

BATTERY MODULE

TECHNICAL FIELD

[0001] The present disclosure relates to a battery module.

BACKGROUND

[0002] Recently, secondary batteries have become increasingly used as power sources for electric vehicles and hybrid vehicles, which are being proposed to solve environmental problems such as air pollution from existing gasoline or diesel vehicles, as the development of the advanced electronics industry has made it possible to miniaturize and lightweight electronic equipment.

[0003] Types of these secondary batteries include lithium-ion batteries, lithium polymer batteries, nickel-cadmium batteries, nickel-hydrogen batteries, and nickel-zinc batteries, and unit secondary batteries with a certain voltage, that is, battery cells, are prismatic, cylindrical, or pouch-shaped depending on the shape thereof, but, pouch-type battery cells that are used is thinner and lighter than square or cylindrical cells, may be manufactured in various shapes and forms, have excellent efficiency and heat dissipation per volume area, and are easy to be stacked in multiple layers are gradually increasing.

[0004] FIG. 1 is a view illustrating a state, in which front and rear covers are removed from a general battery module. As illustrated in FIG. 1, a general battery module 1 includes a cell

stack 2, in which a plurality of battery cells are stacked in a leftward/rightward direction, end plates 3 that are disposed on opposite side surfaces of the cell stack 2 in the leftward/rightward direction, and a clamp 4 that connects the pair of end plates 3. The clamp 4 is a structure for forming a surface-pressure by restraining expansion of battery cells, and may be overlap-welded to the end plates 3.

[0005] Furthermore, the plurality of battery cells have a lead tab 5 on at least one side in a forward/rearward direction. The lead tabs 5 of the plurality of battery cells are electrically connected to each other by a bus bar 6. To achieve this, the lead tabs 5 may be welded to the bus bar 6.

[0006] As described above, when the battery cells are formed, several welding processes are performed. FIG. 2 is an enlarged view illustrating portion "A" of FIG. 1. FIG. 3 is an enlarged view illustrating portion "B" of FIG. 1. When welding is performed, welding beads are formed at an overlapping portion of the lead tab 5 and the bus bar 6 and a portion of the clamp 4 and the end plate 3.

[0007] Meanwhile, a strength of a welding part increases as a welding length of the welding bead increases. Accordingly, conventionally, a method of forming welding beads in a straight line is used for parts that require welding.

[0008] However, when a welding time is extended to increase the welding length, a heat input to the welded part increases whereby

which mechanical properties, particularly, impact toughness or strength may be degraded in a heat affected zone.

[0009] Accordingly, it is necessary to efficiently arrange the welding beads in a specific welding target area to secure a welding length that may exhibit a required strength without consuming a long welding time to form one welding bead.

SUMMARY

[0010] 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.

[0011] An aspect of the present disclosure provides a battery module, in which welding beads are arranged in a specific welding pattern to secure a welding strength of a welded part.

[0012] The technical problems to be solved by the present disclosure are not limited to the aforementioned problems, and any other technical problems not mentioned herein will be clearly understood from the following description by those skilled in the art to which the present disclosure pertains.

[0013] According to an aspect of the present disclosure, a battery module includes a cell stack, in which a plurality of battery cells each having a lead tab on at least one side in a forward/rearward direction are stacked in a leftward/rightward direction, a bus bar electrically connected to the lead tabs of the plurality of battery cells, end plates disposed on opposite

side surfaces of the cell stack in the leftward/rightward direction, a clamp including a pair of contact portions contacting outer surfaces of the pair of end plates, and an extension part extending in the leftward/rightward direction and connecting the contact portions, and an overlapping area including a first overlapping area that is an area, in which any one of the plurality of lead tabs overlaps the bus bar when viewed along the forward/rearward direction, and second overlapping area that are areas, in which the contact portions overlap the end plates when viewed along the leftward/rightward direction, and a plurality of welding beads disposed to be spaced apart from each other are formed in at least any one of the first overlapping area and the second overlapping area.

[0014] In another example, the plurality of welding beads may be formed in the first overlapping area, and when an area, in which a length corresponding to a length of a (1-1)-th line spaced inwards apart from opposite ends of the first overlapping area in the leftward/rightward direction by a (1-1)-th reference length is a leftward/rightward length thereof and a length corresponding to a length of a (1-2)-th line spaced inwards apart from opposite ends of the first overlapping area in an upward/downward direction by a (1-2)-th reference length is an upward/downward length thereof, is defined as a first reference area, the plurality of welding beads may be disposed in the first reference area.

[0015] In another example, when a plurality of imaginary rectangular shapes that divide the first reference area into a plurality of parts along a first reference direction are defined as first reference rectangular shapes, the plurality of welding beads may be disposed in the plurality of first reference rectangular shapes, respectively.

[0016] In another example, each of the first reference rectangular shapes may have a (1-1)-th reference line that is a shorter one of the (1-1)-th line and the (1-2)-th line as a length of any one of a transverse side or a longitudinal side, and has a (1-2)-th reference line that is a line that is perpendicular to the (1-1)-th reference line as a length of the other one of the transverse side or the longitudinal side, and when a length of the welding beads along a direction that is perpendicular to an extension direction of the welding beads located in the first reference area is defined as a first bead width, the (1-2)-th reference line may have a length corresponding to a length obtained by adding a length of the first bead width to a length of a (1-3)-th reference line, and the (1-3)-th reference line may have a length corresponding to a distance, by which two welding beads are spaced apart from each other, when the two welding beads are disposed in the first reference area to be closest to each other such that heat affected zones thereof do not overlap each other.

[0017] In another example, one or more of the plurality of

welding beads may have a shape that connects two of the four apexes of the first reference rectangular shape and corresponds to a line crossing the first reference rectangular shape.

[0018] In another example, the number of the first reference rectangular shapes may be a quotient of a length of a longer one of the (1-1)-th line or the (1-2)-th line divided by a length of the (1-2)-th reference line as a number thereof.

[0019] In another example, a (1-1)-th reference rectangular shape that is one of the plurality of first reference rectangular shapes, which is located at a distal end in the first reference direction, may be disposed to be spaced apart from one of sides defining the first reference area, in the first reference direction, by a half of a remainder of a length of a larger one of the (1-1)-th line or the (1-2)-th line divided by a length of the (1-2)-th reference line.

[0020] In another example, a height of a lower end of any one of the plurality of welding beads may correspond to a height of an upper end of another welding bead located adjacent to a lower side.

[0021] In another example, the plurality of welding beads may have shapes that are parallel to each other.

[0022] In another example, the plurality of welding beads may be formed in the second overlapping area, and when an area, in which a length corresponding to a length of a (2-1)-th line spaced inwards apart from opposite ends of the second overlapping area

in a forward/rearward direction by a (2-1)-th reference length is a forward/rearward length thereof and a length corresponding to a length of a (2-2)-th line spaced inwards apart from opposite ends of the second overlapping area in an upward/downward direction by a (2-2)-th reference length is an upward/downward length thereof, is defined as a second reference area, the plurality of welding beads may be disposed in the second reference area.

[0023] In another example, when a plurality of rectangular shapes that divide the second reference area into a plurality of parts along a second reference direction are defined as second reference rectangular shapes, the plurality of welding beads may be disposed in the plurality of second reference rectangular shapes, respectively.

[0024] In another example, each of the second reference rectangular shape may have a (2-1)-th reference line that is a shorter one of the (2-1)-th line and the (2-2)-th line as a length of any one of a transverse side or a longitudinal side, and may have a (2-2)-th reference line that is a line that is perpendicular to the (2-1)-th reference line as a length of the other one of the transverse side or the longitudinal side, and when a length of the welding beads along a direction that is perpendicular to an extension direction of the welding beads located in the second reference area is defined as a second bead width, the (2-2)-th reference line may have a length obtained by

adding a length of the second bead width to a length of a (2-3)-th reference line, and the (2-3)-th reference line may have a length corresponding to a distance, by which two welding beads are spaced apart from each other, when the two welding beads are disposed in the second reference area to be closest to each other such that heat affected zones thereof do not overlap each other.

[0025] In another example, any one of the plurality of welding beads may have a shape obtained by connecting, among apexes of the second reference rectangular shape, a pair of apexes, which defines a diagonal line crossing the second reference rectangular shape when being connected.

[0026] In another example, the number of the second reference rectangular shapes may be a quotient of a length of a longer one of the (2-1)-th line or the (2-2)-th line divided by a length of the (2-2)-th reference line as a number thereof.

[0027] In another example, a (2-1)-th reference rectangular shape that is, among the plurality of second reference rectangular shapes, a second reference rectangular shape located at a distal end in the second reference direction may be disposed to be spaced apart from, among sides defining the second reference area, a side located in the second reference direction by a distance of a half of a remainder of a length of a larger one of the (2-1)-th line and the (2-2)-th line divided by a length of the (2-2)-th reference line.

BRIEF DESCRIPTION OF THE DRAWINGS

[0028] 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:

[0029] FIG. 1 is a view illustrating a state, in which front and rear covers are removed from a general battery module;

[0030] FIG. 2 is an enlarged view illustrating portion "A" of FIG. 1;

[0031] FIG. 3 is an enlarged view illustrating portion "B" of FIG. 1;

[0032] FIG. 4 is a view illustrating a first overlapping area, a first reference area, and welding beads disposed in the first reference area;

[0033] FIG. 5 is a view illustrating a first reference rectangular shape and welding beads disposed therein;

[0034] FIG. 6 is a cross-sectional view conceptually illustrating welding beads and heat affected zones of the welding beads;

[0035] FIG. 7 is a view illustrating a second overlapping area, a second reference area, and welding beads disposed in the second reference area; and

[0036] FIG. 8 is a view illustrating a second reference rectangular shape and welding beads disposed therein.

DETAILED DESCRIPTION

[0037] Hereinafter, embodiments of the present disclosure will be described in detail with reference to the accompanying drawings. In adding reference numerals to the components of the drawings, it is noted that the same components are denoted by the same reference numerals even when they are drawn in different drawings. Furthermore, in describing the embodiments of the present disclosure, when it is determined that a detailed description of related known configurations and functions may hinder understanding of the embodiments of the present disclosure, a detailed description thereof will be omitted.

[0038] Here, an upward/downward direction, a leftward/rightward direction, and a forward/rearward direction are referred for convenience of description and are determined relative to a viewing direction, and for example, the upward/downward direction does not necessarily mean a vertical direction.

[0039] The battery module 1 according to an embodiment of the present disclosure may be a battery module for a secondary battery. Furthermore, the battery module 1 according to an embodiment of the present disclosure may be the battery module 1 including welding beads WB (FIG. 4) that are arranged while having a specific pattern.

[0040] Hereinafter, a basic structure of the battery module 1 will be described in detail for convenience of description. As illustrated in FIGS. 1 and 2, the battery module 1 may include

the cell stack 2, the end plates 3, the clamp 4, and the bus bar 6. A plurality of battery cells may be stacked in the cell stack 2 in the leftward/rightward direction. As illustrated in FIG. 2, the lead tab 5 may be formed on at least one side of the battery cell in the forward/rearward direction.

[0041] The lead tab 5 may be a positive electrode lead tab or a negative electrode lead tab. A material of the positive electrode lead tab may be aluminum. A material of the negative electrode lead tab may be copper.

[0042] The bus bar 6 may be electrically connected to the lead tabs 5 of the plurality of battery cells. A material of the bus bar 6 may be copper. The bus bar 6 may be welded to the lead tabs 5 for electrical connection to the lead tabs 5. Then, the welding may be overlap-welding. For example, when the positive electrode lead tabs and the bus bar 6 are welded to each other, it may be understood that the copper lower plate may be overlap-welded to the aluminum upper plate. Furthermore, when the negative electrode lead tabs and the bus bar 6 are welded to each other, it may be understood that the copper lower plate is overlap-welded to the copper upper plate.

[0043] As an example, the battery cell may include an electrode assembly and an outer case. The electrode assembly may be formed such that a positive electrode plate and a negative electrode plate coated with a positive electrode active material and a negative electrode active material, respectively, are disposed

while a separator being interposed therebetween. As an example, the positive electrode active material may be a lithium-based oxide. Furthermore, the negative electrode active material may be carbon.

[0044] A pair of end plates 3 may be disposed on opposite side surfaces of the cell stack 2 in the leftward/rightward direction. The end plates 3 may be components for forming a surface pressure of the cell stack 2 by pressing the cell stack 2 in the leftward/rightward direction. The end plates 3 may be formed of a SPFC1180Y material.

[0045] The clamp 4 may be a component that contacts outer surfaces of the pair of end plates 3 to press the end plates 3 toward an inside. The clamp 4 may include contact portions and an extension part. A pair of contact portions may be provided to contact the outer surfaces of the pair of end plates 3. The extension part may extend in the leftward/rightward direction to connect the contact portions. A pair of clamps 4 may be provided, and may be disposed on upper and lower sides of the pair of end plates 3. The clamps 4 may be formed of a SPFC1180Y material. The clamps 4 may be welded to the end plates 3 to maintain surface-pressures of the end plates 3. Then, the welding may be overlap-welding. The welding of the clamp 4 and the end plates 3 may be understood as overlap-welding of the SPFC1180Y lower plate to the SPFC1180Y upper plate.

[0046] Meanwhile, the battery module 1 according to an

embodiment of the present disclosure may include an overlapping area. The overlapping area may be understood as an area, in which a plurality of components overlap each other, and a part that needs to be welded in a process of forming the battery module 1. The overlapping area may include a first overlapping area P1 (FIG. 4) and a second overlapping area P2 (FIG. 7).

[0047] The first overlapping area P1 may mean an area, in which any one of the plurality of lead tabs 5 overlaps the bus bar 6 when viewed along the forward/rearward direction. The first overlapping area P1 may be understood as an area for connecting the lead tab 5 and the bus bar 6.

[0048] Because the number of the lead tabs 5 is plural, the number of parts that may become the first overlapping area P1 also may be plural. Here, for convenience of description, a disposition pattern of the welding beads WB (FIG. 4) will be described in detail while the area, in which the any one lead tab and the bus bar 6 overlap each other, is taken as the first overlapping area P1.

[0049] In the disposition pattern of the welding beads WB, the welding beads WB may be disposed only in an area, in which some of the plurality of lead tabs overlap the bus bar 6 or may be disposed in all areas, in which the plurality of lead tabs overlap the bus bar 6.

[0050] The second overlapping area P2 may mean an area, in which the contact portion of the clamp 4 overlaps the end plate 3 when

viewed along the leftward/rightward direction. The second overlapping area P2 may be understood as an area for connecting the clamp 4 and the end plate 3.

[0051] Meanwhile, a welding bead WB may be formed in at least any one of the first overlapping area P1 and the second overlapping area P2. This may mean that the welding bead WB may be formed only in the first overlapping area P1, the welding bead WB may be formed only in the second overlapping area P2, and the welding bead WB may be formed on both of them.

[0052] The welding bead WB may mean a part that is welded such that welding objects are welded to each other. A plurality of welding beads WB may be provided. Furthermore, the plurality of welding beads WB may be disposed to be spaced apart from each other. As an example, the plurality of welding beads WB may be disposed to be spaced apart from each other while having a specific pattern.

[0053] According to the present disclosure, because the plurality of welding beads are disposed in a specific pattern, welding may be performed with a time gap whenever the beads are formed even though a welding length become larger whereby an amount of heat input may be reduced.

[0054] Furthermore, unlike that a required welding strength may not be maintained when a defect occurs in one welding bead when only the one welding bead is provided, according to the present disclosure, the plurality of welding beads are provided whereby

a required welding strength may be maintained even though a defect occurs in some welding beads.

[0055] Hereinafter, a pattern, in which the plurality of welding beads WB are disposed will be described in detail.

[0056] <First Overlapping Area P1>

[0057] Hereinafter, a case, in which the plurality of welding beads WB are disposed in the first overlapping area P1, will be described in detail. FIG. 4 is a view illustrating the first overlapping area, the first reference area, and the welding beads disposed in the first reference area. FIG. 4 may be understood that portion A' of FIG. 2 is enlarged.

[0058] The plurality of welding beads WB may be disposed in a first reference area RP1. Then, the plurality of welding beads WB may have a specific pattern.

[0059] the first reference area RP1 may mean an area, in which a length corresponding to a length of a (1-1)-th line L1-1 is provided as a leftward/rightward length thereof and a length corresponding to a length of a (1-2)-th line L1-2 is provided as an upward/downward length thereof.

[0060] The (1-1)-th line L1-1 may mean a line that is spaced inwards apart from opposite ends of the first overlapping area P1 in the leftward/rightward direction by a (1-1)-th reference length d1-1. The (1-2)-th line L1-2 may mean a line that is spaced inwards apart from opposite ends of the first overlapping area P1 in the upward/downward direction by a (1-2)-th reference length

d1-2. As an example, the (1-1)-th reference length d1-1 may be 1 mm to 2 mm. Furthermore, the (1-2)-th reference length d1-2 may be 1 mm to 2 mm.

[0061] Meanwhile, the plurality of welding beads WB may be disposed in the plurality of first reference rectangular shapes SQ1. FIG. 5 is a view illustrating the first reference rectangular shape and the welding beads disposed therein.

[0062] The first reference rectangular shape SQ1 may mean a plurality of imaginary rectangular shapes that divide the first reference area RP1 into a plurality of parts along a first reference direction D1. As an example, the first reference direction D1 may be an upward direction.

[0063] Each of the first reference rectangular shapes SQ1 may have a (1-1)-th reference line RL1-1 that is a shorter one of the (1-1)-th line L1-1 and the (1-2)-th line L1-2 as a length of any one of a transverse side or a longitudinal side. Furthermore, it may have a (1-2)-th reference line RL1-2 that is a line that is perpendicular to the (1-1)-th reference line RL1-1 as a length of the other one of the transverse side or the longitudinal side. FIG. 5 illustrates a state, in which the first reference rectangular shape SQ1 has a transverse length while the (1-1)-th line L1-1 is taken as the (1-1)-th reference line RL1-1.

[0064] Meanwhile, the (1-2)-th reference line RL1-2 may have a length corresponding to a length obtained by adding the first bead width W1 (FIG. 6) to a length of a (1-3)-th reference line

RL1-3 (FIG. 6). That is, when the length of the (1-3)-th reference line RL1-3 is "X" and the length of the first bead width W1 is "Y", the length of the (1-2)-th reference line RL1-2 may be 'X+Y'.

[0065] The reference line RL1-3 may be a line having a length corresponding a distance, by which the two welding beads are spaced apart from each other, when the two welding beads are disposed in the first reference area RP1 to be closest to each other such that heat affected zones thereof do not overlap each other in the process of forming the beads.

[0066] Hereinafter, for helping understanding of the (1-3)-th reference line RL1-3, FIG. 6 will be referenced. FIG. 6 is a cross-sectional view conceptually illustrating the welding beads and the heat affected zones of the welding beads. It may be understood that a cross-section of the welding bead, taken along a direction that is perpendicular to an extension direction, is illustrated. As illustrated in FIG. 6, the welding object, in which the welding beads are formed, may include an upper plate UP and a lower plate DP.

[0067] As illustrated in FIG. 6, the (1-3)-th reference line RL1-3 may be a line that has a length corresponding to a distance, by which the two welding beads are spaced apart from each other, when the two welding beads are disposed in the first reference area RP1 to be closest to each other such that heat affected zones thereof do not overlap each other.

[0068] A length of the (1-3)-th reference line RL1-3 may be

different according to materials of the upper plate and the lower plate, in which the welding beads are formed. As an example, when the positive electrode lead tab and the bus bar 6 are welded to each other, that is, when the aluminum upper plate and the copper lower plate are welded to each other, a length of the (1-3)-th reference line may be 0.1 mm to 0.5 mm. As another example, when the negative electrode lead tab and the bus bar 6 are welded to each other, that is, when the copper upper plate and the copper lower plate are welded to each other, a length of the (1-3)-th reference line may be 0.1 mm to 0.3 mm.

[0069] As illustrated in FIG. 6, the first bead width W1 may mean a length of the welding bead WB along a direction that is perpendicular to the extension direction of the welding bead WB located in the first reference area RP1. As an example, the length of the first bead width W1 may be 1 mm to 2 mm. However, the length of the first bead width W1 may be changed according to a specification of a laser beam used during welding.

[0070] Meanwhile, as illustrated in FIG. 5, one or more of the plurality of welding beads WB may have a shape that connects two of the four apexes of the first reference rectangular shape SQ1 and corresponds to a line that crosses the first reference rectangular shape SQ1.

[0071] Then, as illustrated in FIG. 5, a height of a lower end of any one of the plurality of welding beads WB may correspond to a height of an upper end of another welding bead WB that is

located adjacent to a lower side. The plurality of welding beads WB may have shapes that are parallel to each other.

[0072] Meanwhile, as an example, a case, in which a longitudinal length of the first reference area RP1 is not divided by a transverse length of the first reference rectangular shape SQ1, may be considered. Hereinafter, a method of arranging the first reference rectangular shape SQ1 in the first reference area RP1 in this case will be described in detail.

[0073] The number of first reference rectangular shapes SQ1 may be a quotient of a length of a longer one of the (1-1)-th line L1-1 or the (1-2)-th line L1-2 divided by a length of the (1-2)-th reference line RL1-2. In FIG. 4, because the (1-2)-th line L1-2 is longer than the (1-1)-th line L1-1, a quotient of the length of the (1-2)-th reference line RL1-2 divided by the length of the (1-2)-th reference line RL1-2 may be the number of first reference rectangular shapes SQ1.

[0074] Then, a (1-1)-th reference rectangular shape SQ1-1 that is, among the plurality of first reference rectangular shapes SQ1, the first reference rectangular shape SQ1 located at a distal end in the first reference direction D1 may be disposed to be spaced apart from, among the sides that define the first reference area RP1, a side that is located in the first reference direction D1, by a distance of a half of a remainder of a length of a longer one of the (1-1)-th line L1-1 or the (1-2)-th line L1-2 divided by a length of the (1-2)-th reference line RL1-2. This may mean

that areas of the first reference area RP1, in which no first reference rectangular shapes SQ1 is disposed, are uniformly distributed in the first reference direction D1 and an opposite direction thereto.

[0075] <Second Overlapping Area P2>

[0076] Hereinafter, a case, in which the plurality of welding beads WB are disposed in the second overlapping area P2, will be described in detail. FIG. 7 is a view illustrating the second overlapping area, the second reference area, and the welding beads disposed in the second reference area.

[0077] The plurality of welding beads WB may be disposed in a second reference area RP2. Then, the plurality of welding beads WB may have a specific pattern.

[0078] The second reference area RP2 may mean an area, in which a length corresponding to a length of a (2-1)-th line L2-1 is provided as a forward/rearward length thereof and a length corresponding to a length of a (2-2)-th line L2-2 is provided as an upward/downward length thereof.

[0079] The (2-1)-th line L2-1 may mean a line that is spaced inwards apart from opposite ends of the second overlapping area P2 in the forward/rearward direction, by a (2-1)-th reference length d2-1. The (2-2)-th line L2-2 may mean a line that is spaced inwards apart from opposite ends of the second overlapping area P2 in the upward/downward direction, by a (2-2)-th reference length d2-2.

[0080] As an example, the (2-1)-th reference length d2-1 may be 1 mm to 2 mm. Furthermore, the (2-2)-th reference length d2-2 may be 1 mm to 2 mm.

[0081] Meanwhile, the plurality of welding beads WB may be disposed in the plurality of second reference rectangular shapes SQ2, respectively. FIG. 8 is a view illustrating the second reference rectangular shape and the welding beads disposed therein.

[0082] The second reference rectangular shapes SQ2 may mean a plurality of imaginary rectangular shapes that divide the second reference area RP2 to a plurality of parts along a second reference direction D2. As an example, the second reference direction D2 may be a forward direction.

[0083] Each of the second reference rectangular shapes may have a (2-1)-th reference line RL2-1 that is a shorter one of the (2-1)-th line L2-1 and the (2-2)-th line L2-2 as a length of any one of a transverse side or a longitudinal side, and may have a (2-2)-th reference line RL2-2 that is a line that is perpendicular to the (2-1)-th reference line RL2-1 as a length of the other one of the transverse side or the longitudinal side. FIG. 8 illustrates a state, in which the second reference rectangular shape SQ2 has a longitudinal length while the (2-2)-th line L2-2 is taken as the (2-1)-th reference line RL2-1.

[0084] The (2-2)-th reference line RL2-2 may have a length that is obtained by adding a length of the second bead width to a

length of a (2-3)-th reference line.

[0085] The (2-3)-th reference line may have a length corresponding to a distance, by which two welding beads WB are spaced apart from each other, when the two welding beads WB are disposed in the second reference area RP2 to be closest to each other such that heat affected zones thereof do not overlap each other. A description of the (1-3)-th reference line RL1-3 may be referenced for conceptual understanding of the (2-3)-th reference line. As an example, a length of the (2-3)-th reference line may be 0.1 mm to 1 mm.

[0086] The second bead width may mean a length of the welding bead WB along a direction that is perpendicular to the extension direction of the welding bead WB located in the second reference area RP2. The length of the second bead width may be 1 mm to 2 mm.

[0087] Meanwhile, as illustrated in FIG. 8, one or more of the plurality of welding beads WB may have a shape that connects two of the four apexes of the second reference rectangular shape SQ2 and corresponds to a line crossing the second reference rectangular shape SQ2.

[0088] Then, as illustrated in FIG. 5, a height of a lower end of any one of the plurality of welding beads WB may correspond to a height of an upper end of another welding bead WB that is located adjacent to a lower side. The plurality of welding beads WB may have shapes that are parallel to each other.

[0089] Meanwhile, as an example, a case, in which a transverse length of the second reference area RP2 is not divided by a transverse length of the second reference rectangular shape SQ2, may be considered. Hereinafter, a method of arranging the second reference rectangular shape SQ2 in the second reference area RP2 in this case will be described in detail.

[0090] The number of second reference rectangular shapes SQ2 may be a quotient of a length of a longer one of the (2-1)-th line L2-1 or the (2-2)-th line L2-2 divided by a length of the (2-2)-th reference line RL2-2. In FIG. 7, because the (2-1)-th line L2-1 is longer than the (2-2)-th line L2-2, a quotient of the length of the (2-1)-th reference line RL2-1 divided by the length of the (2-2)-th reference line RL2-2 may be the number of the second reference rectangular shape SQ2.

[0091] Then, a (2-1)-th reference rectangular shape SQ2-1 that is, among the plurality of second reference rectangular shapes SQ2, the second reference rectangular shape SQ2 located at a distal end in the second reference direction D2 may be disposed to be spaced apart from, among the sides that define the second reference area RP2, a side that is located in the second reference direction D2, by a distance of a half of a remainder of a length of a longer one of the (2-1)-th line L2-1 or the (2-2)-th line L2-2 divided by a length of the (2-2)-th reference line RL2-2. This may mean that areas of the second reference area RP2, in which no second reference rectangular shape SQ2 is disposed, are

uniformly distributed in the second reference direction D2 and an opposite direction thereto.

[0092] According to the present disclosure, a plurality of welding beads are arranged in a predetermined arrangement pattern that ensures a strength of a welded part in the part of the battery module, which requires welding and does not generate excessive heat input, preventing occurrence of defects and decreasing dispersion of the quality of the battery module.

[0093] Although the present disclosure has been described with reference to the limited embodiments and the drawings in the above description, the above description is simply an exemplary description of the technical spirits of the present disclosure, and an ordinary person in the art, to which the present disclosure pertains, may made various corrections and modifications without departing from the essential characteristics of the present disclosure. Therefore, the embodiments disclosed in the present disclosure are not for limiting the technical spirits of the present disclosure but for describing them, and the scope of the technical spirits of the present disclosure is not limited by the embodiments. The protection scope of the present disclosure should be construed by the following claims, and all the technical spirits in the equivalent range should be construed as being included in the scope of the present disclosure.

WHAT IS CLAIMED IS:

1. A battery module comprising:

a cell stack, in which a plurality of battery cells each having a lead tab on at least one side in a forward/rearward direction are stacked in a leftward/rightward direction;

a bus bar electrically connected to the lead tab of the plurality of battery cells;

end plates disposed on opposite side surfaces of the cell stack in the leftward/rightward direction;

a clamp including a pair of contact portions contacting outer surfaces of the pair of end plates, and an extension part extending in the leftward/rightward direction and connecting the contact portions; and

an overlapping area including a first overlapping area that is an area, in which any one of the plurality of lead tabs overlaps the bus bar when viewed along the forward/rearward direction, and second overlapping areas that are areas, in which the contact portions overlap the end plates when viewed along the leftward/rightward direction,

wherein a plurality of welding beads disposed to be spaced apart from each other are formed in at least any one of the first overlapping area and the second overlapping area.

2. The battery module of claim 1, wherein the plurality of welding beads are formed in the first overlapping area, and

wherein when an area, in which a length corresponding to a length of a (1-1)-th line spaced inwards apart from opposite ends of the first overlapping area in the leftward/rightward direction by a (1-1)-th reference length is a leftward/rightward length thereof and a length corresponding to a length of a (1-2)-th line spaced inwards apart from opposite ends of the first overlapping area in an upward/downward direction by a (1-2)-th reference length is an upward/downward length thereof, is defined as a first reference area,

the plurality of welding beads are disposed in the first reference area.

3. The battery module of claim 2, wherein when a plurality of imaginary rectangular shapes that divide the first reference area into a plurality of parts along a first reference direction are defined as first reference rectangular shapes,

the plurality of welding beads are disposed in the plurality of first reference rectangular shapes, respectively.

4. The battery module of claim 3, wherein each of the first reference rectangular shapes has a (1-1)-th reference line that is a shorter one of the (1-1)-th line and the (1-2)-th line as a length of any one of a transverse side or a longitudinal side, and has a (1-2)-th reference line that is a line that is

perpendicular to the (1-1)-th reference line as a length of the other one of the transverse side or the longitudinal side, and

wherein when a length of the welding beads along a direction that is perpendicular to an extension direction of the welding beads located in the first reference area is defined as a first bead width,

the (1-2)-th reference line has a length corresponding to a length obtained by adding a length of the first bead width to a length of a (1-3)-th reference line, and

the (1-3)-th reference line has a length corresponding to a distance, by which two welding beads are spaced apart from each other, when the two welding beads are disposed in the first reference area to be closest to each other such that heat affected zones thereof do not overlap each other.

5. The battery module of claim 4, wherein one or more of the plurality of welding beads have a shape that connects two of four apexes of the first reference rectangular shape and corresponds to a line crossing the first reference rectangular shape.

6. The battery module of claim 4 or claim 5, wherein the number of first reference rectangular shapes is a quotient of a length of a longer one of the (1-1)-th line or the (1-2)-th line

divided by a length of the (1-2)-th reference line as a number thereof.

7. The battery module of any one of claims 4 to 6, wherein a (1-1)-th reference rectangular shape that is one of the plurality of first reference rectangular shapes, which is located at a distal end in the first reference direction, is disposed to be spaced apart from one of sides defining the first reference area, in the first reference direction, by a half of a remainder of a length of a larger one of the (1-1)-th line or the (1-2)-th line divided by a length of the (1-2)-th reference line.

8. The battery module of any one of claims 1 to 7, wherein a height of a lower end of any one of the plurality of welding beads corresponds to a height of an upper end of another welding bead located adjacent to a lower side.

9. The battery module of any one of claims 1 to 8, wherein the plurality of welding beads have shapes that are parallel to each other.

10. The battery module of claim 1, wherein the plurality of welding beads are formed in the second overlapping area, and

wherein when an area, in which a length corresponding to a length of a (2-1)-th line spaced inwards apart from opposite ends

of the second overlapping area in a forward/rearward direction by a (2-1)-th reference length is a forward/rearward length thereof and a length corresponding to a length of a (2-2)-th line spaced inwards apart from opposite ends of the second overlapping area in an upward/downward direction by a (2-2)-th reference length is an upward/downward length thereof, is defined as a second reference area,

the plurality of welding beads are disposed in the second reference area.

11. The battery module of claim 10, wherein when a plurality of rectangular shapes that divide the second reference area into a plurality of parts along a second reference direction are defined as second reference rectangular shapes,

the plurality of welding beads are disposed in the plurality of second reference rectangular shapes, respectively.

12. The battery module of claim 11, wherein each of the second reference rectangular shape has a (2-1)-th reference line that is a shorter one of the (2-1)-th line and the (2-2)-th line as a length of any one of a transverse side or a longitudinal side, and has a (2-2)-th reference line that is a line that is perpendicular to the (2-1)-th reference line as a length of the other one of the transverse side or the longitudinal side, and

wherein when a length of the welding beads along a direction that is perpendicular to an extension direction of the welding beads located in the second reference area is defined as a second bead width,

the (2-2)-th reference line has a length obtained by adding a length of the second bead width to a length of a (2-3)-th reference line, and

the (2-3)-th reference line has a length corresponding to a distance, by which two welding beads are spaced apart from each other, when the two welding beads are disposed in the second reference area to be closest to each other such that heat affected zones thereof do not overlap each other.

13. The battery module of claim 12, wherein any one of the plurality of welding beads has a shape obtained by connecting, among apexes of the second reference rectangular shape, a pair of apexes, which defines a diagonal line crossing the second reference rectangular shape when being connected.

14. The battery module of claim 12 or claim 13, wherein the number of second reference rectangular shapes is a quotient of a length of a longer one of the (2-1)-th line or the (2-2)-th line divided by a length of the (2-2)-th reference line as a number thereof.

15. The battery module of any one of claims 12 to 14, wherein a (2-1)-th reference rectangular shape that is, among the plurality of second reference rectangular shapes, a second reference rectangular shape located at a distal end in the second reference direction is disposed to be spaced apart from, among sides defining the second reference area, a side located in the second reference direction by a distance of a half of a remainder of a length of a larger one of the (2-1)-th line and the (2-2)-th line divided by a length of the (2-2)-th reference line.