TITLE OF INVENTION: METHOD FOR WELDING OF COATED METALS

TECHNICAL FIELD

[0001] The present disclosure relates to a method for welding of coated metals, and more particularly, to a method for welding of coated metals designed to improve the quality of welding between coated metals which overlap each other.

BACKGROUND

[0002] Coated metals or plated metals may be used in various industrial fields. Here, the coated metal or plated metal may be produced by coating both surfaces of a base metal with a coating material or plating material to improve corrosion resistance, strength, stiffness, and the like.

[0003] Various types of welding may be applied to join the coated metals or plated metals. For example, there is a method for joining the overlapping coated metals by irradiating the overlapping coated metals with a laser beam and melting them. However, since the base metal and the coating material are dissimilar materials, and the melting point of the base metal is different from the boiling point and melting point of the coating material, a blowhole may be created due to a pore in a welded portion (deposited portion) of the coated metals. Specifically, the blowhole, which is an empty space formed in the deposited portion, may reduce stiffness of the welded portion and lower the quality of welding.

[0004] In particular, zinc-coated steel sheets in which steel sheets are coated with zinc may be widely used for various components/parts of a vehicle. The zinc-coated steel sheets may be an inexpensive material with high stiffness and corrosion resistance.

[0005] In order to join the zinc-coated steel sheets, laser welding may be mainly used. However, when the overlapping zinc-coated steel sheets are melted by laser, zinc may be evaporated since a boiling point (907°C) of zinc is significantly lower than a melting point (1,510°C) of steel (base metal). As a gas generated during evaporation of zinc is not smoothly released between the overlapping zinc-coated steel sheets, a pore may be formed in the welded portion. On the other hand, when nickel-coated steel sheets or chromium-coated steel sheets are subjected to laser welding, the possibility of weld failures due to a bubble of gas may be relatively low since a boiling point (2,732°C) of nickel and a boiling point (2,672°C) of chromium are higher than a melting point (1,510°C) of steel (base metal).

[0006] As described above, when the boiling point of the coating material is much lower than the melting point of the base metal as in the case of the zinc-coated steel sheets, there is proposed a welding method for minimizing the formation of pores in the welded portion of the coated steel sheets. Such a welding method may include the following steps: primarily melting overlapping portions of coated metals to be welded by laser irradiation; removing a blowhole formed in the welded portion; and secondarily melting the welded portion by irradiating the welded portion with a laser beam at a temperature higher than the melting point of the base metal. However, as the melting operations are carried out twice, the amount of heat input (exposure time) increases, which reduces the strength of the material, and the weld quality may not be stably maintained.

[0007] The above information described in this background section is provided to assist in understanding the background of the inventive concept, and may include any technical concept which is not considered as the prior art that is already known to those skilled in the art.

SUMMARY

[0008] The present disclosure has been made to solve the above-mentioned problems occurring in the prior art while advantages achieved by the prior art are maintained intact.

[0009] An aspect of the present disclosure provides a method for welding of coated metals designed to improve the quality of welding between coated metals or plated metals including a coating material or plating material having a boiling point lower than a melting point of a base metal.

[0010] According to an aspect of the present disclosure, a method for welding of coated metals may include: at least partially overlapping two coated metals; spacing overlapping portions of the two coated metals apart from each other at a predetermined gap; and joining the overlapping portions of the two coated metals by laser welding.

[0011] The two coated metals may be spaced apart from each other at the predetermined gap by at least two spacers.

[0012] The at least two spacers may be spaced apart from each other between the two coated metals so that the at least two spacers and the two coated metals may be configured to define a passage.

[0013] The laser welding may be keyhole mode laser welding in which a laser beam penetrates through the overlapping portions of the two coated metals.

[0014] An axis of the laser beam may be parallel to an axis of each coated metal extending along a thickness direction of the coated metal.

[0015] In the keyhole mode laser welding, as the laser beam penetrates through the overlapping portions of the two coated metals, one continuous bridge may be formed between the overlapping portions of the two coated metals, and thus the quality of welding between the two coated metals may be improved.

[0016] Each coated metal may include a base metal and a coating material with which a surface of the base metal is coated, and a boiling point of the coating material may be lower than a melting point of the base metal.

[0017] According to another aspect of the present disclosure, a method for welding of a coupling portion of a battery clamp and a joint wall of an end plate may include: at least partially overlapping the coupling portion and the joint wall; spacing overlapping portions of the coupling portion and the joint wall apart from each other at a predetermined gap; and joining the overlapping portions of the coupling portion and the joint wall by laser welding, wherein the coupling portion and the joint wall may be coated metals of the same material.

[0018] The coupling portion may include a pair of support fingers connected to both side edges thereof, the pair of support fingers may be spaced apart from the coupling portion, a gap between the pair of support fingers and the coupling portion may be greater than a thickness of the joint wall, and the joint wall may be inserted between the pair of support fingers and the coupling portion.

[0019] The pair of support fingers may directly contact the joint wall so that the coupling portion and the joint wall may be spaced apart from each other at the predetermined gap.

[0020] Each of the coupling portion and the joint wall may include a base metal and a coating material with which a surface of the base metal is coated, and a boiling point of the coating material may be lower than a melting point of the base metal.

BRIEF DESCRIPTION OF THE DRAWINGS

[0021] The above and other objects, features and advantages of the present disclosure will be more apparent from the following detailed description taken in conjunction with the accompanying drawings:

[0022] FIG. 1 illustrates a state in which two coated metals or plated metals are at least partially overlapped and spaced apart from each other;

[0023] FIG. 2 illustrates a view, viewed in a direction indicated by arrow A of FIG. 1;

[0024] FIG. 3 illustrates a state in which a laser beam penetrates into an upper one of overlapping portions of two coated metals;

[0025] FIG. 4 illustrates a state in which a laser beam completely penetrates through an upper one of overlapping portions of two coated metals;

[0026] FIG. 5 illustrates a state in which a laser beam completely penetrates through a lower one of overlapping portions of two coated metals;

[0027] FIG. 6 is a photograph showing that overlapping portions of two coated metals are welded by laser welding in a state in which the two coated metals are spaced apart from each other at a predetermined gap;

[0028] FIG. 7 is a photograph showing that overlapping portions of two coated metals are welded by laser welding in a state in which the two coated metals are spaced apart from each other outside of a predetermined gap;

[0029] FIG. 8 illustrates an example of a battery module;

[0030] FIG. 9 illustrates a perspective view of a battery clamp of a battery module;

[0031] FIG. 10 illustrates a perspective view of a state in which a coupling portion of a battery clamp is coupled to a joint wall of an end plate;

[0032] FIG. 11 illustrates a cross-sectional view, taken along line B-B of FIG. 10;

[0033] FIG. 12 illustrates a cross-sectional view, taken along line C-C of FIG. 10; and

[0034] FIG. 13 illustrates a state in which a coupling portion of a battery clamp and a joint wall of an end plate are joined by laser welding.

DETAILED DESCRIPTION

[0035] Hereinafter, exemplary embodiments of the present disclosure will be described in detail with reference to the accompanying drawings. In the drawings, the same reference numerals will be used throughout to designate the same or equivalent elements. In addition, a detailed description of well-known techniques associated with the present disclosure will be ruled out in order not to unnecessarily obscure the gist of the present disclosure.

[0036] Terms such as first, second, A, B, (a), and (b) may be used to describe the elements in exemplary embodiments of the present disclosure. These terms are only used to distinguish one element from another element, and the intrinsic features, sequence or order, and the like of the corresponding elements are not limited by the terms. Unless otherwise defined, all terms used herein, including technical or scientific terms, have the same meanings as those generally understood by those with ordinary knowledge in the field of art to which the present disclosure belongs. Such terms as those defined in a generally used dictionary are to be interpreted as having meanings equal to the contextual meanings in the relevant field of art, and are not to be interpreted as having ideal or excessively formal meanings unless clearly defined as having such in the present application.

[0037] Referring to FIG. 1, two coated metals (or plated metals) 11 and 12 may be at least partially overlapped, and the two coated metals 11 and 12 may be parallel to each other. The two coated metals 11 and 12 may be made of the same material. Overlapping portions (facing portions) of the two coated metals 11 and 12 may be spaced apart from each other at a predetermined gap g along a thickness direction of each of the coated metals 11 and 12. The coated metals 11 and 12 may include base metals 11a and 12a, and coating materials (or plating materials) 11b and 12b with which surfaces of the base metals 11a and 12a are coated, respectively. The coating materials 11b and 12b and the base metals 11a and 12a may be dissimilar materials. According to an exemplary embodiment, the base metals 11a and 12a may be steel, aluminum (Al), and/or the like, and the coating materials 11b and 12b may be zinc (Zn), nickel (Ni), chromium (Cr), and/or the like.

[0038] According to an exemplary embodiment, the two coated metals 11 and 12 may be spaced apart from each other at the predetermined gap g by at least two spacers 13 and 14. The predetermined gap g may be constantly maintained by the at least two spacers 13 and 14 along the overlapping portions of the two coated metals 11 and 12. Referring to FIG. 2, each of the spacers 13 and 14 may have a constant thickness, and the spacers 13 and 14 may be interposed between the two coated metals 11 and 12 so that the two coated metals 11 and 12 may be spaced apart from each other at the predetermined gap g which is the same as the thickness of each of the spacers 13 and 14. That is, the gap g between the two coated metals 11 and 12 may be determined by the thicknesses of the spacers 13 and 14. In addition, the two coated metals 11 and 12 may be of the same coated metal.

[0039] Referring to FIG. 2, the plurality of spacers 13 and 14 may be spaced apart from each other at a predetermined gap between the two coated metals 11 and 12, and accordingly the plurality of spacers 13 and 14 and the two coated metals 11 and 12 may define a passage 15.

[0040] The plurality of spacers 13 and 14 may be connected to a support structure (not shown), and accordingly the plurality of spacers 13 and 14 may be stably maintained between the two coated metals 11 and 12.

[0041] Referring to FIGS. 3 to 5, in a state in which the two partially overlapping coated metals 11 and 12 are spaced apart from each other at the predetermined gap g, the two coated metals 11 and 12 may be joined by laser welding.

[0042] The laser welding may be carried out by exposing materials to heat energy by laser irradiation to change a solid phase to a liquid phase, allowing the liquid-phase materials to be fused, and then changing the fused materials into a solid phase. In particular, the laser welding may be performed at a speed of 50 mm/s - 400 mm/s, and a welding time per unit mm may be 1/50 sec - 1/400 sec which is very short. In addition, the laser welding does not need a filler material, and has a relatively high welding speed, a short welding cycle, low weld heat input, a small heat affected zone (HAZ), minimal distortion, and so on, so it has been widely used in joining parts/components of a vehicle while replacing spot welding and arc welding. In particular, keyhole mode laser welding using multiple reflection and absorption of energy in a focal region of a laser beam has been advantageously used to join two overlapping parts/components. The keyhole mode laser welding may be performed in the focal region (the distance of the keyhole welding region from a focus is within about 2 mm) where the laser beam is focused by a lens and the multiple reflection and multiple absorption of energy with respect to the material occurs. That is, the keyhole mode laser welding may be a high-power laser welding process in which electromagnetic waves of the laser beam collide with the material surface at a focal point where the laser beam is converged, collision energy is transformed into heat energy, and a keyhole effect occurs. Such a keyhole effect means a state in which welding is performed while making a small hole (keyhole) in a molten pool by vapor pressure. As the keyhole mode laser welding produces the keyhole, the solid material reflects the laser and the liquid material absorbs the laser so that the continuous molten pool may be created.

[0043] The laser welding according to an exemplary embodiment of the present disclosure may be keyhole mode laser welding in which a laser beam LB penetrates through the overlapping portions of the two coated metals 11 and 12. First of all, a high-power Gaussian laser beam LB may travel along the thickness of an upper coated metal 11 (see FIG. 3). Thereafter, the laser beam LB may travel up to a bottom surface of the upper coated metal 11 (see FIG. 4). Finally, the laser beam LB may penetrate through the overlapping portions of the upper and lower coated metals 11 and 12 (see FIG. 5). An axis X of the laser beam LB may be parallel to an axis of each of the coated metals 11 and 12 extending along thickness directions W1 and W2 of the coated metals 11 and 12, and accordingly the laser beam LB may penetrate through the overlapping portions of the two coated metals 11 and 12.

[0044] Referring to FIG. 3, when the laser beam LB travels from a top surface of the upper coated metal 11 to the bottom surface of the upper coated metal 11, the base metal 11a of the upper coated metal 11 may be melted and vaporized by the laser beam LB so that a molten pool 11c may be formed by a keyhole in the base metal 11a.

[0045] Referring to FIG. 4, as the laser beam LB travels up to the bottom surface of the upper coated metal 11, the laser beam LB may completely penetrate through the upper coated metal 11. Here, the base metal 11a and the coating material 11b of the upper coated metal 11 may be melted and vaporized by the laser beam LB so that the molten pool 11c may completely penetrate the base metal 11a through the keyhole, and the vaporized gas may be released outwards through the passage 15 between the upper coated metal 11 and the lower coated metal 12.

[0046] Referring to FIG. 5, as the laser beam LB travels up to a bottom surface of the lower coated metal 12, the laser beam LB may completely penetrate through the lower coated metal 12. Here, the base metal 12a and the coating material 12b of the lower coated metal 12 may be melted and vaporized by the laser beam LB so that a molten pool 12c may completely penetrate the base metal 11a through the keyhole, and the vaporized gas may be released outwards through the passage 15 between the upper coated metal 11 and the lower coated metal 12.

[0047] Conventional laser welding may be performed in a condition in which two components are in close contact. On the other hand, the laser welding according to an exemplary embodiment of the present disclosure may be performed in a state in which the at least two partially overlapping coated metals 11 and 12 are spaced apart from each other at the predetermined gap g. Accordingly, the gas generated when the base metals 11a and 12a and the coating materials 11b and 12b are melted and vaporized by the laser beam may be released outwards through the passage 15 between the two adjacent coated metals 11 and 12 so that the gas may be prevented from forming pores and blowholes in the molten pools 11c and 12c.

Thus, the quality of welding between the two adjacent coated metals 11 and 12 may be significantly improved.

[0048] Referring to FIG. 5, the molten pool 11c of the upper coated metal 11 and the molten pool 12c of the lower coated metal 12 may be continuously connected to each other, and the molten pool 11c of the upper coated metal 11 and the molten pool 12c of the lower coated metal 12 may be solidified so that a weld bead of the upper coated metal 11 and a weld bead of the lower coated metal 12 may be continuously connected to each other. As the weld bead of the upper coated metal 11 and the weld bead of the lower coated metal 12 are continuously connected to each other, a continuous bridge 16 may penetrate through the overlapping portions of the upper coated metal 11 and the lower coated metal 12. In particular, the gas generated when the base metal 11a and the coating material 11b of the upper coated metal 11 are vaporized and the gas generated when the base metal 12a and the coating material 12b of the lower coated metal 12 are vaporized may be released through the top surface of the upper coated metal 11, the bottom surface of the lower coated metal 12, and the passage 15 between the upper coated metal 11 and the lower coated metal 12 so that the molten pool 11c of the upper coated metal 11 and the molten pool 12c of the lower coated metal 12 may be continuously connected due to surface tension. As the molten pool 11c of the upper coated metal 11 is solidified, the weld bead of the upper coated metal 11 may be formed, and as the molten pool 12c of the lower coated metal 12 is solidified, the weld bead of the lower coated metal 12 may be formed. As the molten pool 11c of the upper coated metal 11 and the molten pool 12c of the lower coated metal 12 are continuously connected to each other, the weld bead of the upper coated metal 11 and the weld bead of the lower coated metal 12 may be continuously connected to each other, and thus one solidified bridge 16 may penetrate through the upper coated metal 11 and the lower coated metal 12.

[0049] According to an exemplary embodiment, the gap g between the upper coated metal 11 and the lower coated metal 12 may be greater than or equal to 0.05 mm and be less than or equal to 0.3 mm ($0.05 \leq g \leq 0.3$).

[0050] When the gap g between the upper coated metal 11 and the lower coated metal 12 is 0.1 mm (g=0.1), the surface tension of the molten pool 11c of the upper coated metal 11 and the surface tension of the molten pool 12c of the lower coated metal 12 may be maximized so that the molten pool 11c of the upper coated metal 11 and the molten pool 12c of the lower coated metal 12 may be continuously connected to each other. Accordingly, the weld bead of the upper coated metal 11 and the weld bead of the lower coated metal 12 may be continuously connected to each other to thereby form one bridge penetrating through the upper coated metal 11 and the lower coated metal 12. FIG. 6 is a photograph showing the result of performing keyhole mode laser welding when the gap g between the upper coated metal 11 and the lower coated metal 12 is 0.1 mm. Referring to FIG. 6, an upper weld bead of the upper coated metal 11 and a lower weld bead of the lower coated metal 12 may be continuously connected to each other so that one continuous bridge 16 penetrating through the upper coated metal 11 and the lower coated metal 12 may be formed, and thus the bridge 16 may firmly join the upper coated metal 11 and the lower coated metal 12.

[0051] When the gap g between the upper coated metal 11 and the lower coated metal 12 exceeds 0.3 mm, the surface tension of the molten pool 11c of the upper coated metal 11 and the surface tension of the molten pool 12c of the lower coated metal 12 may be relatively lowered so that the molten pool 11c of the upper coated metal 11 and the molten pool 12c of the lower coated metal 12 may not be continuously connected to each other. FIG. 7 is a photograph showing the result of performing keyhole mode laser welding when the gap g between the upper coated metal 11 and the lower coated metal 12 exceeds 0.3 mm. Referring to FIG. 7, a weld bead 16a of the upper coated metal 11 and a weld bead 16b of the lower coated metal 12 may not be continuously connected to each other, but a discontinuous pore 16c may be formed between the weld bead 16a of the upper coated metal 11 and the weld bead 16b of the lower coated metal 12.

[0052] When the coated metals 11 and 12 in which the boiling point of each of the coating materials 11b and 12b is significantly lower than the melting point and boiling point of the corresponding one of the base metals 11a and 12a are welded, the two overlapping coated metals 11 and 12 may be spaced apart from each other at the predetermined gap g so that the coating materials 11b and 12b may be vaporized by the laser beam before the base metals 11a and 12a. Since the vapor of the coating materials 11b and 12b is released through the passage 15, the formation of pores or blowholes in the molten pools 11c and 12c of the two coated metals 11 and 12 may be minimized or prevented. Thus, the two coated metals 11 and 12 may be firmly joined through one bridge

16, and the quality of welding between the coated metals 11 and 12 may be significantly improved.

[0053] For example, when the base metals 11a and 12a are steel, and the coating materials 11b and 12b are zinc (Zn), the boiling point (907°C) of zinc is much lower than the melting point (1,510°C) and boiling point (2,750°C) of steel. That is, when laser welding is performed in a state in which zinc-coated steel sheets are in close contact, zinc may vaporize before steel. In this state, a zinc vapor may form a pore and/or a blowhole in the molten pools of the zinc-coated steel sheets, resulting in very poor welding quality between the two zinc-coated steel sheets.

[0054] According to an exemplary embodiment of the present disclosure, since two zinc-coated steel sheets are spaced apart from each other at a predetermined gap, the zinc vapor first vaporized by the keyhole mode laser welding may be released outwards through the passage, and the very firm bridge between the two zinc-coated steel sheets may be formed. Thus, the two zinc-coated steel sheets may be firmly joined. The welding method according to an exemplary embodiment of the present disclosure may be used when joining the coated metals in which the boiling point of the coating material is lower than the melting point and boiling point of the base metal.

[0055] FIG. 8 illustrates an example of a battery module 20. Referring to FIG. 8, the battery module 20 may include battery cells 21 which are stacked, a pair of end plates 22 which are disposed on both sides of the stacked battery cells 21, and a pair of battery clamps 23 by which the pair of end plates 22 are connected. The pair of battery clamps 23 may connect the pair of end plates 22 so that the stacked battery cells 21 may be stably supported between the pair of end plates 22. The pair of battery clamps 23 may be disposed on the top and bottom of the stacked battery cells 21, respectively. An upper battery clamp 23 may connect top edges of the pair of end plates 22, and a lower battery clamp 23 may connect bottom edges of the pair of end plates 22. An upper cover 29 may be disposed on the top of the stacked battery cells 21, and the upper battery clamp 23 may be seated in a groove 29a of the upper cover 29.

[0056] Referring to FIG. 9, each battery clamp 23 may include a pair of coupling portions 24 provided on both ends thereof, respectively, and the coupling portions 24 may be bent from the ends of the battery clamp 23, respectively. Each coupling portion 24 may be perpendicular to a longitudinal axis of the battery clamp 23. Each battery clamp 23 may include a pair of support fingers 25 provided at both side edges of each coupling portion 24. Each support finger 25 may be connected to the corresponding edge of the coupling portion 24 through a connection portion 26. The connection portion 26 may be bent from the edge of the coupling portion 24 toward the center of the battery clamp 23. Accordingly, the support fingers 25 may be spaced apart from the coupling portion 24 toward the center of the battery clamp 23 at a predetermined gap t1. Referring to FIGS. 11 and 12, the pair of support fingers 25 may be spaced apart from the coupling portion 24 toward the center of the battery clamp 23 at the predetermined gap t1 by the connection portions 26.

[0057] Referring to FIG. 10, each end plate 22 may have a plurality of joint walls 28 provided on the top and bottom edges thereof, respectively. Referring to FIGS. 11 and 12, each joint wall 28 may be recessed from the end plate 22 toward the battery cell 21, and a thickness t2 of the joint wall 28 may be less than the gap t1 between the coupling portion 24 of the battery clamp 23 and the support finger 25 connected thereto. Each joint wall 28 of the end plate 22 may be inserted between the coupling portion 24 and the support fingers 25 of the battery clamp 23 so that the pair of support fingers 25 may directly contact the joint wall 28 of the end plate 22, and thus the joint wall 28 may be supported by the pair of support fingers 25. Since the joint wall 28 of each end plate 22 contacts the pair of support fingers 25, and the thickness t2 of each joint wall 28 is less than the gap t1 between the coupling portion 24 of the battery clamp 23 and the support finger 25 connected thereto, the joint wall 28 of the end plate 22 may be spaced apart from the coupling portion 24 of the battery clamp 23 at a predetermined gap g. That is, the predetermined gap g may be obtained by subtracting the thickness t2 of the joint wall 28 from the gap t1 between the coupling portion 24 and the support finger 25 (g= t1-t2).

[0058] The battery clamp 23 and the end plate 22 may be coated metals of the same material, and thus the coupling portion 24 of the battery clamp 23 and the joint wall 28 of the end plate 22 may be coated metals of the same material.

[0059] Referring to FIG. 13, the coupling portion 24 of the battery clamp 23 may include a base metal 24a, and a coating material 24b with which a surface of the base metal 24a is coated. The joint wall 28 of the end plate 22 may include a base metal 28a, and a coating material 28b with which a surface of the base metal 28a is coated. The coupling portion 24 of the battery clamp 23 and the joint wall 28 of the end plate 22 may be coated metals in which the boiling point of each of the coating materials 24b and 28b is lower than the melting point and boiling point of the corresponding one of the base metals 24a and 28a.

[0060] The coupling portion 24 of the battery clamp 23 and the joint wall 28 of the end plate 22 may be at least partially overlapped, and the overlapping portions of the coupling portion 24 and the joint wall 28 may be spaced apart from each other at the predetermined gap g. In this state, the coupling portion 24 and the joint wall 28 may be joined by the keyhole mode laser welding illustrated in FIGS. 3 to 5. Accordingly, as illustrated in FIG. 13, a bridge 36 penetrating through the overlapping portions of the coupling portion 24 and the joint wall 28 may be formed.

[0061] As set forth above, according to exemplary embodiments of the present disclosure, the overlapping portions of the two coated metals may be spaced apart from each other at a predetermined gap along the thickness direction of each coated metal so that the passage may be formed between the overlapping portions of the two coated metals. Since the metal vapor (the vapor of the coating material vaporized by laser welding) is released through the passage, the formation of pores or blowholes in the molten pools of the two coated metals may be prevented. Thus, the two coated metals may be firmly joined, and the quality of welding may be significantly improved.

[0062] Hereinabove, although the present disclosure has been described with reference to exemplary embodiments and the accompanying drawings, the present disclosure is not limited thereto, but may be variously modified and altered by those skilled in the art to which the present disclosure pertains without departing from the spirit and scope of the present disclosure claimed in the following claims.

WHAT IS CLAIMED IS:

[Claim 1] A method for welding of coated metals, the method comprising:

at least partially overlapping two coated metals;

spacing overlapping portions of the two coated metals apart from each other at a predetermined gap; and

joining the overlapping portions of the two coated metals by laser welding.

[Claim 2] The method according to claim 1, wherein the two coated metals are spaced apart from each other at the predetermined gap by at least two spacers.

[Claim 3] The method according to claim 2, wherein the at least two spacers are spaced apart from each other between the two coated metals so that the at least two spacers and the two coated metals are configured to define a passage.

[Claim 4] The method according to claim 1, wherein the laser welding is keyhole mode laser welding in which a laser beam penetrates through the overlapping portions of the two coated metals.

[Claim 5] The method according to claim 4, wherein an axis of the laser beam is parallel to an axis of each coated metal extending along a thickness direction of the coated metal.

[Claim 6] The method according to claim 1, wherein the two coated metals are of the same material,

each coated metal includes a base metal and a coating material with which a surface of the base metal is coated, and

a boiling point of the coating material is lower than a melting point of the base metal.

[Claim 7] A method for welding of a coupling portion of a battery clamp and a joint wall of an end plate, the method comprising:

at least partially overlapping the coupling portion and the joint wall;

spacing overlapping portions of the coupling portion and the joint wall apart from each other at a predetermined gap; and

joining the overlapping portions of the coupling portion and the joint wall by laser welding.

[Claim 8] The method according to claim 7, wherein the coupling portion includes a pair of support fingers connected to both side edges thereof,

the pair of support fingers are spaced apart from the coupling portion,

a gap between the pair of support fingers and the coupling portion is greater than a thickness of the joint wall, and

the joint wall is inserted between the pair of support fingers and the coupling portion.

[Claim 9] The method according to claim 8, wherein the pair of support fingers directly contact the joint wall so that the coupling portion and the joint wall are spaced apart from each other at the predetermined gap.

[Claim 10] The method according to claim 7, wherein the coupling portion and the joint wall are coated metals of the same material,

each of the coupling portion and the joint wall includes a base metal and a coating material with which a surface of the base metal is coated, and

a boiling point of the coating material is lower than a melting point of the base metal.