

BONDING APPARATUS, FRAME FEEDER, AND HEATER UNIT

[Technical Field]

[0001]

The present invention relates to a bonding apparatus, a frame feeder, and a heater unit.

5 [Background Art]

[0002]

So-called die bonding is work of joining a semiconductor die to a lead frame. In addition, so-called wire bonding is work of joining a bonding wire to a semiconductor die. When such joining work is performed, a lead frame is heated to a predetermined temperature
10 higher than room temperature. If a lead frame is heated in a region for performing joining work, the lead frame stays in the region for performing joining work for a time corresponding to the total time of a time for heating and a time for joining.

[0003]

For example, the semiconductor assembly device in Patent Literature 1 includes a
15 region for performing preliminary heating of a lead frame and a region for performing wire bonding. According to this device, a time of performing preliminary heating and a time of performing wire bonding can overlap each other. As a result, work efficiency of joining work can be enhanced.

[Citation List]

20 [Patent Literature]

[0004]

[Patent Literature 1]

Japanese Patent Laid-Open No. S62-169340

[Summary of Invention]

[Technical Problem]

[0005]

In recent years, it has been desired to further improve productivity of a bonding apparatus performing bonding work. Hence, an objective of the present invention is to provide
5 a bonding apparatus, a frame feeder, and a heater unit capable of improving productivity.

[Solution to Problem]

[0006]

According to an aspect of the present invention, there is provided a bonding apparatus including a bonding part that performs bonding work for a lead frame which has been conveyed
10 to a working region, and a frame feeder that conveys the lead frame to the working region using a conveyance part and performs preliminary heating of the lead frame before being conveyed to the working region using a heater unit. The heater unit has a heating body, and a heater block which is disposed so as to face a rear surface of the lead frame on an upstream side of the working region in a conveyance direction of the lead frame and provides the lead frame with
15 heat received from the heating body. A heat dissipation part having a plurality of fins formed from a surface of the heater block in a depth direction is provided in the heater block.

[0007]

In the bonding apparatus, bonding work using the bonding part is performed in the working region. The heater unit heating the lead frame before being conveyed to the working
20 region is disposed on an upstream side of this working region. Therefore, a region for performing preliminary heating before bonding work and a region for performing bonding work can differ from each other. Moreover, the heater block provided in the heater unit has a plurality of fins extending in the depth direction. According to the plurality of fins, since heat is efficiently transferred from the heater block to the lead frame, a time required for preliminary

heating can be shortened. As a result, productivity can be improved.

[0008]

The plurality of fins may be separated from each other in a direction orthogonal to the conveyance direction of the lead frame. According to this constitution, the rear surface of the lead frame can be protected.

[0009]

Holes which are provided between the fins and penetrate the heater block in the depth direction may be provided in the heater block. Heat is transferred from the heater block to the lead frame due to convection of air from the heater block toward the lead frame. Since air for transferring heat is suitably supplied to the fins by providing these holes, heat is more efficiently transferred from the heater block to the lead frame. As a result, productivity can be further improved.

[0010]

Lengths of the fins in the depth direction may be longer than a distance from tips of the fins to the lead frame in the depth direction. According to this constitution, heated air can be suitably supplied to the rear surface of the lead frame by the fins.

[0011]

The foregoing bonding apparatus may further include a controller that controls operation of the bonding part and the frame feeder. The controller may provide the bonding part with a first control signal for causing the bonding part to perform bonding work during a first period, and provide the frame feeder with a second control signal for causing the heater unit to perform preliminary heating of the lead frame during a second period overlapping the first period. A length of the second period may be equal to or shorter than a length of the first period. According to this control, while bonding work is performed, preliminary heating for a

next lead frame is completed. Therefore, after bonding work ends, in parallel with carrying out of the lead frame from the working region, the lead frame for which preliminary heating has ended can be carried in. That is, regarding preliminary heating, there is no need to provide a standby time for bonding work. As a result, productivity can be further enhanced.

5 [0012]

According to another aspect of the present invention, there is provided a frame feeder including a conveyance part that conveys a lead frame to a working region in which bonding work is performed for the lead frame, and a first heater unit that performs preliminary heating of the lead frame before being conveyed to the working region. The first heater unit has a first
10 heating body, and a first heater block which is disposed so as to face a rear surface of the lead frame on an upstream side of the working region in a conveyance direction of the lead frame and provides the lead frame with heat received from the first heating body. A first heat dissipation part having a plurality of first fins formed from a surface of the first heater block in a depth direction is provided in the first heater block.

15 [0013]

The heater block provided in the heater unit of the frame feeder has a plurality of fins extending in the depth direction. According to the plurality of fins, since heat is efficiently transferred from the heater block to the lead frame, a time required for preliminary heating can be shortened. As a result, productivity can be improved.

20 [0014]

The foregoing frame feeder may further include a second heater unit that heats the lead frame conveyed from the working region after the bonding work is performed. The second heater unit may have a second heating body, and a second heater block which is disposed so as to face the rear surface of the lead frame on a downstream side of the working region in the

conveyance direction of the lead frame and provides the lead frame with heat received from the second heating body. A second heat dissipation part having a plurality of second fins formed from a surface of the second heater block in the depth direction may be provided in the second heater block. According to this constitution, sudden cooling of the lead frame subjected to bonding work is curbed. Therefore, results obtained through bonding work can be protected.

[0015]

According to still another aspect of the present invention, there is provided a heater unit performing preliminary heating of a lead frame before being conveyed to a working region in which bonding work is performed for the lead frame. The heater unit has a heating body, and a heater block that is disposed so as to face a rear surface of the lead frame on an upstream side of the working region in a conveyance direction of the lead frame and provides the lead frame with heat received from the heating body. A heat dissipation part having a plurality of fins formed from a surface of the heater block in a depth direction is provided in the heater block.

[0016]

The heater block provided in the heater unit has a plurality of fins extending in the depth direction. According to the plurality of fins, since heat is efficiently transferred from the heater block to the lead frame, a time required for preliminary heating can be shortened. As a result, productivity can be improved. In addition, the plurality of fins may be separated from each other in a direction orthogonal to the conveyance direction of the lead frame. In addition, holes which are provided between the fins and penetrate the heater block in the depth direction may be provided in the heater block. Moreover, lengths of the fins in the depth direction may be longer than a distance from tips of the fins to the lead frame in the depth direction.

[Advantageous Effects of Invention]

[0017]

In the bonding apparatus, the frame feeder, and the heater unit according to the present invention, productivity can be improved.

[Brief Description of Drawings]

[0018]

5 Fig. 1 is a perspective view illustrating a wire bonding apparatus of an embodiment.

Fig. 2 is a view illustrating a positional relationship between a preheater, a heat plate, and a follow-up heater; and a lead frame.

Fig. 3 is a perspective view illustrating a heater unit.

Fig. 4 is a perspective view illustrating a cross section of the heater unit.

10 Fig. 5 is a chart diagram describing operation of the wire bonding apparatus.

Fig. 6 is a graph illustrating heating performance of a heater unit of a comparative example and heating performance of a heater unit in an example.

[Description of Embodiment]

[0019]

15 Hereinafter, an embodiment of the present invention will be described in detail with reference to the accompanying drawings. In description of the drawings, the same reference signs are applied to the same elements, and duplicate description thereof will be omitted.

[0020]

[Wire bonding apparatus]

20 For example, a wire bonding apparatus 1 (bonding apparatus) illustrated in Fig. 1 electrically connects an electrode of a lead frame 100 to an electrode of a semiconductor element subjected to die bonding to the lead frame 100 using a metal wire having a small diameter. The wire bonding apparatus 1 provides a wire with heat, ultrasonic waves, or pressure such that the wire is connected to an electrode. The wire bonding apparatus 1 has a frame feeder 2, a

bonding unit 3 (bonding part), and a control unit 4 (controller). The frame feeder 2, the bonding unit 3, and the control unit 4 are provided in a base 6.

[0021]

In the following description, terms such as a conveyance direction D1, a facing
5 direction D2, and a width direction D3 may be used. The conveyance direction D1 is a direction in which the lead frame 100 is conveyed by the frame feeder 2. The facing direction D2 is a direction toward a rear surface 100a of the lead frame 100 from a main surface 11a of a preheater 11, which will be described below. It is also possible to mention that the facing
10 direction D2 of the bonding unit 3 is parallel to a moving direction of a capillary 8. Moreover, the facing direction D2 is also referred to as a depth direction of a heater block 16. The width direction D3 is a direction orthogonal to each of the conveyance direction D1 and the facing direction D2.

[0022]

The frame feeder 2 conveys the lead frame 100 that is a component to be processed.
15 In addition, the frame feeder 2 heats the lead frame 100 for temperature control of the lead frame 100. The frame feeder 2 will be described below in detail. The bonding unit 3 includes a bonding tool 7 and the capillary 8. The capillary 8 is provided at a tip of the bonding tool 7 in an attachable/detachable manner. The capillary 8 provides a wire with heat, ultrasonic waves, or pressure. The control unit 4 controls operation of the wire bonding apparatus 1 in its entirety
20 including operation of the frame feeder 2 and the bonding unit 3.

[0023]

The control unit 4 provides the bonding unit 3 and the frame feeder 2 with some control signals. For example, control signals include a signal for controlling conveyance of the lead frame 100 in the frame feeder 2 and a signal for controlling heating of the lead frame 100 in the

frame feeder 2. In addition, control signals may include a signal for controlling a position of the capillary 8 with respect to the lead frame 100 and a signal for starting and stopping provision of heat, ultrasonic waves, or pressure.

[0024]

5 [Frame feeder]

The frame feeder 2 has rails 9 (conveyance parts), the preheater 11 (heater unit: first heater unit), a heat plate 12, and a follow-up heater 13 (second heater unit).

[0025]

10 The rails 9 are a pair of members extending in the conveyance direction D1 and are disposed such that they are separated from each other in a direction orthogonal to the conveyance direction D1. Through the rails 9, the lead frame 100 is taken out from a magazine accommodating unprocessed lead frames 100. The lead frame 100 moves in the conveyance direction D1 through the rails 9. In this conveyance, the rails 9 hold the position of the lead frame 100 above each of the preheater 11, the heat plate 12, and the follow-up heater 13 for a
15 predetermined period. Further, the lead frame 100 which has been processed is stored in another magazine through the rails 9.

[0026]

20 The preheater 11, the heat plate 12, and the follow-up heater 13 are disposed between the pair of rails 9. In addition, the preheater 11, the heat plate 12, and the follow-up heater 13 are disposed in this order in the conveyance direction D1. Further, as illustrated in the part (a) of Fig. 2, a preliminary heating region A1 is set above the preheater 11. A bonding region A2 (working region) is set above the heat plate 12. Moreover, a post-heating region A3 is set above the follow-up heater 13. According to this disposition, the lead frame 100 moves through the preliminary heating region A1, the bonding region A2, and the post-heating region

A3 in this order.

[0027]

The preheater 11 and the follow-up heater 13 are disposed such that they are separated from the rear surface 100a of the lead frame 100 by a predetermined distance. That is, a gap L1 is formed between the preheater 11 and the follow-up heater 13, and the lead frame 100. For example, the gap L1 is within a range of 0.5 mm to 3.0 mm and may be within a range of 1 mm to 2 mm, as an example. The preheater 11 and the follow-up heater 13 are fixed to the base 6 (Fig. 1). Therefore, the distance between the preheater 11 and the follow-up heater 13, and the lead frame 100 is basically invariable.

[0028]

The distance from the heat plate 12 to the rear surface 100a of the lead frame 100 is variable. Specifically, when bonding work is performed, the heat plate 12 comes into contact with the rear surface 100a of the lead frame 100 (refer to the part (a) of Fig. 2). In contrast, when the lead frame 100 is conveyed to the heat plate 12 and when the lead frame 100 is carried out from the heat plate 12, the heat plate 12 is moved downward by a driving mechanism 10 (refer to the part (b) of Fig. 2). At this time, a gap L2 is formed between the heat plate 12 and the lead frame 100. For example, this gap L2 is within a range of 1 mm to 15 mm and may be 10 mm, as an example.

[0029]

[Preheater]

Fig. 3 is a perspective view more specifically illustrating a constitution of the preheater 11. The preheater 11 has a cartridge heater 14 (heating body: first heating body) and the heater block 16 (first heater block). The cartridge heater 14 generates heat through electrification. For example, the temperature of the cartridge heater 14 may be within a range of 200°C to

400°C.

[0030]

The heater block 16 transfers heat generated by the cartridge heater 14 to the lead frame 100. The heater block 16 includes a main surface 16a facing the lead frame 100. The width of the heater block 16 in the width direction D3 may be larger than the width of the lead frame 100. The heater block 16 has a heater fixing surface 17, an upstream heat dissipation part 18, and a downstream heat dissipation part 19. The heater fixing surface 17 is fixed to the base 6 using an adaptor or the like. The upstream heat dissipation part 18 and the downstream heat dissipation part 19 are formed on a surface of the heater block 16 facing the lead frame 100. The upstream heat dissipation part 18 and the downstream heat dissipation part 19 may be on a main surface of the preheater 11 or a main surface of the heater block 16. The upstream heat dissipation part 18 and the downstream heat dissipation part 19 face the lead frame 100 with a gap L1 interposed therebetween. Heat received from the heater fixing surface 17 is provided to the lead frame 100 from the upstream heat dissipation part 18 and the downstream heat dissipation part 19.

[0031]

The upstream heat dissipation part 18 is provided on an upstream side in the conveyance direction D1. The downstream heat dissipation part 19 is provided on a downstream side in the conveyance direction D1. The cylindrical cartridge heater 14 is provided in the downstream heat dissipation part 19. A coupling part 21 is provided between the upstream heat dissipation part 18 and the downstream heat dissipation part 19. Fins 22 (will be described below) are not provided in the coupling part 21. For example, a bolt hole for fixing the preheater 11 to the base 6 (refer to Fig. 1) may be provided in the coupling part 21.

[0032]

With reference to Fig. 4, the downstream heat dissipation part 19 will be described. Fig. 4 is a perspective view of a cross section along a virtual surface K illustrated in Fig. 3. Since the upstream heat dissipation part 18 simply differs from the downstream heat dissipation part 19 in a position at which it is formed, detailed description thereof will be omitted. The downstream heat dissipation part 19 has a plurality of fins 22 (plurality of first fins), grooves 23, and air supply holes 24.

[0033]

In the heater block 16, the main surface 16a constitutes a heat dissipation part (first heat dissipation part). Further, the fins 22 having openings on the main surface 16a increase a heat dissipation area and form the grooves 23 as run-up sections. The fins 22 extend in the facing direction D2. Tip surfaces 22a of the fins 22 are a part on the main surface 16a of the heater block 16. Therefore, the gap L1 from the preheater 11 to the lead frame 100 is synonymous with a distance from the tip surfaces 22a of the fins 22 to the rear surface 100a of the lead frame 100.

[0034]

The fins 22 are separated from each other in a direction orthogonal to each of the facing direction D2 and the conveyance direction D1 (width direction D3). Therefore, the ridgeline at a fin tip is parallel to the conveyance direction D1. According to this constitution, the grooves 23 are formed. That is, the grooves 23 are formed between the fins 22. That is, depths L3 of the grooves 23 are synonymous with heights of the fins 22. The depths L3 of these grooves 23 are larger than the gap L1. For example, the depths L3 of the grooves 23 are within a range of 5 mm to 30 mm and are 12 mm, as an example. In addition, the depths L3 of the grooves 23 may be within a range of five times ($L3=5 \times L1$) to twenty times the gap L1 and may be stipulated as ten times, as an example.

[0035]

Openings 24a of the air supply holes 24 are provided on bottom surfaces 23a of the grooves 23. The air supply holes 24 extend in the facing direction D2. Openings 24b on the opposite side in the air supply holes 24 are provided on the heater fixing surface 17 side. These
5 air supply holes 24 take in air from the openings 24b and discharge air to the bottom surfaces 23a of the grooves 23. That is, the air supply holes 24 supply air (refer to the outlined arrow) between the fins 22. The air supply holes 24 are provided in the respective grooves 23. Therefore, in a plan view of the heater block 16, the air supply holes 24 are provided in the heater block 16 such that they are separated from each other in the width direction D3.

10 [0036]

According to this preheater 11, heat is generated in the cartridge heater 14. The heat moves to the heater block 16. Further, heat arrives at the fins 22. Heat which has arrived at the fins 22 heats air in the vicinity of side surfaces of the fins 22. That is, air present in the grooves 23 is heated. Since the density of heated air becomes relatively small, it starts to rise.
15 Here, in the fins 22, the foregoing heat transfer occurs on the side surfaces of the fins 22, and an upward flow of heated air is generated. Sections in which heat transfer from the fins 22 to air occurs will be referred to as run-up sections. That is, heat transfer from the fins 22 to air occurs even in a case in which the fins 22 are not provided, but the run-up sections are not formed. The lead frame 100 can be provided with necessary and sufficient heat energy from the preheater
20 11 by utilizing natural convection heating in which run-up sections are provided.

[0037]

The follow-up heater 13 has a constitution similar to that of the preheater 11. That is, the follow-up heater 13 has the cartridge heater 14 (second heating body) and the heater block 16 (second heater block). Further, the heater block 16 has the upstream heat dissipation part 18

and the downstream heat dissipation part 19 (second heat dissipation part), and the fins 22 (second fins) are provided in the upstream heat dissipation part 18 and the downstream heat dissipation part 19. Therefore, detailed description regarding the follow-up heater 13 will be omitted.

5 [0038]

[Operation of wire bonding apparatus]

Next, operation of the wire bonding apparatus 1 will be described. Fig. 5 is a view schematically illustrating operation of the wire bonding apparatus 1. In Fig. 5, the horizontal axis in the uppermost stage corresponds to the preliminary heating region A1. The horizontal
10 axis in the intermediate stage corresponds to the bonding region A2. The horizontal axis in the lowermost stage corresponds to the post-heating region A3. Each of the horizontal axes indicates that the time progresses from the left to the right. In addition, rectangles overlapping each of the horizontal axes indicate that the lead frames 100 are present in respective regions.

[0039]

15 First, the control unit 4 provides the preheater 11, the heat plate 12, and the follow-up heater 13 with a current. According to this operation, each of the preheater 11, the heat plate 12, and the follow-up heater 13 is set to a predetermined temperature. For example, the setting temperature of the preheater 11 is within a range of 200°C to 350°C. For example, the setting temperature of the heat plate 12 is 300°C. For example, the setting temperature of the
20 follow-up heater 13 is 300°C.

[0040]

Next, the control unit 4 provides the frame feeder 2 with a control signal and controls conveyance of the lead frame 100. Hereinafter, operation of the frame feeder 2 will be described. However, each step of the operation is performed in accordance with a control

signal received by the frame feeder 2 from the control unit 4.

[0041]

Specifically, the frame feeder 2 takes out a lead frame 100 from the magazine. Further, the frame feeder 2 conveys the taken-out lead frame 100 to the preliminary heating region A1 (S1). Next, the frame feeder 2 holds the position of the lead frame 100 for a predetermined period (S2). During this period, since the lead frame 100 receives provision of heat from the preheater 11, it is heated to a predetermined temperature.

[0042]

After a lapse of a predetermined period, the frame feeder 2 conveys the lead frame 100 to the bonding region A2 (S3). In parallel with this conveyance, the frame feeder 2 takes out another lead frame 100 from the magazine again and conveys the taken-out lead frame 100 to the preliminary heating region A1 (S4). Further, the frame feeder 2 holds the position of the lead frame 100 which has been conveyed to the bonding region A2 for a predetermined period (first period). Similarly, the frame feeder 2 holds the position of the lead frame 100 which has been conveyed to the preliminary heating region A1 for a predetermined period (second period). During this period, the control unit 4 provides the bonding unit 3 with a control signal. In accordance with this control signal, the bonding unit 3 performs bonding work for the lead frame 100 (S5). Moreover, in parallel with the bonding work, since the lead frame 100 disposed in the preliminary heating region A1 receives provision of heat from the preheater 11, it is heated to a predetermined temperature (S6).

[0043]

Here, a period during which the lead frame 100 is disposed in the preliminary heating region A1 (S6) is the same as the period required for the bonding work (S5). That is, if a timing at which the lead frame 100 has arrived at the preliminary heating region A1 is the same

as a timing at which the lead frame 100 has arrived at the bonding region A2, the preliminary heating (S6) and the bonding work (S5) end at the same time.

[0044]

5 The said period during which the lead frame 100 is disposed may be a period from when the position of the lead frame 100 is paused in the preliminary heating region A1 until it starts to move again. The period required for bonding work may be a period from when the position of the lead frame 100 is paused in the bonding region A2 until it starts to move again. In addition, the period required for bonding work may be a period from when operation of the bonding unit 3 starts until it stops. That is, the period required for bonding work may include
10 or may not include a period from when the position of the lead frame 100 is paused in the bonding region A2 until operation of the bonding unit 3 starts.

[0045]

After a lapse of a predetermined period, the frame feeder 2 conveys the lead frame 100 which has been subjected to bonding work to the post-heating region A3 (S7). In parallel with
15 this conveyance, the frame feeder 2 conveys the lead frame 100 which has been subjected to preliminary heating to the bonding region A2 (S8). Moreover, the frame feeder 2 takes out another lead frame 100 from the magazine again and conveys the taken-out lead frame 100 to the preliminary heating region A1 (S9).

[0046]

20 Further, the frame feeder 2 holds the position of the lead frame 100 which has been conveyed to the post-heating region A3 for a predetermined period. Similarly, the frame feeder 2 holds the position of the lead frame 100 which has been conveyed to the bonding region A2 for a predetermined period. Moreover, the frame feeder 2 holds the position of the lead frame 100 which has been conveyed to the preliminary heating region A1 for a predetermined period.

During this period, the lead frame 100 disposed in the post-heating region A3 receives provision of heat from the follow-up heater 13 (S11). In addition, the bonding unit 3 performs bonding work for the lead frame 100 (S12). Moreover, in parallel with the bonding work, since the lead frame 100 disposed in the preliminary heating region A1 receives provision of heat from the preheater 11, it is heated to a predetermined temperature (S14). Thereafter, the frame feeder 2 stores the lead frame 100 in the magazine (S14).

[0047]

[Operational effects]

Hereinafter, operational effects of the wire bonding apparatus 1 will be described.

[0048]

In the wire bonding apparatus 1, preliminary heating and bonding work are performed in parallel. More specifically, a period required for preliminary heating is the same as or shorter than that of the period required for bonding work. Consequently, if bonding work ends, the lead frame 100 for which preliminary heating has ended can be immediately conveyed to the bonding region A2. Therefore, since there is no standby time for the bonding unit 3 except for a conveyance time of the lead frame 100, productivity is improved.

[0049]

On the other hand, operation of the wire bonding apparatus may include operation in which a lead frame for which bonding work has ended is carried out and then the lead frame which has not reached a predetermined temperature is immediately carried into the bonding region. However, in this operation, after being carried into the bonding region, bonding work cannot be started until the lead frame reaches a predetermined temperature. Because there is a need for the bonding unit 3 to accurately move the capillary 8 to the bonding position (for example, the position of an electrode pad) at the time of bonding work. Here, if the

temperature of the lead frame 100 disposed in the bonding region A2 rises, thermal expansion occurs in the lead frame 100. Therefore, the position of the electrode pad varies. As a result, it is difficult to accurately position the capillary 8 in the electrode pad. Therefore, in this operation as well, a standby time for the bonding unit is necessary.

5 [0050]

On the other hand, in the wire bonding apparatus 1, the bonding region A2 can always be provided with the lead frame 100 which has reached a target temperature. That is, the lead frame 100 which has been conveyed to the bonding region A2 does not cause thermal expansion to the extent that bonding work is affected. Therefore, accurate bonding work can be performed without generating a standby time as described above.

[0051]

In addition, the preheater 11 included in the frame feeder 2 of the wire bonding apparatus 1 does not require a facility for providing compressed air or a complicated mechanism such as a piping air channel. Therefore, the lead frame 100 can be quickly heated to a predetermined temperature due to a simple constitution.

[0052]

[Example 1 and comparative example 1]

Effects of the preheater 11 (heater unit) have been checked by comparing effects of a heater unit of a comparative example. The heater unit of the comparative example differs from the preheater 11 in that the fins 22 and the air supply holes 24 are not provided. The constitution of the heater unit of the comparative example is otherwise the same as the preheater 11 of the embodiment. That is, according to the heater unit of the comparative example, heat is provided from the heater unit to the lead frame through heat transfer due to radiation between the main surface of the heater block and the rear surface of the lead frame and heat transfer

caused by rise convection generated from the main surface of the heater block.

[0053]

In an example 1 and a comparative example 1, the temperature of the cartridge heater 14 was set to 350°C. Further, the lead frame 100 was conveyed, and the state of the temperature rise of the lead frame 100 was checked based on the timing at which it was paused on the main surface 16a of the heater block 16. Fig. 6 is a graph illustrating results of the example 1 and the comparative example 1. The horizontal axis indicates time. The vertical axis indicates temperature of the lead frame 100. A graph G6a indicates results of the example 1. A graph G6b indicates results of the comparative example 1.

[0054]

First, the results of the comparative example 1 were checked. According to the graph G6b, first, it was confirmed that the temperature of the lead frame 100 was approximately 25°C (refer to the plotting P1). This temperature generally corresponds to the room temperature. Next, the lead frame 100 was conveyed to a place above the heater unit approximately after the elapse of 40 seconds from starting of measurement (refer to the plotting P2). As a result, it was confirmed that the temperature of the lead frame 100 has suddenly risen. Further, after 120 seconds from starting of measurement, the temperature of the lead frame converged to approximately 260°C (refer to the plotting P3).

[0055]

Next, the results of the example 1 were checked. According to the graph G6a, first, it was confirmed that the temperature of the lead frame 100 was approximately 25°C (refer to the plotting P1). Next, the lead frame 100 was conveyed to a place above the heater unit approximately after the elapse of 40 seconds from starting of measurement (refer to the plotting P2). As a result, it was confirmed that the temperature of the lead frame 100 has suddenly risen.

Further, after 120 seconds from starting of measurement, the temperature of the lead frame converged to approximately 260°C (refer to the plotting P3).

[0056]

That is, it could be confirmed that there was no meaningful difference between the converged temperatures of the lead frames 100 regardless of the presence or absence of the fins 22.

[0057]

On the other hand, there was a difference between the periods in which the lead frames have reached a convergence temperature. For example, periods from starting of heating until the lead frames reach 95% of the convergence temperature (260°C) were compared to each other. First, in the case of the comparative example (graph G6b), a time of approximately 48 seconds (87 seconds to 39 seconds) was required for a period from starting of heating until the lead frames reach 95% of the convergence temperature (refer to the plotting P4). In the case of the example 1 (graph G6a), a time of approximately 28 seconds (71 seconds to 42 seconds) was required for a period from starting of heating until the lead frames reach 95% of the convergence temperature (refer to the plotting P5). That is, it was possible to succeed in shortening 20 seconds by providing the fins 22 and the air supply holes 24. Therefore, it could be checked that the period required for preliminary heating could be shortened by providing the fins 22 and the air supply holes 24.

[0058]

[Modification example]

Hereinabove, the embodiment of the present invention has been described, but the present invention is not limited to the foregoing embodiment and may be performed in various forms.

[0059]

For example, in the foregoing embodiment, the wire bonding apparatus 1 has been described as an example of a bonding apparatus. For example, the bonding apparatus may be a die bonding apparatus. In this case, bonding work denotes die bonding, not wire bonding.

5 Further, the bonding part may include a mechanism for conveying semiconductor chips to the lead frame 100, a mechanism for disposing an adhesive in a semiconductor chip and/or a lead frame 100, or the like.

[Reference Signs List]

[0060]

- | | |
|----|---|
| 10 | 1 Wire bonding apparatus (bonding apparatus) |
| | 2 Frame feeder |
| | 3 Bonding unit |
| | 4 Control unit |
| | 6 Base |
| 15 | 7 Bonding tool |
| | 8 Capillary |
| | 9 Rail |
| | 10 Driving mechanism |
| | 11 Preheater (heater unit, first heater unit) |
| 20 | 12 Heat plate |
| | 13 Follow-up heater (heater unit, second heater unit) |
| | 14 Cartridge heater (heating body, first heating body, second heating body) |
| | 16 Heater block |
| | 16a Main surface |

	17 Heater fixing surface
	18 Upstream heat dissipation part
	19 Downstream heat dissipation part
	21 Coupling part
5	22 Fin
	23 Groove
	24 Air supply hole
	100 Lead frame
	D1 Conveyance direction
10	D2 Facing direction
	D3 Width direction
	K Virtual surface
	L1 Gap
	L3 Depth
15	A1 Preliminary heating region
	A2 Bonding region
	A3 Post-heating region

[CLAIMS]

[Claim 1]

A bonding apparatus comprising:

a bonding part that performs bonding work for a lead frame which has been conveyed to

5 a working region; and

a frame feeder that conveys the lead frame to the working region using a conveyance part and performs preliminary heating of the lead frame before being conveyed to the working region using a heater unit,

wherein the heater unit has

10 a heating body, and

a heater block which is disposed so as to face a rear surface of the lead frame on an upstream side of the working region in a conveyance direction of the lead frame and provides the lead frame with heat received from the heating body, and

wherein a heat dissipation part having a plurality of fins formed from a surface of the
15 heater block in a depth direction is provided in the heater block.

[Claim 2]

The bonding apparatus according to claim 1,

wherein the plurality of fins is separated from each other in a direction orthogonal to the conveyance direction of the lead frame.

20 [Claim 3]

The bonding apparatus according to claim 1 or 2,

wherein holes which are provided between the fins and penetrate the heater block in the depth direction are provided in the heater block.

[Claim 4]

The bonding apparatus according to any one of claims 1 to 3,
wherein lengths of the fins in the depth direction are longer than a distance from tips of the fins to the lead frame in the depth direction.

5 [Claim 5]

The bonding apparatus according to any one of claims 1 to 4 further comprising:
a controller that controls operation of the bonding part and the frame feeder,
wherein the controller

provides the bonding part with a control signal for causing the bonding part to
10 perform bonding work during a first period, and

provides the frame feeder with a control signal for causing the heater unit to
perform preliminary heating of the lead frame during a second period overlapping the first
period, and

wherein a length of the second period is equal to or shorter than a length of the first
15 period.

[Claim 6]

A frame feeder comprising:

a conveyance part that conveys a lead frame to a working region in which bonding work
is performed for the lead frame; and

20 a first heater unit that performs preliminary heating of the lead frame before being
conveyed to the working region,

wherein the first heater unit has

a first heating body, and

a first heater block which is disposed so as to face a rear surface of the lead

frame on an upstream side of the working region in a conveyance direction of the lead frame and provides the lead frame with heat received from the first heating body, and

wherein a first heat dissipation part having a plurality of first fins formed from a surface of the first heater block in a depth direction is provided in the first heater block.

5 [Claim 7]

The frame feeder according to claim 6 further comprising:

a second heater unit that heats the lead frame conveyed from the working region after the bonding work is performed,

wherein the second heater unit has

10 a second heating body, and

a second heater block which is disposed so as to face the rear surface of the lead frame on a downstream side of the working region in the conveyance direction of the lead frame and provides the lead frame with heat received from the second heating body, and

15 wherein a second heat dissipation part having a plurality of second fins formed from a surface of the second heater block in the depth direction is provided in the second heater block.

[Claim 8]

A heater unit performing preliminary heating of a lead frame before being conveyed to a working region in which bonding work is performed for the lead frame, the heater unit comprising:

20 a heating body; and

a heater block that is disposed so as to face a rear surface of the lead frame on an upstream side of the working region in a conveyance direction of the lead frame and provides the lead frame with heat received from the heating body,

wherein a heat dissipation part having a plurality of fins formed from a surface of the

heater block in a depth direction is provided in the heater block.

[Claim 9]

The heater unit according to claim 8,

wherein the plurality of fins is separated from each other in a direction orthogonal to the

5 conveyance direction of the lead frame.

[Claim 10]

The heater unit according to claim 8 or 9,

wherein holes which are provided between the fins and penetrate the heater block in the depth direction are provided in the heater block.

10 [Claim 11]

The heater unit according to any one of claim 8 to 10,

wherein lengths of the fins in the depth direction are longer than a distance from tips of the fins to the lead frame in the depth direction.