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(54) **METHOD FOR PRODUCING HOT-PRESSED MEMBER**

(57) Provided is a method for manufacturing a hot-pressed member excellent in terms of surface appearance with which it is possible to stably manufacture a hot-pressed member having a homogeneous and good surface appearance without causing a significant increase in cost. A method for manufacturing a hot-pressed member includes heating a zinc-based coated steel sheet to a temperature range from the Ac3 transformation temperature to 1000°C, performing hot pressing work, and performing cooling, in which a surface-cleaning treatment is performed on the zinc-based coated steel sheet before the heating is performed. A method for manufacturing a hot-pressed member includes performing cold

pressing work on a zinc-based coated steel sheet, heating the zinc-based coated steel sheet to a temperature range from the Ac3 transformation temperature to 1000°C, and cooling the heated steel sheet, in which a surface-cleaning treatment is performed on the zinc-based coated steel sheet before the heating is performed. It is preferable that the zinc-based coated steel sheet be a Zn-Ni-alloy-coated steel sheet having a coating layer on one or both sides of the Zn-Ni-alloy-coated steel sheet, and the coating layer have a chemical composition containing 10 mass% to 25 mass% of Ni and the balance being Zn and inevitable impurities and a coating weight per side of 10 g/m<sup>2</sup> to 90 g/m<sup>2</sup>.

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**Description**

## Technical Field

5 **[0001]** The present invention relates to a method for manufacturing a hot-pressed member which can preferably be used for, for example, chassis and body structure members of an automobile.

## Background Art

10 **[0002]** To date, for example, chassis and body structure members of an automobile have usually been manufactured by performing press working on steel sheets having a specified strength. Nowadays, since there is a strong demand for the weight reduction of an automobile body from the viewpoint of global environment conservation, efforts are being made to reduce the thickness of a steel sheet which is used for an automobile body by increasing the strength of the steel sheet. However, an increase in the strength of steel sheets causes a deterioration in press workability, and therefore  
15 there is an increase in the number of cases where it is difficult to form a steel sheet into desired shapes of the members.

**[0003]** In view of the situation described above, Patent

**[0004]** In view of the situation described above, Patent Literature 1 proposes a working technique called hot pressing which makes it possible to realize an improvement in workability and an increase in strength at the same time by performing working and rapid cooling at the same time on a heated steel sheet by using a mold which is composed of a die and a punch. However, in the case of this hot pressing, since a steel sheet is heated to a high temperature of about  
20 950°C before hot pressing is performed, scale (iron oxide) is generated on the surface of the steel sheet, and the flaking of the scale occurs when hot pressing is performed, which results in a problem in that a mold is damaged or the surface of a member is damaged after the hot pressing. Also, scale which remained on the surface of a member causes a deterioration in surface appearance and paint adhesiveness. Therefore, scale which is present on the surface of a  
25 member is usually removed by performing a treatment such as pickling or shot blasting. However, such a treatment makes a manufacturing process complex, and thus there is a decrease in productivity.

**[0005]** Moreover, for example, chassis and body structure members of an automobile are also required to have excellent corrosion resistance. However, since a hot-pressed member, which is manufactured by using the process described above, is not provided with an anti-corrosion film such as a coating layer, the member is very poor in terms of corrosion  
30 resistance.

**[0006]** Therefore, a hot-pressing technique is desired with which the generation of scale can be inhibited when heating is performed before hot pressing and with which the corrosion resistance of a hot-pressed member can be improved, and thus a steel sheet to be hot-pressed whose surface is coated with a film such as a coating layer and a method for hot pressing which utilizes the steel sheet have been proposed.

35 **[0007]** For example, Patent Literature 2 discloses a method for manufacturing a hot-pressed member excellent in terms of corrosion resistance whose surface is coated with a Zn-Fe-based compound or a Zn-Fe-Al-based compound by performing hot pressing on a steel sheet, which is coated with Zn or a Zn-based alloy.

**[0008]** In addition, Patent Literature 3 discloses a hot-pressed member excellent in terms of scale resistance, paint adhesiveness, after-painting corrosion resistance, and hydrogen entry resistance which is manufactured by forming a  
40 Ni diffusion region, a layer of an intermetallic compound, which is equivalent to the  $\gamma$  phase of a Zn-Ni alloy, and a ZnO layer in the surface layer of a steel sheet.

**[0009]** Moreover, Patent Literature 4 discloses a steel sheet to be hot-pressed which is manufactured by forming a ZnO layer, which inhibits the vaporization of Zn, in the surface layer of a Zn-based coating layer in advance, and indicates that it is possible to obtain a hot-pressed product having good surface appearance, excellent paint adhesiveness, and  
45 excellent after-painting corrosion resistance by using the steel sheet.

## Citation List

## Patent Literature

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**[0010]**

PTL 1: UK Patent No. GB1490535

PTL 2: Japanese Patent No. 3663145

55 PTL 3: Japanese Patent No. 4849186

PTL 4: Japanese Patent No. 3582511

## Summary of Invention

## Technical Problem

**[0011]** As disclosed in the conventional techniques described above, using a zinc-based coated steel sheet as a steel sheet to be hot-pressed is effective for improving corrosion resistance. However, since the melting point of zinc is 419°C and the boiling point of zinc is 907°C, that is, since both are low, the melting of zinc in the coating layer and the vaporization of zinc from the coating layer occur in a heating process before hot pressing, which makes it difficult to stably manufacture a hot-pressed member having a homogeneous and good surface appearance.

**[0012]** For example, in the case of a hot-pressed member which is manufactured by using the method described in Patent Literature 2, since a zinc-coated steel sheet or a zinc-aluminum-coated steel sheet, whose coating layer has a low melting point, is used, the melting of the coating layer or the vaporization of zinc which occurs in a heating process before hot pressing is significant. As a result, a hot-pressed member, which is finally obtained, has, for example, a spotty inhomogeneous surface appearance or many white or black point-like defects. Therefore, it is difficult to obtain a hot-pressed member having a homogeneous and good surface appearance. Here, since not only a deterioration in surface appearance but also a deterioration in paint adhesiveness occur in a portion in which point-like defects exist, there is a strong demand for a technique for preventing point-like defects. However, an effective technique has not been proposed.

**[0013]** In the case of a hot-pressed member described in Patent Literature 3 which is manufactured by using a steel sheet coated with a Zn-Ni-alloy coating layer, which has a melting point higher than that of Zn, there is an improvement in the surface appearance of a hot-pressed member compared with the case where a zinc-coated steel sheet or a zinc-aluminum-coated steel sheet is used. However, it is not possible to completely prevent the generation of local point-like defects.

**[0014]** In the case where a steel sheet to be hot-pressed described in Patent Literature 4 is used, there is an improvement in the surface appearance of a hot-pressed member to some extent through the effect of a ZnO layer which is formed in the surface layer of the steel sheet. However, there is still a problem in that local point-like defects are generated in a portion in which the result of a treatment for forming a ZnO layer is inhomogeneous. In addition, there is a problem of a significant increase in cost when a treatment for forming a ZnO layer is performed, because it is necessary to use a method which involves, for example, an oxidizing treatment through the use of heat, a contact treatment with a solution, an electrolysis treatment in an aqueous solution, and a treatment of coating and drying a solution.

**[0015]** The present invention has been completed in order to solve the problems of the conventional techniques described above, and an object of the present invention is to provide a method for manufacturing a hot-pressed member excellent in terms of surface appearance with which it is possible to stably manufacture a hot-pressed member having a homogeneous and good surface appearance without causing a significant increase in cost.

## Solution to Problem

**[0016]** The present inventors, in order to solve the problems described above, diligently conducted investigations regarding a method for manufacturing a hot-pressed member excellent in terms of surface appearance. First, investigations regarding a state in which point-like defects are generated on the surface of a hot-pressed member were conducted. As a result, it was found that the position or number of point-like defects is not necessarily the same even if the same kind of zinc-based coated steel sheet is heated under the same condition. Also, it was found that it is not possible to completely prevent point-like defects even with a Zn-Ni-alloy-coated steel sheet, although a steel sheet coated with a Zn-Ni-alloy coating layer, which has a higher melting point than that of zinc-based coated steel sheet, can be used as a steel sheet to be hot-pressed more advantageously than a zinc-based coated steel sheet such as a galvanized steel sheet or a galvanized steel sheet, which has a coating layer having a comparatively low melting point, from the viewpoint of inhibiting point-like defects from occurring.

**[0017]** From such facts, on the basis of the hypothesis that the generation of point-like defects depends not only on the kind of a coating layer and heating conditions but also on other factors such as a stain on the surface, verification experiments were conducted in which a zinc-based coated steel sheet was heated after the surface of the steel sheet had been stained or cleaned. As a result, it was found that point-like defects, which are generated on the surface of a hot-pressed member, are caused by stains due to, for example, dirt, dust, and fingerprint which are adhered to the surface of a coating layer. That is, it was found that there is a local increase in temperature due to extraneous matter derived from such stain materials being burned in a heating process before hot pressing work, which results in the vaporization of zinc being promoted due to the breakage of a ZnO layer with which the surface of the zinc-based coating layer has been covered, and which results in scale being generated in such a portion. In addition, it was further found that it is possible to significantly inhibit the generation of point-like defects by performing a surface-cleaning treatment in order to remove such stain materials before a heating process. Moreover, it was found that the effect of inhibiting point-like defects through the use of a surface-cleaning treatment before heating is realized not only in a process in

which a zinc-based coated steel sheet is subjected to hot pressing work and cooling after having been heated but also in a process in which a zinc-based coated steel sheet is heated and cooled after having been subjected to cold pressing work, resulting in the completion of the present invention.

**[0018]** The method for manufacturing a hot-pressed member according to the present invention has been completed on the basis of such findings, and the subject matter of the present invention is as follows.

[1] A method for manufacturing a hot-pressed member having an excellent surface appearance, the method including heating a zinc-based coated steel sheet to a temperature range from the Ac3 transformation temperature to 1000°C, performing hot pressing work, and performing cooling, in which a surface-cleaning treatment is performed on the zinc-based coated steel sheet before the heating is performed.

[2] A method for manufacturing a hot-pressed member having an excellent surface appearance, the method including performing cold pressing work on a zinc-based coated steel sheet, heating the zinc-based coated steel sheet to a temperature range from the Ac3 transformation temperature to 1000°C, and cooling the heated steel sheet, in which a surface-cleaning treatment is performed on the zinc-based coated steel sheet before the heating is performed.

[3] The method for manufacturing a hot-pressed member according to item [1] or [2], in which the zinc-based coated steel sheet is a Zn-Ni-alloy-coated steel sheet having a coating layer on one or both sides of the Zn-Ni-alloy-coated steel sheet, and the coating layer has a chemical composition containing 10 mass% to 25 mass% of Ni and the balance being Zn and inevitable impurities and a coating weight per side of 10 g/m<sup>2</sup> to 90 g/m<sup>2</sup>.

**[0019]** Here, in the present description, % used when describing the chemical composition of steel or a coating layer always means mass%.

#### Advantageous Effects of Invention

**[0020]** According to the present invention, it is possible to stably manufacture a hot-pressed member having a homogeneous and good surface appearance without causing a significant increase in cost. The hot-pressed member which is manufactured by using the present invention can preferably be used for the chassis and body structure members of an automobile.

#### Brief Description of Drawings

##### **[0021]**

[Fig. 1] Fig. 1 is a diagram illustrating typical examples of the surface appearance of a hot-pressed member, where (a) is a photograph indicating a product having a good surface appearance and (b) is a photograph indicating a product having point-like defects.

[Fig. 2] Fig. 2 is a diagram illustrating typical examples of the surface appearance of point-like defects, where (a) is an enlarged photograph of a white defect and (b) is an enlarged photograph of a black defect.

#### Description of Embodiments

##### 1) Zinc-based coated steel sheet

**[0022]** In the method for manufacturing a hot-pressed member according to the present invention, a zinc-based coated steel sheet having a zinc-based coating layer on one or both sides thereof is used. Examples of a zinc-based coating layer include, but are not limited to, a galvanizing layer, a galvannealing layer, a hot-dip zinc-aluminum-alloy coating layer, a hot-dip zinc-aluminum-magnesium-alloy coating layer, a zinc electroplating layer, and a zinc-nickel-alloy electroplating layer, and all of the known zinc-based coating layers containing zinc may be used.

**[0023]** It is preferable that the coating weight on the surface of such a zinc-based coated steel sheet be 10 g/m<sup>2</sup> to 90 g/m<sup>2</sup> per side. In the case where the coating weight per side (hereinafter, also simply referred to as "coating weight") is 10 g/m<sup>2</sup> or more, the corrosion resistance does not become insufficient. On the other hand, in the case where the coating weight is 90 g/m<sup>2</sup> or less, there is no increase in cost. It is more preferable that the coating weight be 20 g/m<sup>2</sup> to 80 g/m<sup>2</sup>. Here, it is possible to determine coating weight by using a wet analysis method. Specifically, for example, by dissolving the whole coating layer of a test piece whose coated area is known in an aqueous solution in which 1 g/L of hexamethylenetetramine is added as an inhibitor to a 6-mass%-hydrochloric acid aqueous solution, the coating weight of the coating layer should be derived from the amount of decrease in mass at this time.

**[0024]** It is preferable that the zinc-based coated steel sheet described above be a Zn-Ni-alloy-coated steel sheet having a coating layer on one or both sides thereof, in which the coating layer having a chemical composition containing

10 mass% to 25 mass% of Ni and the balance being Zn and inevitable impurities. In the case where the Ni content in the coating layer is 10 mass% to 25 mass%, since the structure of the coating layer becomes a  $\gamma$  phase structure, and since this  $\gamma$  phase has a high melting point of 881°C, there is an increase in the effect of inhibiting the generation of point-like defects to a higher level. Here a  $\gamma$  phase has one of the crystal structures of  $\text{Ni}_2\text{Zn}_{11}$ ,  $\text{NiZn}_3$ , and  $\text{Ni}_5\text{Zn}_{21}$ , and it is possible to identify the structure by using an X-ray diffraction method. Here, an underlying coating layer such as a coating layer mainly containing, for example, Ni may be formed under the above-described coating layer.

## 2) Base steel sheet

**[0025]** In order to obtain the hot-pressed member according to the present invention, a hot-rolled steel sheet or a cold-rolled steel sheet having a chemical composition containing, by mass%, C: 0.15% to 0.50%, Si: 0.05% to 2.00%, Mn: 0.5% to 3.0%, P: 0.10% or less, S: 0.05% or less, Al: 0.10% or less, N: 0.010% or less, and the balance being Fe and inevitable impurities may be used as a base steel sheet for a zinc-based coating layer. In the case where a hot-rolled steel sheet or a cold-rolled steel sheet having such a chemical composition is used as a base steel sheet, it is possible to obtain a hot-pressed member having a desired high strength of, for example, 980 MPa or more.

**[0026]** The reasons for the limitations on the constituent chemical elements will be described hereafter.

C: 0.15% to 0.50%

**[0027]** C is a chemical element which increases the strength of steel, and it is necessary that the C content be 0.15% or more in order to control the tensile strength (hereinafter, also referred to as "TS") of a hot-pressed member to be 980 MPa or more. On the other hand, in the case where the C content is more than 0.50%, there is a significant deterioration in the blanking performance of a steel sheet as a material. Therefore, it is preferable that the C content be 0.15% to 0.50%.

Si: 0.05% to 2.00%

**[0028]** Si is, like C, a chemical element which increases the strength of steel, and it is necessary that the Si content be 0.05% or more in order to control the TS of a hot-pressed member to be 980 MPa or more. On the other hand, in the case where the Si content is more than 2.00%, there is a significant increase in the amount of a surface defect, which is called red scale, generated when hot rolling is performed, there is an increase in rolling load, and there is a deterioration in the ductility of a hot-rolled steel sheet. Moreover, in the case where the Si content is more than 2.00%, there may be a negative effect on coatability when a coating treatment is performed in order to form a coating film containing mainly Zn and Al on the surface of a steel sheet. Therefore, it is preferable that the Si content be 0.05% to 2.00%.

Mn: 0.5% to 3.0%

**[0029]** Mn is a chemical element which is effective for improving hardenability by inhibiting ferrite transformation and which is effective for decreasing a heating temperature before hot pressing is performed, because Mn decreases the  $\text{Ac}_3$  transformation temperature. It is necessary that the Mn content be 0.5% or more in order to realize such effects. On the other hand, in the case where the Mn content is more than 3.0%, since Mn is segregated, there is a deterioration in the homogeneity of the properties of a steel sheet as a material and a hot-pressed member. Therefore, it is preferable that the Mn content be 0.5% to 3.0%.

P: 0.10% or less

**[0030]** In the case where the P content is more than 0.10%, since P is segregated, there is a deterioration in the homogeneity of the properties of a steel sheet as a material and a hot-pressed member, and there is a significant decrease in toughness. Therefore, it is preferable that the P content be 0.10% or less.

S: 0.05% or less

**[0031]** In the case where the S content is more than 0.05%, there is a decrease in the toughness of a hot-pressed member. Therefore, it is preferable that the S content be 0.05% or less.

Al: 0.10% or less

**[0032]** In the case where the Al content is more than 0.10%, there is a deterioration in the blanking performance and hardenability of a steel sheet as a material. Therefore, it is preferable that the Al content be 0.10% or less.

N: 0.010% or less

**[0033]** In the case where the N content is more than 0.010%, since nitrides of AlN are formed when hot rolling is performed or when heating is performed before hot pressing work is performed, there is a deterioration in the blanking performance and hardenability of a steel sheet as a material. Therefore, it is preferable that the N content be 0.010% or less.

**[0034]** The remainder is Fe and inevitable impurities. Moreover, it is preferable that at least one selected from Cr: 0.01% to 1.0%, Ti: 0.01% to 0.20%, and B: 0.0005% to 0.0800% and Sb: 0.003% to 0.030% be added separately or at the same time in addition to the chemical composition described above for the reasons described below.

Cr: 0.01% to 1.0%

**[0035]** Cr is a chemical element which is effective for increasing the strength of steel and improving hardenability of steel. It is preferable that the Cr content be 0.01% or more in order to realize such effects. On the other hand, in the case where the Cr content is more than 1.0%, there is a significant increase in cost. Therefore, it is preferable that the upper limit of the Cr content be 1.0%.

Ti: 0.01% to 0.20%

**[0036]** Ti is a chemical element which is effective for increasing the strength of steel and which is effective for increasing toughness by decreasing a crystal grain size. In addition, Ti is a chemical element which is effective for realizing the effect of improving hardenability through the use of solid solution B by forming nitrides more readily than B, which will be described below. Therefore, it is preferable that the Ti content be 0.01% or more. However, in the case where the Ti content is more than 0.20%, there is a significant increase in rolling load when hot rolling is performed, and there is a decrease in the toughness of a hot-pressed member. Therefore, it is preferable that the upper limit of the Ti content be 0.20%.

B: 0.0005% to 0.0800%

**[0037]** B is a chemical element which is effective for improving hardenability when hot pressing is performed and for increasing toughness after the hot pressing. It is preferable that the B content be 0.0005% or more in order to realize such effects. On the other hand, in the case where the B content is more than 0.0800%, there is a significant increase in rolling load when hot rolling is performed, and, for example, cracking occurs in a steel sheet due to the formation of a martensite phase and a bainite phase after the hot rolling. Therefore, it is preferable that the upper limit of the B content be 0.0800%.

Sb: 0.003% to 0.030%

**[0038]** Sb is effective for inhibiting the formation of a decarburized layer in the surface layer of a steel sheet in a process in which a zinc-based coated steel sheet is subjected to heating followed by hot pressing work and cooling. It is necessary that the Sb content be 0.003% or more in order to realize such an effect. On the other hand, in the case where the Sb content is more than 0.030%, since there is an increase in rolling load, there is a decrease in productivity. Therefore, it is preferable that the Sb content be 0.003% to 0.030%.

### 3) Hot pressing process

**[0039]** In the method for manufacturing a hot-pressed member according to the present invention, a hot-pressed member is manufactured by using one of the processes in the two embodiments described below as a hot pressing process.

**[0040]** The first embodiment is a method for manufacturing a hot-pressed member and is a hot pressing process called direct process in which a zinc-based coated steel sheet is subjected to heating to a temperature range from the Ac3 transformation temperature to 1000°C followed by hot pressing work and cooling. In the case where the heating temperature is lower than the Ac3 transformation temperature, since there is an insufficient degree of quenching of a steel sheet, there may be a case where it is not possible to achieve the desired strength. In addition, in the case where the heating temperature is higher than 1000°C, there is an economic disadvantage from the viewpoint of energy, and it is difficult to manufacture a hot-pressed member having a homogeneous and good surface appearance due to the significant generation of point-like defects. In addition, cooling after hot pressing work may be performed by using a mold at the same time as hot pressing work, or the cooling may be performed by using a coolant such as water at the same time

as hot pressing work or immediately after the hot pressing work.

**[0041]** The second embodiment is a method for manufacturing a hot-pressed member and is a hot pressing process called indirect process in which a zinc-based coated steel sheet is subjected to cold pressing work followed by heating to a temperature range from the Ac3 transformation temperature to 1000°C and cooling. In this process, cold pressing work is first performed before a zinc-based coated steel sheet is heated. Subsequently, the cold-pressed member is subjected to heating followed by cooling. The heating temperature is set to be in a temperature range from the Ac3 transformation temperature to 1000°C for the reasons described above. Cooling may be performed by using a mold which is used for cooling a member or by using a coolant such as water. In addition, when cooling is performed by using a mold, work may be added by performing hot pressing.

**[0042]** Here, the term "heating temperature" means the maximum end-point temperature of a steel sheet. In addition, examples of a method for performing the heating described above include heating which utilizes, for example, an electric furnace or a gas furnace, direct-fired heating, electrical heating, high-frequency heating, and induction heating.

#### 4) Surface-cleaning treatment

**[0043]** In the method for manufacturing a hot-pressed member according to the present invention, a surface-cleaning treatment is performed on a zinc-based coated steel sheet before the zinc-based coated steel sheet is heated in order to remove stains due to, for example, dirt, dust, and fingerprint which are adhered to the surface of a coating layer. This surface-cleaning treatment is an important requirement in the present invention. In the case where this surface-cleaning treatment is not performed, point-like defects are generated as illustrated in Fig. 1(b). On the other hand, in the case where a surface-cleaning treatment is performed, it is possible to manufacture a product having a good surface appearance as illustrated in Fig. 1(a). Here, examples of point-like defects include a white defect illustrated in Fig. 2(a), which is a mark of intense vaporization of zinc left at the position of the breakage of a ZnO layer, with which the surface of a zinc-based coating layer has been covered, and a black defect illustrated in Fig. 2(b), which is generated as a result of scale being generated through the progress of the oxidation of a base steel sheet at the position of a white defect. Since, both of the point-like defects deteriorate surface appearance and paint adhesiveness, it is necessary to inhibit point-like defects as much as possible by performing a surface-cleaning treatment. As described above, a surface-cleaning treatment according to the present invention is a treatment which removes the origins of point-like defects.

**[0044]** It is necessary to perform a surface-cleaning treatment before a heating process. Therefore, in the case of the first embodiment described above (in which a zinc-based coated steel sheet is subjected to heating to a temperature range from the Ac3 transformation temperature to 1000°C followed by hot pressing work), it is necessary to perform a surface-cleaning treatment on a steel sheet in the form of a coiled steel sheet or in the form of a cut steel sheet or a steel sheet blank, which has been cut out of the coiled steel sheet. In addition, in the case of the second embodiment described above (in which a zinc-based coated steel sheet is subjected to cold pressing work followed by heating to a temperature range from the Ac3 transformation temperature to 1000°C), a surface-cleaning treatment may be performed on a steel sheet in the form of a coiled steel sheet or in the form of a cut steel sheet or a steel sheet blank, which has been cut out of the coiled steel sheet, or on a cold-pressed member after cold pressing work. Here, in any one of the first embodiment and the second embodiment, it is preferable that the period of time from the end of a surface-cleaning treatment to the beginning of heating be as short as possible. In addition, it is preferable that a surface-cleaning treatment be performed on a steel sheet in the form of a steel sheet blank, because this facilitates the treatment with a high level of surface-cleaning effect.

**[0045]** There is no particular limitation on the method used for performing a surface-cleaning treatment as long as it is possible to remove stains due to, for example, dirt, dust, and fingerprint which are adhered to the surface of a coating layer. Examples of a method for performing a surface-cleaning treatment include one in which the surface of a steel sheet is wiped with waste cloth, one in which the surface of a steel sheet is brushed by using, for example, a nylon brush, one in which the surface of a steel sheet is brushed after a liquid such as a wash oil, which has no negative effect on a steel sheet, has been applied to the surface, and one in which alkaline degreasing or solvent degreasing is performed. Since a method in which a liquid is in contact with the surface of a steel sheet such as a combined method of wash-oil application and brushing, an alkaline degreasing method, or a solvent degreasing method has a higher cleaning effect than a physical method such as one in which wiping with waste cloth or brushing is performed, it is preferable that a method in which a liquid be in contact with the surface of a steel sheet be performed to clean the surface of a steel sheet completely. However, in the case where alkaline degreasing is performed as a surface-cleaning treatment by using an alkaline degreasing liquid having a pH of 12.5 or more, since there is an excessive effect of dissolving a zinc-based coating layer, the generation of point-like defects is conversely promoted due to inhomogeneous dissolution, and there is a deterioration in corrosion resistance due to a decrease in coating weight. Therefore, in the case where alkaline degreasing is performed as a surface-cleaning treatment by using an alkaline degreasing liquid, the pH of the alkaline degreasing liquid is set to be less than 12.5. Moreover, it is preferable that the process of a surface-cleaning treatment have a low cost. In the case where apparatuses for cold pressing work has an apparatus for performing the combination

of wash-oil application and brushing, such equipment can preferably be used for hot pressing work, because it is possible to perform a treatment at low cost with a high cleaning effect by using such equipment.

## EXAMPLES

**[0046]** A cold-rolled steel sheet having a chemical composition containing, by mass%, C: 0.23%, Si: 0.25%, Mn: 1.2%, P: 0.01%, S: 0.01%, Al: 0.03%, N: 0.005%, Cr: 0.2%, Ti: 0.02%, B: 0.0022%, Sb: 0.008%, and the balance being Fe and inevitable impurities, an Ac3 transformation temperature of 820°C, and a thickness of 1.6 mm was used as a base steel sheet. The surface of this cold-rolled steel sheet was coated with one of a galvanizing layer, a hot-dip Zn-Al-alloy coating layer (Al content: 55 mass%), a galvannealing layer (Fe content: 10 mass%), a Zn electroplating layer, and a Zn-Ni-alloy electroplating layer (Ni content: 12 mass%) and cut into a sample having a size of 200 mm × 300 mm.

**[0047]** The sample obtained as described above was subjected to a surface-cleaning treatment. A surface-cleaning treatment was performed by using one of A: a wiping method with waste cloth, B: a brushing method, C: a combined method of wash-oil application and brushing, D: an alkaline degreasing method (pH: 12.0), and E: a solvent degreasing method. As comparative examples, samples which had been subjected to F: strong alkaline degreasing (pH: 13.0) and samples which had not been subjected to a surface-cleaning treatment were also prepared.

**[0048]** Wiping with waste cloth was performed by using waste cloth (Cleaning White Stockinet Waste (Cotton) produced by Nihon Waste Co., Ltd.) and by wiping the surface of a sample twice with a reciprocating movement of a hand.

**[0049]** Brushing was performed by using a nylon-fiber plant brush (SK-type Straight Brush produced by Showa Kogyo Co., Ltd.) and by brushing the surface of a sample twice with a reciprocating movement of a hand.

**[0050]** The combination of wash-oil application and brushing was performed by performing brushing as described above after having applied a wash rust-prevention oil (PRETON R352L produced by Sugimura Chemical Industrial Co., Ltd.) to the surface of a sample so that the amount of oil applied was 2.0 g/m<sup>2</sup>.

**[0051]** Alkaline degreasing was performed by spraying a sample with an alkaline degreasing liquid (CL-N364S, 20g/L, 60°C, produced by Nihon Parkerizing Co., LTD.) for 10 seconds, and thereafter performing water washing followed by drying. Here, at this time, the pH of the alkaline degreasing liquid was 12.0.

**[0052]** Solvent degreasing was performed by immersing a sample in a combined solvent of toluene and ethanol having a mixture ratio of 1:1, and thereafter performing ultrasonic cleaning for one minute and drying.

**[0053]** Strong alkaline degreasing, which was performed as a comparative example, was performed by immersing a sample in a strong alkaline degreasing liquid (NaOH aqueous solution, pH: controlled to be 13.0, 50°C) for 5 seconds, and thereafter performing water washing followed by drying.

**[0054]** Subsequently, the sample was heated in an electric furnace at a temperature of 950°C so that duration of the sample in the electric furnace was 8 minutes, the sample was taken out of the furnace immediately after completion of heating, and then held in a flat mold made of Al in order to perform a rapid cooling treatment (cooling rate: 50°C/s).

**[0055]** The surface appearance of the samples (zinc-based coated steel sheets) obtained as described above was evaluated by using the following method.

**[0056]** Ten samples were each prepared under the same condition in order to increase the judgment accuracy of surface appearance. After having performed a visual test regarding the state of point-like defects of the samples, surface appearance was judged on the basis of the judgment criteria below, and the case of ○ or ○ was judged as satisfactory. Here, in the examples of the present invention, although the effect of the present invention was evaluated on the basis of the evaluation of the surface appearance after having heated and cooled a flat sheet as described above without performing practical press forming which utilized a direct process or an indirect process, the results of the present evaluation are the same as those of the evaluation of the surface appearance after having performed practical press forming which utilizes the above-mentioned two processes, because the surface appearance after having performed heating and cooling depends on whether or not stain components exist on the surface of the sample and on the effect of removing the stain components.

- ⊙: 10 out of the 10 samples had no point-like defect
- : 8 to 9 out of the 10 samples had no point-like defect
- △: 5 to 7 out of the 10 samples had no point-like defect
- ×: 0 to 4 out of the 10 samples had no point-like defect

**[0057]** The results of the evaluation of surface appearance are given in Table 1 in combination with the manufacturing conditions.

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[Table 1]

| Steel Sheet No. | Coating Layer |                                             | Surface-cleaning Treatment |                                 | Surface Appearance | Note    |
|-----------------|---------------|---------------------------------------------|----------------------------|---------------------------------|--------------------|---------|
|                 | Type *        | Coating Weight per Side (g/m <sup>2</sup> ) | Code                       | Treatment Method                |                    |         |
| 1               | GI            | 60                                          | A                          | Wiping with Waste Cloth         | ○                  | Example |
| 2               | GL            | 80                                          | A                          | Wiping with Waste Cloth         | ○                  | Example |
| 3               | GA            | 20                                          | A                          | Wiping with Waste Cloth         | ○                  | Example |
| 4               | GA            | 45                                          | A                          | Wiping with Waste Cloth         | ○                  | Example |
| 5               | GA            | 90                                          | A                          | Wiping with Waste Cloth         | ○                  | Example |
| 6               | EG            | 40                                          | A                          | Wiping with Waste Cloth         | ○                  | Example |
| 7               | ZN            | 10                                          | A                          | Wiping with Waste Cloth         | ⊙                  | Example |
| 8               | ZN            | 60                                          | A                          | Wiping with Waste Cloth         | ⊙                  | Example |
| 9               | ZN            | 90                                          | A                          | Wiping with Waste Cloth         | ⊙                  | Example |
| 10              | GI            | 60                                          | B                          | Brushing                        | ○                  | Example |
| 11              | GL            | 80                                          | B                          | Brushing                        | ○                  | Example |
| 12              | GA            | 20                                          | B                          | Brushing                        | ○                  | Example |
| 13              | GA            | 45                                          | B                          | Brushing                        | ○                  | Example |
| 14              | GA            | 90                                          | B                          | Brushing                        | ○                  | Example |
| 15              | EG            | 40                                          | B                          | Brushing                        | ○                  | Example |
| 16              | ZN            | 10                                          | B                          | Brushing                        | ⊙                  | Example |
| 17              | ZN            | 60                                          | B                          | Brushing                        | ⊙                  | Example |
| 18              | ZN            | 90                                          | B                          | Brushing                        | ⊙                  | Example |
| 19              | GI            | 60                                          | C                          | Wash-oil Application + Brushing | ⊙                  | Example |
| 20              | GL            | 80                                          | C                          | Wash-oil Application + Brushing | ⊙                  | Example |
| 21              | GA            | 20                                          | C                          | Wash-oil Application + Brushing | ⊙                  | Example |
| 22              | GA            | 45                                          | C                          | Wash-oil Application + Brushing | ⊙                  | Example |
| 23              | GA            | 90                                          | C                          | Wash-oil Application + Brushing | ⊙                  | Example |
| 24              | EG            | 40                                          | C                          | Wash-oil Application + Brushing | ⊙                  | Example |
| 25              | ZN            | 10                                          | C                          | Wash-oil Application + Brushing | ⊙                  | Example |

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(continued)

| Steel Sheet No. | Coating Layer |                                             | Surface-cleaning Treatment |                                 | Surface Appearance | Note                |
|-----------------|---------------|---------------------------------------------|----------------------------|---------------------------------|--------------------|---------------------|
|                 | Type *        | Coating Weight per Side (g/m <sup>2</sup> ) | Code                       | Treatment Method                |                    |                     |
| 26              | ZN            | 60                                          | C                          | Wash-oil Application + Brushing | ⊙                  | Example             |
| 27              | ZN            | 90                                          | C                          | Wash-oil Application + Brushing | ⊙                  | Example             |
| 28              | GI            | 60                                          | D                          | Alkaline Degreasing             | ⊙                  | Example             |
| 29              | GL            | 80                                          | D                          | Alkaline Degreasing             | ⊙                  | Example             |
| 30              | GA            | 20                                          | D                          | Alkaline Degreasing             | ⊙                  | Example             |
| 31              | GA            | 45                                          | D                          | Alkaline Degreasing             | ⊙                  | Example             |
| 32              | GA            | 90                                          | D                          | Alkaline Degreasing             | ⊙                  | Example             |
| 33              | EG            | 40                                          | D                          | Alkaline Degreasing             | ⊙                  | Example             |
| 34              | ZN            | 10                                          | D                          | Alkaline Degreasing             | ⊙                  | Example             |
| 35              | ZN            | 60                                          | D                          | Alkaline Degreasing             | ⊙                  | Example             |
| 36              | ZN            | 90                                          | D                          | Alkaline Degreasing             | ⊙                  | Example             |
| 37              | GI            | 60                                          | E                          | Solvent Degreasing              | ⊙                  | Example             |
| 38              | GL            | 80                                          | E                          | Solvent Degreasing              | ⊙                  | Example             |
| 39              | GA            | 20                                          | E                          | Solvent Degreasing              | ⊙                  | Example             |
| 40              | GA            | 45                                          | E                          | Solvent Degreasing              | ⊙                  | Example             |
| 41              | GA            | 90                                          | E                          | Solvent Degreasing              | ⊙                  | Example             |
| 42              | EG            | 40                                          | E                          | Solvent Degreasing              | ⊙                  | Example             |
| 43              | ZN            | 10                                          | E                          | Solvent Degreasing              | ⊙                  | Example             |
| 44              | ZN            | 60                                          | E                          | Solvent Degreasing              | ⊙                  | Example             |
| 45              | ZN            | 90                                          | E                          | Solvent Degreasing              | ⊙                  | Example             |
| 46              | GI            | 60                                          | F                          | Strong Alkaline Degreasing      | ×                  | Comparative Example |
| 47              | GL            | 80                                          | F                          | Strong Alkaline Degreasing      | ×                  | Comparative Example |
| 48              | GA            | 20                                          | F                          | Strong Alkaline Degreasing      | ×                  | Comparative Example |
| 49              | GA            | 45                                          | F                          | Strong Alkaline Degreasing      | ×                  | Comparative Example |
| 50              | GA            | 90                                          | F                          | Strong Alkaline Degreasing      | ×                  | Comparative Example |
| 51              | EG            | 40                                          | F                          | Strong Alkaline Degreasing      | ×                  | Comparative Example |
| 52              | ZN            | 10                                          | F                          | Strong Alkaline Degreasing      | Δ                  | Comparative Example |
| 53              | ZN            | 60                                          | F                          | Strong Alkaline Degreasing      | Δ                  | Comparative Example |

(continued)

| Steel Sheet No.                                                                                                                                                                                                            | Coating Layer |                                             | Surface-cleaning Treatment |                            | Surface Appearance | Note                |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|---------------------------------------------|----------------------------|----------------------------|--------------------|---------------------|
|                                                                                                                                                                                                                            | Type *        | Coating Weight per Side (g/m <sup>2</sup> ) | Code                       | Treatment Method           |                    |                     |
| 54                                                                                                                                                                                                                         | ZN            | 90                                          | F                          | Strong Alkaline Degreasing | Δ                  | Comparative Example |
| 55                                                                                                                                                                                                                         | GI            | 60                                          | -                          | No Treatment               | ×                  | Comparative Example |
| 56                                                                                                                                                                                                                         | GL            | 80                                          | -                          | No Treatment               | ×                  | Comparative Example |
| 57                                                                                                                                                                                                                         | GA            | 20                                          | -                          | No Treatment               | ×                  | Comparative Example |
| 58                                                                                                                                                                                                                         | GA            | 45                                          | -                          | No Treatment               | ×                  | Comparative Example |
| 59                                                                                                                                                                                                                         | GA            | 90                                          | -                          | No Treatment               | ×                  | Comparative Example |
| 60                                                                                                                                                                                                                         | EG            | 40                                          | -                          | No Treatment               | ×                  | Comparative Example |
| 61                                                                                                                                                                                                                         | ZN            | 10                                          | -                          | No Treatment               | Δ                  | Comparative Example |
| 62                                                                                                                                                                                                                         | ZN            | 60                                          | -                          | No Treatment               | Δ                  | Comparative Example |
| 63                                                                                                                                                                                                                         | ZN            | 90                                          | -                          | No Treatment               | Δ                  | Comparative Example |
| * GI: galvanizing layer GL: hot-dip Zn-Al-alloy coating layer (Al content 55 mass%) GA: galvannealing layer (Fe content: 10 mass%) EG: Zn electroplating layer ZN: Zn-Ni-alloy electroplating layer (Ni content: 12 mass%) |               |                                             |                            |                            |                    |                     |

**[0058]** It is clarified that all the zinc-based coated steel sheets (examples of the present invention), which were manufactured by performing a surface-cleaning treatment in the manufacturing method according to the present invention, were excellent in terms of surface appearance. In particular, it is clarified that the surface appearance was absolutely excellent in the case where a Zn-Ni-alloy-electroplated steel sheet was used. On the other hand, the zinc-based coated steel sheet (comparative example), which was subjected to degreasing with a strong alkali having a pH of 12.5 or more, and the zinc-based coated steel sheet (comparative example), which was not subjected to a surface-cleaning treatment, were poor in terms of surface appearance.

## Claims

1. A method for manufacturing a hot-pressed member having an excellent surface appearance, the method comprising heating a zinc-based coated steel sheet to a temperature range from the Ac3 transformation temperature to 1000°C, performing hot pressing work, and performing cooling, wherein a surface-cleaning treatment is performed on the zinc-based coated steel sheet before the heating is performed.
2. A method for manufacturing a hot-pressed member having an excellent surface appearance, the method comprising performing cold pressing work on a zinc-based coated steel sheet, heating the zinc-based coated steel sheet to a temperature range from the Ac3 transformation temperature to 1000°C, and cooling the heated steel sheet, wherein a surface-cleaning treatment is performed on the zinc-based coated steel sheet before the heating is performed.
3. The method for manufacturing a hot-pressed member according to Claim 1 or 2, wherein the zinc-based coated steel sheet is a Zn-Ni-alloy-coated steel sheet having a coating layer on one or both sides of the Zn-Ni-alloy-coated steel sheet, and the coating layer has a chemical composition containing 10 mass% to 25 mass% of Ni and the

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balance being Zn and inevitable impurities and a coating weight per side of 10 g/m<sup>2</sup> to 90 g/m<sup>2</sup>.

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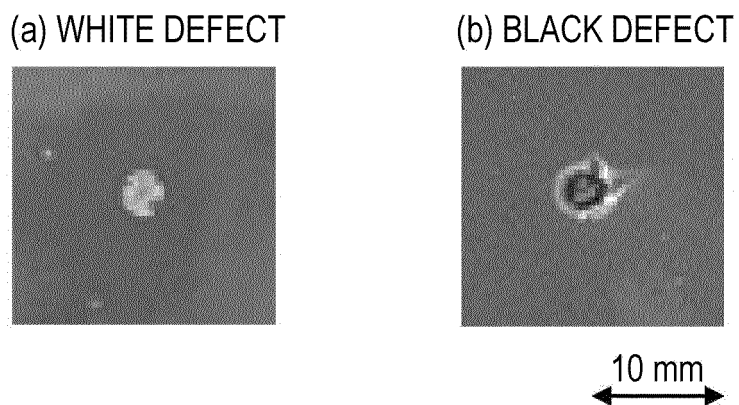
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FIG. 1



FIG. 2



## INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2016/003196

## A. CLASSIFICATION OF SUBJECT MATTER

B21D22/20(2006.01)i, C23C2/06(2006.01)i, C23C2/26(2006.01)i, C23C2/40  
(2006.01)i, C25D5/26(2006.01)i, C25D5/48(2006.01)i, B21D22/26(2006.01)n

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)

B21D22/20, C23C2/06, C23C2/26, C23C2/40, C25D5/26, C25D5/48, B21D22/26

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

Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2016

Kokai Jitsuyo Shinan Koho 1971-2016 Toroku Jitsuyo Shinan Koho 1994-2016

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

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages                                 | Relevant to claim No. |
|-----------|--------------------------------------------------------------------------------------------------------------------|-----------------------|
| X<br>Y    | JP 2015-71810 A (Nippon Steel & Sumitomo Metal Corp.),<br>16 April 2015 (16.04.2015),<br>claim 1<br>(Family: none) | 1<br>3                |
| X<br>Y    | JP 2015-94006 A (Nippon Steel & Sumitomo Metal Corp.),<br>18 May 2015 (18.05.2015),<br>claim 1<br>(Family: none)   | 1<br>3                |

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

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"&amp;" document member of the same patent family

Date of the actual completion of the international search  
21 September 2016 (21.09.16)Date of mailing of the international search report  
04 October 2016 (04.10.16)Name and mailing address of the ISA/  
Japan Patent Office  
3-4-3, Kasumigaseki, Chiyoda-ku,  
Tokyo 100-8915, Japan

Authorized officer

Telephone No.

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

## INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2016/003196

## C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages                                                                                                                                                                  | Relevant to claim No. |
|-----------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|
| X<br>Y    | WO 2008/153183 A1 (Sumitomo Metal Industries, Ltd.),<br>18 December 2008 (18.12.2008),<br>claim 1; paragraphs [0044] to [0054]<br>& JP 5218404 B & EP 2159292 A1<br>paragraphs [0046] to [0057]; claim 1<br>& CN 101680048 A & KR 10-2010-0019500 A | 2<br>3                |
| Y         | JP 2015-104753 A (Nippon Steel & Sumitomo Metal Corp.),<br>08 June 2015 (08.06.2015),<br>paragraphs [0108], [0112] to [0115]<br>(Family: none)                                                                                                      | 3                     |
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Form PCT/ISA/210 (continuation of second sheet) (January 2015)

**REFERENCES CITED IN THE DESCRIPTION**

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