floating during the galvanizing process was removed sufficiently. A peel width of powdering and a welding point are listed in Table 2.

[46] In the Table 2, the powdering degree is divided into the following levels (using a steel sheet having a thickness of 0.9 mm or less as the standard),

[47] Level 1: a peel width of a steel sheet is 4.0 mm or less,

[48] Level 2: a peel width is 6.0 mm or less (the width limit of an outer plate),

[49] Level 3: a peel width is 7.0 mm or less,

[50] Level 4: a peel width is 8.0 mm or less (the width limit of an inner plate),

[51] Level 5: a peel width exceeds 8.0 mm.

[52]

[53] Also, the welding points as listed in Table 2 were obtained under the welding conditions as listed in Table 3. As the reference used to determine the welding points, I_{min} was 8.2kA, and I_{max} was 10.6kA. The inventive steel sheets were analyzed for physical properties using SEM (Scanning Electron Microscopy), ICP (Inductive coupled plasma), and GDS (Glow Discharge Spectroscopy).

[54] Table 1

[Table 1]

	C	Mn	Cu	P	Si	Ti	Al	S
A1	0.0016	0.102	-	0.0123	-	0.018	0.028	0.005
A2	0.0013	0.09	0.09	0.08	0.05	0	0.03	0.01
A3	0.0012	0.08	0.09	0.075	0.045	0	0.025	0.012

[55]

[56] Table 2

[Table 2]

Products	Kinds of Steel sheets	Alloying temp. (°C)	Fe content (before/after)	Powdering degree (peel width, mm)	Comparison of welding points
PSM	A1	430±10	5.6/5.8	1 (0)	600~800
	A2	510±10	6.8/8.5	1 (0)	
	A3	510±10	5.4/6.2	1 (0)	
GA	A3	540±10	9.5/10.2	2 (4.5)	1000 or more
	A1	470±10	10.1/10.5	1 (4.0)	
GI	A3	-	-	-	300~500
	A1	-	-	-	
As the measurement results of peel widths of powdering in 7 test samples to an A2 steel sheet, six test samples had a peel width of 0 mm, and one test sample had a peel width of 1.5 mm.					

[57]

[58] Table 3

[Table 3]

Electrode Force	Schedule (cycle, 60Hz)			Electrode			
	Squeeze	Weld	Hold	Material	Type	Tip dia.	Coolant
3.0 kN	20	12	12	Cu-Cr	DR	6.0mm	4 l/min

[59] A kind and ratios of the Zn-Fe phases in the coating layer of the steel sheets of Table 2 are listed in Table 4, and the ratios of the Zn-Fe phases were measured, as follows.

[60] The ratios of the Zn-Fe phases were measured using an X-ray diffractometer (XRD). In this case, since the steel sheets have their own natural frequencies (wavelengths), peaks of the natural frequencies are detected according to the Zn-Fe phases in coating layers when a test sample is illuminated with an X-ray, and the intensities of the peaks

are determined according to the ratios (capacities) of the Zn-Fe phases.

[61] Table 4

[Table 4]

Kinds of Steel sheets	η (eta phase)	ζ (zeta phase)	Δ (delta phase)	Γ (capital gamma phase)
PSM-A1	94	6	0	0
PSM-A2	91	9	0	0
PSM-A3	93	7	0	0
GA-A3	0	10	85	5
GA-A1	0	12	85	3

[62] From the results of measuring the powdering property and welding point of a coating layer in which oil pockets are formed in the PSM-A3 steel sheet, it was revealed that the powdering property and welding point are measured at equivalent levels regardless of the formed oil pockets.

[63] As seen from the above results, it was seen that the steel sheets satisfying the requirements of Fe content and Zn-Fe phase according to the present invention have good physical properties such as powdering resistance and welding point. Furthermore, the results obtained by testing adhesiveness of the steel sheets are shown in FIG. 3. It was revealed that the peeling occurs in an adhesive layer other than a coating layer in the case of the PSM-A1, A2 and A3 steel sheets, but the peeling occurs in a coating layer in the case of the GA-A1 steel sheet.

[64] While the present invention has been shown and described in connection with the exemplary embodiments, it will be apparent to those skilled in the art that modifications and variations can be made without departing from the spirit and scope of the invention as defined by the appended claims.

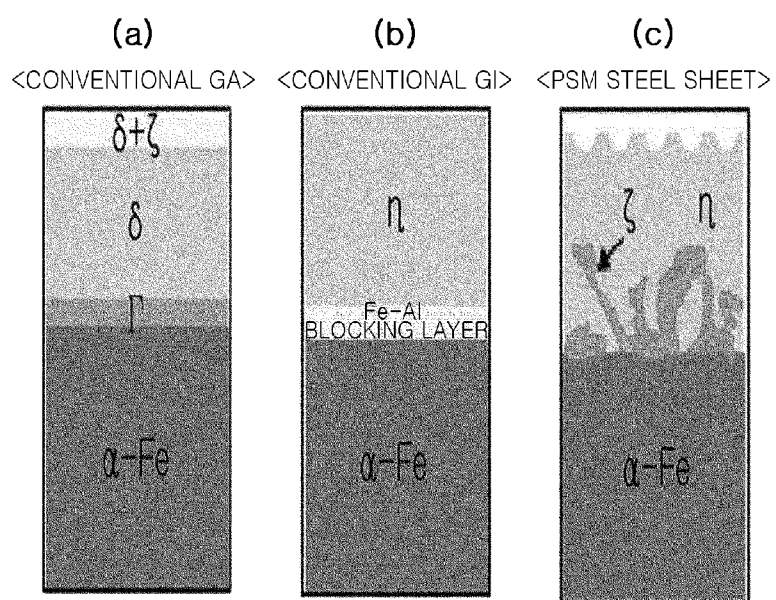
Claims

- [1] A galvanized steel sheet having excellent adhesiveness to zinc coating layer, the steel sheet having a galvanized coating layer formed in at least one surface thereof, wherein a Fe content of the galvanized coating layer is in a range from 5 to 9%, and having an eta phase and a zeta phase as a Zn-Fe phase.
- [2] The galvanized steel sheet of claim 1, wherein the eta phase is present as the Zn-Fe phase at contents of 90% or more, and the zeta phase is present as the Zn-Fe phase at contents of 10% or less.
- [3] The galvanized steel sheet of claim 1, wherein oil pockets having a diameter of 20 to 50 μm (micrometer) are formed in a surface of the galvanized coating layer.
- [4] The galvanized steel sheet of claim 1, comprising by weight: 0.005% or less of carbon (C); 0.003 to 0.02% of sulfur (S); at least one selected from the group consisting of 0.2% or less of manganese (Mn) and 0.2% or less of copper (Cu); and the balance of Fe and other inevitable impurities.
- [5] The galvanized steel sheet of claim 1, comprising by weight: 0.01% or less of C; 0.005 to 0.02% of S; 0.0001 to 0.002% of boron (B); at least one compound of 0.01 to 0.2% of Cu and 0.01 to 0.3% of Mn; at least one compound of 0.002 to 0.04% of niobium (Nb) and 0.005 to 0.15% of titanium (Ti); and the balance of Fe and other inevitable impurities.
- [6] The galvanized steel sheet of claim 4 or 5, comprising at least one compound selected from the group consisting of compounds A, B and C:
A: at least one selected from the group consisting of 0.1 to 0.8% of silicon (Si), 0.03 to 0.2% of phosphorus (P) and 0.2 to 1.2% of chromium (Cr),
B: at least one selected from the group consisting of 0.01 to 0.2% of molybdenum (Mo) and 0.01 to 0.2% of vanadium (V), and
C: 0.01 to 0.1% of aluminum (Al) and 0.02% or less of nitrogen (N).
- [7] A method for manufacturing a galvanized steel sheet having excellent adhesiveness to zinc coating layer, the method comprising:
galvanizing a steel sheet, and
alloying the galvanized steel sheet at a temperature of 470 to 530°C so that an alloyed coating layer has a Fe content of 5 to 9% and has an eta phase and a zeta phase as a Zn-Fe phase.
- [8] The method of claim 7, wherein the eta phase is present as the Zn-Fe phase at

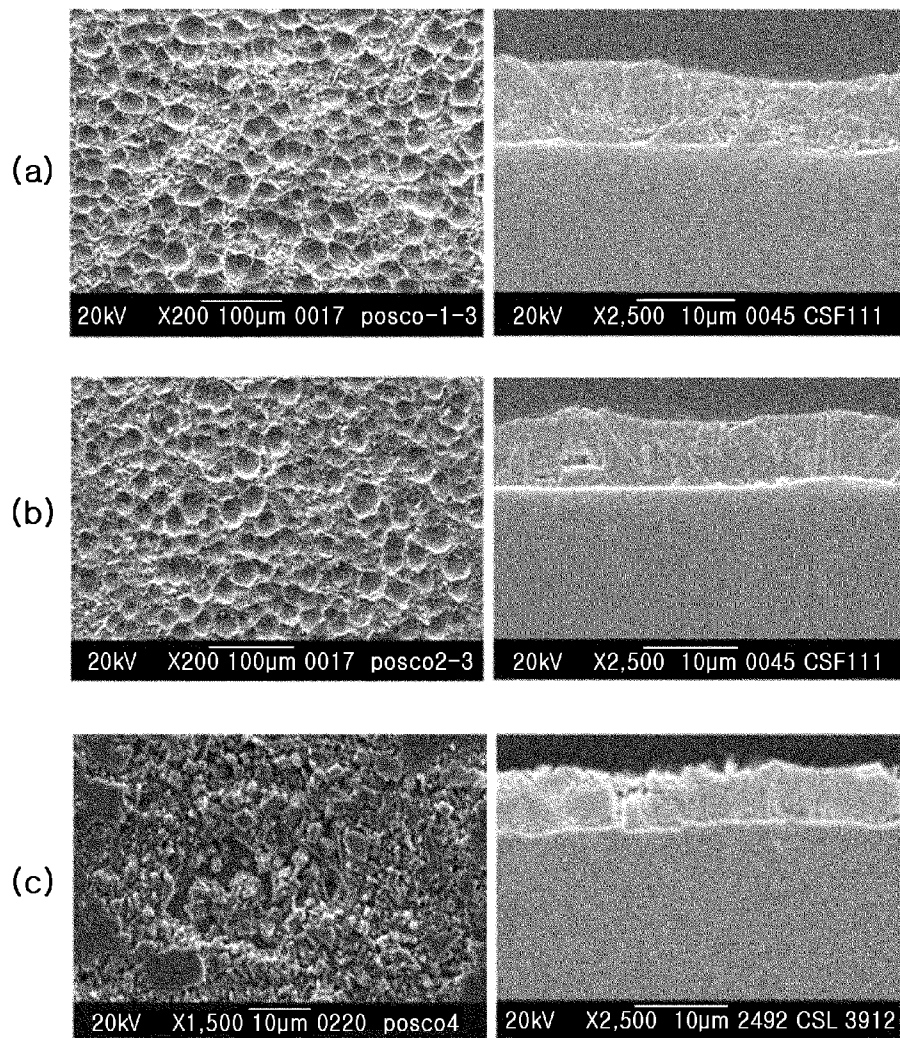
contents of 90% or more, and the zeta phase is present as the Zn-Fe phase at contents of 10% or less.

- [9] The method of claim 7, comprising: forming oil pockets in a surface of the alloyed coating layer by performing a temper rolling process on the alloyed steel sheet using an embossing roll.
- [10] The method of claim 7, wherein the galvanizing process is performed in a galvanizing bath containing Al of 0.12 to 0.2% by weight and the balance of Zn and other inevitable impurities.
- [11] The method of claim 9, wherein the embossing roll has embossing projections having a diameter of 20 to 50 μm .
- [12] The method of claim 7, wherein the steel sheet comprises, by weight: 0.005% or less of C; 0.003 to 0.02% of S; at least one selected from the group consisting of 0.2% or less of Mn and 0.2% or less of Cu; and the balance of Fe and other inevitable impurities, and the alloying temperature is in a range from 500 to 520°C.
- [13] The method of claim 7, wherein the steel sheet comprises, by weight: 0.01% or less of C; 0.005 to 0.02% of S; 0.0001 to 0.002% of B; at least one compound of 0.01 to 0.2% of Cu and 0.01 to 0.3% of Mn; at least one compound of 0.002 to 0.04% of niobium (Nb) and 0.005 to 0.15% of titanium (Ti); and the balance of Fe and other inevitable impurities, and the alloying temperature is in a range from 420 to 440°C.
- [14] The method of claim 12 or 13, wherein the steel sheet comprises at least one compound selected from the group consisting of compounds A, B and C:
A: at least one selected from the group consisting of 0.1 to 0.8% of silicon (Si), 0.03 to 0.2% of phosphorus (P) and 0.2 to 1.2% of chromium (Cr),
B: at least one selected from the group consisting of 0.01 to 0.2% of molybdenum (Mo) and 0.01 to 0.2% of vanadium (V), and
C: 0.01 to 0.1% of aluminum (Al) and 0.02% or less of nitrogen (N).

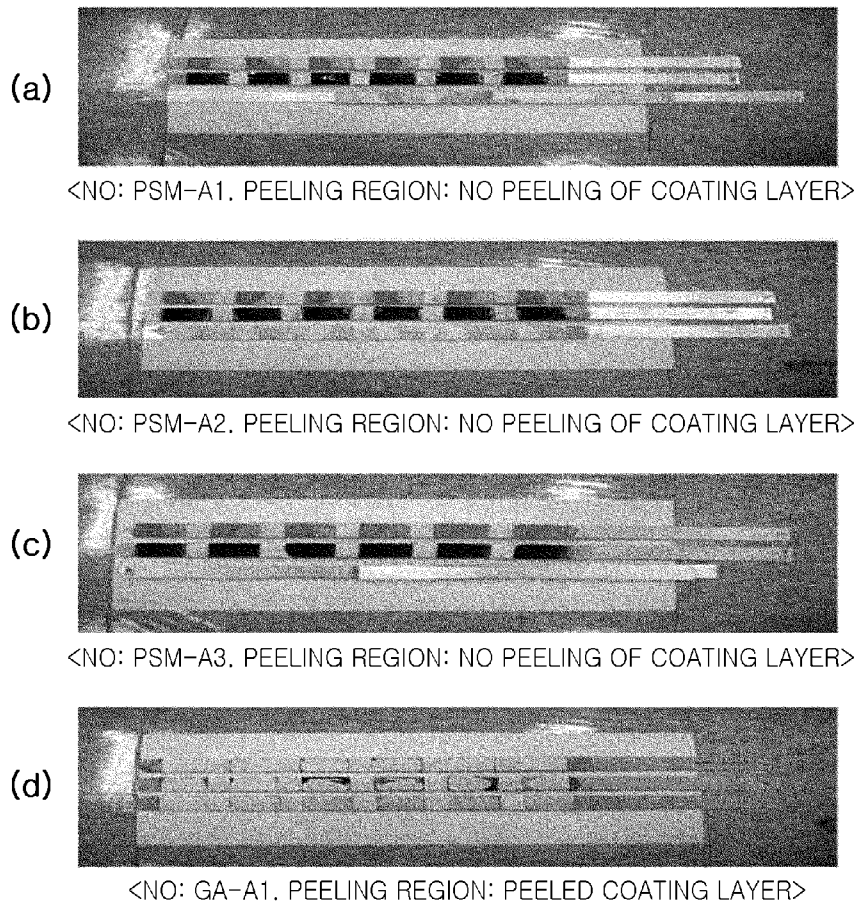
[Fig. 1]



[Fig. 2]



[Fig. 3]



A. CLASSIFICATION OF SUBJECT MATTER*C23C 2/06(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 C23C 2/06, C23C 2/28, C23C 2/40, C22C 38/00

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 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) & keyword : galvanized steel sheet, Zn alloy plating layer, η and ζ -phases**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP 11302812 A (SUMITOMO METAL IND LTD) 02 November 1999	1,7
Y	See the abstract and claims 1-4	3-6,9-14
Y	EP 01327697 A1 (NKK CORPORATION) 16 July 2003 See the abstract and page 33 paragraph (0300)	3,9,11
Y	EP 01291448 B1 (JFE STEEL CORPORATION) 28 June 2006 See the abstract and claims 1-30	4-6,10,12-14
A	JP 2005256042 A (JFE STEEL CORPORATION) 22 October 2005 See the abstract and claims 1-6	1 - 14



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

14 APRIL 2008 (14.04.2008)

Date of mailing of the international search report

14 APRIL 2008 (14.04.2008)

Name and mailing address of the ISA/KR

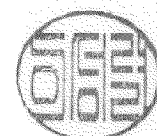
Korean Intellectual Property Office
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Facsimile No. 82-42-472-7140

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/KR2007/006920

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

Independent claim 1 describes a galvanized steel sheet comprising a Zn alloy plating layer having η and ζ -shapes.
Independent claim 7 describes a method of manufacturing the same galvanized steel sheet.

The only common technical feature between claims 1 and 7 is a galvanized steel sheet comprising a Zn alloy plating layer having η and ζ -shapes. However, this feature lacks novelty and inventive step with respect to the following documents cited in this ISR: JP 11302812 A (SUMITOMO METAL IND LTD)

Thus, there is no technical relationship left over the prior art among the claimed invention, leaving the claims without a single general inventive concept. Hence, there is a lack of unity "a posteriori" (PCT Rule 13.1 and 13.2)

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☒ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- ☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- ☐ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/KR2007/006920

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