

DESCRIPTION

TITLE OF INVENTION:

5 Method of Manufacturing Processed Product, Method of Manufacturing
Semiconductor Device, and Processed Product Manufacturing Apparatus

TECHNICAL FIELD

[0001] The present specification relates to a method of manufacturing a processed product, a method of manufacturing a semiconductor device, and a processed product manufacturing apparatus.

10 BACKGROUND ART

[0002] As disclosed in Japanese Patent Laying-Open No. 2011-77278 (PTL 1), regarding a workpiece such as a lead frame, various processing treatments are performed on a workpiece alone or an object obtained by integrating a workpiece and another member such as a resin with each other, with the result that a processed product (for example, a finished product) is obtained. After the workpiece (lead frame) disclosed in PTL 1 is subjected to a prescribed process, a plating treatment is performed on a surface of this workpiece, which is then divided into a plurality of pieces, which are then mounted on a substrate or the like.

CITATION LIST

20 PATENT LITERATURE

[0003] PTL 1: Japanese Patent Laying-Open No. 2011-77278

SUMMARY OF INVENTION

TECHNICAL PROBLEM

25 [0004] As disclosed in PTL 1, when preparing a workpiece, there may be a case where a workpiece having a groove portion (a recessed portion) formed in advance along a position to be finally cut is prepared. Due to the presence of such a groove portion, for example, a plating film provided on an inner surface of the groove portion has a concave space recessed inwardly after the lead frame is cut (in PTL 1, after the workpiece is divided into a plurality of pieces). A bonding material such as solder is

guided into this concave space. For example, when a semiconductor device is mounted on a substrate or the like, solder can be satisfactorily bonded to both a lower surface and a side surface of a lead, so that the connection reliability is improved.

[0005] In this case, in a state in which the workpiece is prepared in a preparation stage, the inner surface of the groove portion may have a surface shape, for example, curved in a concave shape. In an initial state in which the workpiece is prepared in the preparation stage, the inner surface of the groove portion may not have a surface shape suitable for a treatment in subsequent steps such as guiding and bonding of solder or the like. In order to improve the connection reliability achieved when solder or the like is applied, for example, it is preferable that the concave space is formed to be wide and the inner surface of the groove portion has a wider bonding area.

[0006] The present description is disclosed in view of the above-described circumstances, and an object thereof is to disclose a method of manufacturing a processed product, a method of manufacturing a semiconductor device, and a processed product manufacturing apparatus, by which the connection reliability higher than that achieved by conventional methods can be achieved when a processed product is manufactured from a workpiece having a groove portion formed in advance along a position to be cut.

SOLUTION TO PROBLEM

[0007] A method of manufacturing a processed product according to the present disclosure includes: a preparing step of preparing a workpiece including at least a lead frame having a groove portion formed in advance along a position to be cut; a surface layer removing step of, before cutting the workpiece, partially removing a surface layer portion forming the groove portion in the workpiece; and a plating step of, before cutting the workpiece, performing a plating treatment on the workpiece from which the surface layer portion is partially removed. In a state before the surface layer removing step is performed, the surface layer portion includes: a cut region to be removed by cutting the workpiece; and an uncut region located between the cut region and an opening end of the groove portion. In the surface layer removing step, at least a part

of the uncut region is removed.

[0008] A method of manufacturing a semiconductor device according to the present disclosure employs the above-described method of manufacturing a processed product, and includes: a resin sealing step of sealing the lead frame and a semiconductor chip
5 with a resin material in a state in which the semiconductor chip is bonded to the lead frame; a resin removing step of removing the resin material inside the groove portion; and a cutting step of cutting the lead frame along the groove portion. As the method of manufacturing a processed product, the surface layer removing step and the plating step are performed between the resin removing step and the cutting step, the surface
10 layer removing step and the plating step are performed before the resin sealing step, or the surface layer removing step is performed before the resin sealing step, and the plating step is performed between the resin removing step and the cutting step.

[0009] A processed product manufacturing apparatus according to the present disclosure is a processed product manufacturing apparatus that performs processing on
15 a workpiece including at least a lead frame having a groove portion formed in advance along a position to be cut. The processed product manufacturing apparatus includes: a surface layer removing unit that, in a state in which the workpiece is not cut, partially removes a surface layer portion forming the groove portion in the workpiece; and a plating treatment unit that, in the state in which the workpiece is not cut, performs a
20 plating treatment on the workpiece from which the surface layer portion is partially removed. In a state before the surface layer removing unit partially removes the surface layer portion, the surface layer portion includes: a cut region to be removed by cutting the workpiece; and an uncut region located between the cut region and an opening end of the groove portion. The surface layer removing unit removes at least a
25 part of the uncut region.

ADVANTAGEOUS EFFECTS OF INVENTION

[0010] According to the disclosure described above, it is possible to obtain a method of manufacturing a processed product, a method of manufacturing a semiconductor device, and a processed product manufacturing apparatus, by which connection

reliability higher than that achieved by conventional methods can be achieved when a processed product is manufactured from a workpiece having a groove portion formed in advance along a position to be cut.

BRIEF DESCRIPTION OF DRAWINGS

5 [0011] Fig. 1 is a diagram showing a processed product manufacturing apparatus 20.

Fig. 2 is a diagram illustrating a method of manufacturing a processed product and a method of manufacturing a semiconductor device employing the same.

Fig. 3 is a plan view showing a configuration of a lead frame 1 prepared in a preparing step as viewed from a side of a rear surface 1b of lead frame 1.

10 Fig. 4 is a cross-sectional view taken along a line IV-IV in Fig. 3.

Fig. 5 is a perspective view showing a configuration of a part (a lead portion 3, a tie bar 4, and a groove portion 5) of lead frame 1 prepared in the preparing step as viewed from the side of rear surface 1b.

15 Fig. 6 is a cross-sectional view showing a state in which a semiconductor chip 6 is bonded onto lead frame 1 (a die pad 2) prepared in the preparing step.

Fig. 7 is a cross-sectional view showing a state in which a resin sealing step is performed.

Fig. 8 is a cross-sectional view showing a state in which a protective film has been removed before a resin removing step is performed.

20 Fig. 9 is a cross-sectional view showing a state in which the resin removing step is performed.

Fig. 10 is a cross-sectional view showing a state in which a surface layer removing step is performed.

25 Fig. 11 is a plan view for illustrating a range in which the surface layer removing step is performed.

Fig. 12 is an enlarged cross-sectional view showing a part of Fig. 10 and illustrating a state after the surface layer removing step is performed.

Fig. 13 is a cross-sectional view showing a state after a plating step is performed.

Fig. 14 is a cross-sectional view showing a state in which a cutting step is performed.

Fig. 15 is a perspective view showing a semiconductor device obtained by a manufacturing method according to an embodiment.

5 Fig. 16 is a cross-sectional view showing a state in which the semiconductor device obtained by the manufacturing method according to the embodiment is mounted.

10 Fig. 17 is a cross-sectional view showing a state in which a semiconductor device obtained by a manufacturing method according to a comparative example is mounted.

Fig. 18 is a cross-sectional view corresponding to Fig. 12 and illustrating functions and effects related to the embodiment.

Fig. 19 is a cross-sectional view corresponding to Fig. 12 and illustrating a surface layer removing step according to a first modification of the embodiment.

15 Fig. 20 is a cross-sectional view corresponding to Fig. 12 and illustrating a surface layer removing step according to a second modification of the embodiment.

Fig. 21 is a cross-sectional view corresponding to Fig. 12 and illustrating a surface layer removing step according to a third modification of the embodiment.

20 Fig. 22 is a diagram illustrating a method of manufacturing a processed product and a method of manufacturing a semiconductor device employing the same, according to a fourth modification of the embodiment.

Fig. 23 is a diagram illustrating a method of manufacturing a processed product and a method of manufacturing a semiconductor device employing the same, according to a fifth modification of the embodiment.

25 DESCRIPTION OF EMBODIMENTS

[0012] The following describes embodiments with reference to the accompanying drawings. In the following description, the same or corresponding components are denoted by the same reference characters, and the description thereof may not be repeated. The following first describes configurations of a processed product

manufacturing apparatus 20 and a lead frame 1 employed in a method of manufacturing a processed product (or a method of manufacturing a semiconductor device), and then describes a method of manufacturing a processed product (or a method of manufacturing a semiconductor device).

5 [0013] [Processed Product Manufacturing Apparatus 20]

Fig. 1 is a diagram showing processed product manufacturing apparatus 20. Processed product manufacturing apparatus 20 processes a workpiece 22 held on a stage 21. Workpiece 22 has a groove portion formed in advance along a position to be cut. In this case, the groove portion is a portion formed as a groove having a bottom
10 and may be referred to as a bottomed groove. When workpiece 22 is a lead frame 1 described later, lead frame 1 is provided with a groove portion 5 (see Fig. 5 and the like), and processed product manufacturing apparatus 20 is capable of functioning as an apparatus for manufacturing a semiconductor device. The following description is based on an example in which processed product manufacturing apparatus 20 is an
15 apparatus for manufacturing a semiconductor device.

[0014] Processed product manufacturing apparatus 20 includes an emission unit 23, a scanning unit 24, a control unit 25, and a plating treatment unit 26. Control unit 25 controls emission unit 23 and scanning unit 24 according to the prescribed processing conditions. Emission unit 23 generates and emits a laser beam. The laser beam
20 emitted from emission unit 23 is transmitted to scanning unit 24 which then irradiates workpiece 22 with a laser beam L, for example, by using a lens and a scanner mirror. Scanning unit 24 applies laser beam L onto workpiece 22 to scan in a prescribed scanning direction by changing the relative position between workpiece 22 and a beam spot of laser beam L. Thereby, a part of workpiece 22 is removed.

25 [0015] As will be described later in detail, emission unit 23, scanning unit 24, and control unit 25 are capable of functioning as a "surface layer removing unit". The surface layer removing unit partially removes a surface layer portion (a surface layer portion 3c in lead frame 1) forming a groove portion in workpiece 22 (groove portion 5 in lead frame 1 (see Fig. 4)) in the state in which workpiece 22 has not been cut.

[0016] As will be described later with reference to Fig. 4, surface layer portion 3c of lead frame 1 is partially removed by laser irradiation from the surface layer removing unit. In the state in which workpiece 22 (lead frame 1) has not been cut, plating treatment unit 26 performs a plating treatment on workpiece 22 (lead frame 1) from which surface layer portion 3c has been partially removed.

[0017] [Method of Manufacturing Semiconductor Device]

Fig. 2 is a diagram illustrating a method of manufacturing a processed product and a method of manufacturing a semiconductor device employing the same. The method of manufacturing a semiconductor device can be performed with processed product manufacturing apparatus 20 shown in Fig. 1. The method of manufacturing a semiconductor device includes a preparing step ST10, a resin sealing step ST12, a resin removing step ST13, a surface layer removing step ST14, a plating step ST15, and a cutting step ST16. Preparing step ST10 includes a groove portion forming step ST11.

[0018] (Method of Manufacturing Processed Product)

Preparing step ST10, surface layer removing step ST14, and plating step ST15 can constitute a method of manufacturing a processed product. In other words, the method of manufacturing a semiconductor device may include the method of manufacturing a processed product. Hereinafter, steps will be sequentially described.

[0019] [Lead Frame 1 (Preparing Step ST10)]

Fig. 3 is a plan view showing a configuration of lead frame 1 prepared in a preparing step as viewed from a side of a rear surface 1b of lead frame 1. Fig. 4 is a cross-sectional view taken along a line IV-IV in Fig. 3. Fig. 5 is a perspective view showing a configuration of a part (a lead portion 3, a tie bar 4, and groove portion 5) of lead frame 1 prepared in the preparing step as viewed from the side of rear surface 1b.

[0020] In Fig. 3 that does not show a cross-sectional configuration of lead frame 1, for convenience of illustration, each of portions constituting lead frame 1 is represented by hatching lines extending in an oblique direction. In this case, two types of hatching lines are used, and the difference therebetween will be described later. For convenience of description, Figs. 3 to 5 each show a length direction S, a width

direction W, and a height direction H, and these directions are referred to as appropriate in the description below. These directions are also shown as appropriate in Fig. 6 and the figures subsequent thereto.

[0021] As shown in Fig. 3, lead frame 1 has a substantially plate-like shape extending both in length direction S and width direction W. Lead frame 1 has a front surface 1a located on the side on which a semiconductor chip 6 (Fig. 6) is mounted and rear surface 1b located on the opposite side of front surface 1a, and is made of metal such as copper. Lead frame 1 includes a plurality of die pads 2, a plurality of lead portions 3, and a plurality of tie bars 4.

[0022] (Die Pad 2, Lead Portion 3, and Tie Bar 4)

A plurality of die pads 2 are arranged at intervals in both length direction S and width direction W. Semiconductor chip 6 is mounted on front surface 1a of each die pad 2 (see Fig. 6). The plurality of lead portions 3 are arranged side by side in a rectangular shape around (along four sides of) each of the plurality of die pads 2. The plurality of tie bars 4 are arranged in a grid pattern so as to surround each of the plurality of die pads 2. The plurality of lead portions 3 are provided on each of both sides of one tie bar 4, and the plurality of lead portions 3 are arranged at intervals in the extending direction of tie bar 4. Each of the plurality of lead portions 3 has a thick portion 3a and a thin portion 3b (Figs. 3 and 5). In lead portion 3, thick portion 3a is connected to tie bar 4 with thin portion 3b interposed therebetween. In height direction H, die pad 2 and thick portion 3a each are greater in height dimension (i.e., thickness) than thin portion 3b.

[0023] Die pad 2 and thick portion 3a each are represented by hatching lines extending from an upper right side toward a lower left side of the sheet plane in Fig. 3. Thin portion 3b of lead portion 3 and tie bar 4 each are represented by hatching lines extending from an upper left side toward a lower right side of the sheet plane in Fig. 3.

[0024] (Groove Portion 5)

Referring to Fig. 5, with attention being paid to a surface of tie bar 4 and surfaces of thick portion 3a and thin portion 3b of lead portion 3 that are located on a

"negative side in height direction H" shown in Fig. 5, these surfaces are located at the same height position. On the other hand, with attention being paid to surfaces located on a "positive side in height direction H" shown in Fig. 5, the surface of thick portion 3a of lead portion 3 is higher in height position than the surface of tie bar 4 and the surface of thin portion 3b of lead portion 3.

[0025] In other words, the surface on the positive side of tie bar 4 and the surface on the positive side of thin portion 3b of lead portion 3 are shaped to be recessed with respect to the surface on the positive side of thick portion 3a of lead portion 3. Due to such a structure, lead frame 1 is provided with groove portions 5 placed in a grid pattern and extending on the side of rear surface 1b (Fig. 3) of tie bar 4 in height direction H and width direction W and also in height direction H and length direction S.

[0026] Groove portion 5 does not penetrate through lead frame 1 in height direction H direction but has a groove depth that is, for example, one-half of lead frame 1 (thick portion 3a) and can be formed by etching (wet etching) of lead frame 1. A groove width is, for example, 0.30 mm to 0.50 mm. The groove width and the groove depth should only be set in consideration of: the strength ensured to such an extent as not to cause a defect such as deformation in a post process; the ability to conduct a satisfactory visual inspection in a post process; satisfactory strength with which a semiconductor device as a finished product is mounted; and the like.

[0027] As shown in Fig. 4, groove portion 5, which is a space, is defined by a bottom portion 5a of groove portion 5, a side portion 5b of groove portion 5, and an opening end 5c of groove portion 5. Opening end 5c of groove portion 5 is an inner edge portion forming groove portion 5 on rear surface 1b of lead frame 1, and extends linearly (Fig. 5). Bottom portion 5a of groove portion 5 has a shape of a substantially flat surface. Side portion 5b of groove portion 5 is curved to be located closer to a center position in the width direction than to opening end 5c of groove portion 5 toward bottom portion 5a of groove portion 5.

[0028] As shown in Figs. 4 and 5 (particularly, Fig. 4), lead frame 1 has surface layer portion 3c that forms groove portion 5. In Fig. 4, surface layer portion 3c is

represented by a dashed line. Surface layer portion 3c of lead frame 1 is a portion of lead frame 1 that forms groove portion 5 and that is defined in a range from the outer surface of lead frame 1 to a prescribed depth. The surface shape of surface layer portion 3c forms (defines) groove portion 5 as a space. As shown in the cross-

sectional shape in Fig. 4, surface layer portion 3c has a prescribed thickness and extends in a U-shape or a C-shape in this case. The "range ... to a prescribed depth" and the "prescribed thickness" used herein are not limited to a configuration in which surface layer portion 3c has a constant (uniform) thickness in width direction W. As long as groove portion 5 is provided, surface layer portion 3c may have any thickness in width direction W and may have different thicknesses in width direction W.

[0029] Lead frame 1 is divided into a plurality of pieces by performing cutting step ST16 (see Fig. 14), which will be described later in detail. Surface layer portion 3c includes: a cut region 3m to be removed by cutting lead frame 1; and an uncut region 3n located between cut region 3m and opening end 5c of groove portion 5. In Fig. 4, a blade 12 used in cutting step ST16 is imaginarily illustrated by a two-dot chain line.

[0030] Cut region 3m is located inside a frame defined by the two-dot chain line indicating blade 12, and uncut region 3n is located outside the frame defined by the two-dot chain line indicating blade 12. Surface layer portion 3c includes a boundary portion 3t between cut region 3m and uncut region 3n. Boundary portion 3t has a surface 3q located on the two-dot chain line indicating blade 12. Note that both the width and the position of the frame of the two-dot chain line are schematically shown, and the range actually removed by cutting is wider than the width of blade 12.

[0031] A surface shape 3p of cut region 3m corresponds to bottom portion 5a of groove portion 5. A surface shape 3r of uncut region 3n corresponds to side portion 5b of groove portion 5. An upper end portion 3s of surface shape 3r of uncut region 3n corresponds to opening end 5c of groove portion 5. In the example shown in Fig. 4, side portion 5b of groove portion 5 is entirely included in surface shape 3r of uncut region 3n. A lower end portion of surface shape 3r of uncut region 3n may include bottom portion 5a (a flat surface) of groove portion 5 (in other words, a part of bottom

portion 5a of groove portion 5 may be included in uncut region 3n).

[0032] (Resin Sealing Step)

Fig. 6 is a cross-sectional view showing the state in which semiconductor chip 6 is bonded onto lead frame 1 (die pad 2) prepared in the preparing step. As shown in Fig. 6, a plurality of electrodes provided on each semiconductor chip 6 are electrically connected to lead portion 3 (thick portion 3a) via a bonding wire 7.

[0033] Fig. 7 is a cross-sectional view showing the state in which a resin sealing step is performed. In the resin sealing step, lead frame 1 and semiconductor chip 6 are sealed with a resin material 9 in the state in which semiconductor chip 6 is bonded. Before the resin sealing step, a protective film 8 (for example, a polyimide resin tape) may be attached to lead frame 1 on the side of groove portion 5, and then, resin sealing may be performed in the state in which protective film 8 is attached.

[0034] The method of manufacturing a semiconductor device may further include a step of performing laser marking by irradiating a surface 9a (Fig. 7) of lead frame 1 opposite to groove portion 5 with a laser beam L1 at some point in a process from the resin sealing step to a cutting step described later. Any information such as a model number or a serial number can be printed by scanning with a scanning optical system using a pulse laser.

[0035] As shown in Fig. 8, protective film 8 is peeled off from lead frame 1 before the resin removing step described below is performed. By removing protective film 8, resin material 9 (9b) formed inside groove portion 5 of lead frame 1 is exposed. Note that protective film 8 may be peeled off from lead frame 1 before the step of performing laser marking described with reference to Fig. 7.

[0036] (Resin Removing Step)

Fig. 9 is a cross-sectional view showing the state in which the resin removing step is performed. In the resin removing step, resin material 9 (9b) inside groove portion 5 is irradiated with a laser beam L2, and laser beam L2 is applied to scan in length direction S. Thereby, the resin material inside groove portion 5 is removed. Examples of laser beam L2 applicable in this case may be infrared laser, green laser,

ultraviolet laser, or the like as pulse laser.

[0037] Regarding a pulse width, laser that generates a pulse width of nanoseconds, picoseconds, or the like can be used. Further, control unit 25 (Fig. 1) controls emission unit 23 and scanning unit 24 to make it possible to change the conditions of processing by laser beam L2. In accordance with the material of resin material 9 (9b) and the size of resin material 9 (9b) (the groove width and the like of groove portion 5), the wavelength, the output, the laser beam focusing diameter, the irradiation time period, and the like of laser beam L2 are optimized such that resin material 9 (9b) can be efficiently removed.

[0038] (Surface Layer Removing Step)

Fig. 10 is a cross-sectional view showing the state in which the surface layer removing step is performed. Fig. 11 is a plan view for illustrating a range in which the surface layer removing step is performed. In the surface layer removing step, surface layer portion 3c of lead frame 1 that forms groove portion 5 is partially removed before lead frame 1 is cut (in other words, before the cutting step is performed). The surface layer removing step is performed, for example, with a laser. In order to highly efficiently process the material (copper and the like) of lead frame 1 and to suppress any thermal influence upon the material (copper and the like) of lead frame 1, an oscillator with a short pulse (less than picoseconds) may be used. The surface layer removing step may be performed with other grinding means, other polishing means, or the like.

[0039] Referring to Fig. 10, in the state before the surface layer removing step is performed, surface layer portion 3c of lead frame 1 includes: cut region 3m to be removed by cutting lead frame 1; and uncut region 3n located between cut region 3m and opening end 5c of groove portion 5. In the state before the surface layer removing step is performed, surface shape 3r of uncut region 3n is curved to be located closer to the center position in the groove width direction than to opening end 5c of groove portion 5 toward bottom portion 5a of groove portion 5. In Fig. 10, only a side wall portion of blade 12 used in cutting step ST16 is imaginarily represented by a two-dot

chain line.

[0040] In the surface layer removing step, at least uncut region 3n is irradiated with a laser beam L3, and laser beam L3 is applied to scan in length direction S (see Fig. 11). Thereby, at least a part of uncut region 3n is removed. For example, a part of uncut region 3n may be removed by a depth of 30 μm to 40 μm from surface layer portion 3c. As laser beam L3, for example, a short pulse laser such as a picosecond pulse laser may be used.

[0041] Fig. 12 is an enlarged cross-sectional view showing a part of Fig. 10 and illustrating the state after the surface layer removing step is performed. In the examples shown in Figs. 10 and 12, a portion of uncut region 3n is removed, the portion being located at a position substantially below the central portion in the height direction (being located close to bottom portion 5a of groove portion 5). Further, both side portions of cut region 3m in the width direction are also slightly removed. In other words, in the surface layer removing step applied herein, in addition to at least a part of uncut region 3n, a portion of cut region 3m that is close to uncut region 3n is also removed.

[0042] In the state after the surface layer removing step is performed and before lead frame 1 is cut, surface layer portion 3c of lead frame 1 includes boundary portion 3t between cut region 3m and uncut region 3n. When the position of the surface of surface layer portion 3c in the depth direction of groove portion 5 is defined as a "height", and in the state after the surface layer removing step is performed and before lead frame 1 is cut, a height H1 of the surface of cut region 3m is equal to a height H2 of surface 3q of boundary portion 3t, or height H1 of the surface of at least a part of cut region 3m is higher than height H2 of surface 3q of boundary portion 3t (surface 3q of boundary portion 3t is lower in height position than the surface of at least a part of cut region 3m).

[0043] (Plating Step)

Fig. 13 is a cross-sectional view showing the state after a plating step is performed. After the surface layer removing step is performed and before lead frame

1 is cut, a plating treatment is performed on lead frame 1 from which surface layer portion 3c has been partially removed. A plating layer 10 is formed on a surface of die pad 2 of lead frame 1, a surface of tie bar 4 of lead frame 1, a surface of thin portion 3b of lead portion 3, and a surface of surface layer portion 3c on which the surface layer removing step has been performed. By formation of plating layer 10, the method of manufacturing a processed product is completed, and lead frame 1 on which plating layer 10 is formed at this point in time constitutes a "processed product".

[0044] As a material of plating layer 10, a material having excellent solder wettability can be selected depending on a solder material to be used for mounting. For example, when tin (Sn)-based solder is used, tin (Sn), a tin-copper alloy (Sn-Cu), a tin-silver alloy (Sn-Ag), tin-bismuth (Sn-Bi), or the like can be used.

[0045] In the plating step, it is desirable that lead frame 1 is subjected to a prescribed cleaning treatment and thereafter subjected to a plating treatment. As a surface treatment of lead frame 1 in a pretreatment of the plating step, removal of an oxide film, treatments for surface activation and the like may be performed in addition to the cleaning treatment. Resin material 9 inside groove portion 5 may have been reformed (for example, carbonized) as a result of irradiation with laser beams. Even when resin material 9 more or less remains, reformed resin material 9 can be removed from the inside of groove portion 5 by a surface treatment such as a cleaning treatment performed before the plating treatment.

[0046] (Cutting Step)

As shown in Fig. 14, lead frame 1 subjected to the plating treatment is cut along groove portion 5. In this cutting step, blade 12 is used to cut the entire thickness portions of lead frame 1 and resin material 9. Performing the cutting step provides semiconductor devices 11 as a plurality of unit resin molded products. As shown in Fig. 15, semiconductor device 11 is a non-lead type product such as a quad flat non-leaded package (QFN)-type product from which a lead for electrical connection does not protrude to the outside thereof in a plan view.

[0047] Fig. 16 is a cross-sectional view showing the state in which semiconductor

device 11 is mounted. As shown in Fig. 16, in semiconductor device 11, a step is formed on a side portion (one side) of each lead portion 3, and plating layer 10 is not formed on a side surface 3d of lead portion 3, at which original metal is exposed.

Semiconductor device 11 is mounted on a printed board, for example, with the side of resin material 9 facing upward and the side of lead portion 3 facing downward. The printed board is provided with a land 13 at a position corresponding to lead portion 3, and lead portion 3 and land 13 are connected to each other with solder 14 interposed therebetween.

[0048] At this time, solder 14 accumulates in the inside (a recess) of a portion of surface layer portion 3c (Fig. 12) of lead frame 1 that has been subjected to the surface layer removing step, to thereby improve the wettability of solder 14 and make it to possible to obtain a more satisfactory soldered structure. By performing the surface layer removing step, the bonding area (the surface area) of the above-mentioned recessed portion is increased, and the volume of the recessed portion through which solder 14 can be guided is also increased.

[0049] Fig. 17 is a cross-sectional view showing the state in which a semiconductor device obtained by a manufacturing method according to a comparative example is mounted. In the comparative example, the surface layer removing step is not performed, and thus, the bonding area (surface area) and the volume of the portion corresponding to the recessed portion are both small. On the other hand, according to the above-described embodiment (Fig. 16), when a processed product is manufactured from a workpiece having a groove portion formed in advance along a position to be cut, connection reliability higher than that achieved by conventional methods can be achieved. Further, by performing the surface layer removing step, a height HS of the recessed portion can also be made higher, the inspection using an automatic inspection machine for inspecting solder 14 can also be more easily conducted, and more accurate results can also be obtained.

[0050] When groove portion 5 of lead frame 1 is formed by wet etching, surface shape 3r of uncut region 3n tends to be curved to be located closer to the center position in the

groove width direction than to opening end 5c of groove portion 5 toward bottom portion 5a of groove portion 5. When wet etching is performed, the above-described effect can be achieved by performing the surface layer removing step on surface shape 3r of uncut region 3n as described above.

5 [0051] As shown in Fig. 18, in the above-described embodiment, when the position of the surface of surface layer portion 3c in the depth direction of groove portion 5 is defined as a "height", and in the state after the surface layer removing step is performed and before lead frame 1 is cut, height H1 of the surface of cut region 3m is equal to height H2 of surface 3q of boundary portion 3t, or height H1 of the surface of at least a
10 part of cut region 3m is higher than height H2 of surface 3q of boundary portion 3t. In the latter case, surface 3q of boundary portion 3t is lower in height position than the surface of at least a part of cut region 3m. According to the above-described configuration, during cutting with blade 12, blade 12 first comes into contact with a portion at height H1 in cut region 3m. At this point in time, a gap 3w (Fig. 18) is
15 formed below each of both sides of blade 12 in the width direction. Thereafter, blade 12 comes into contact with a portion at height H2 in boundary portion 3t (surface 3q of boundary portion 3t). In this way, since the thickness of lead frame 1 is reduced at both end portions of blade 12, the occurrence of burrs at boundary portion 3t can be reduced.

20 [0052] [First Modification]

Fig. 19 is a cross-sectional view corresponding to Fig. 12 and illustrating a surface layer removing step according to the first modification of the embodiment. In the above-described example (Fig. 18 and the like), in addition to at least a part of uncut region 3n, an end portion of cut region 3m (a portion corresponding to gap 3w
25 shown in Fig. 18) is also removed. Such a configuration is not indispensable, and as shown in Fig. 19, when cut region 3m is flat and side portion 5b of groove portion 5 is not included in cut region 3m, cut region 3m may not be removed in the surface layer removing step. The above-described object of forming a recess contributing to guiding and bonding of solder can be achieved also by performing the surface layer

removing step only on uncut region 3n but not on cut region 3m. In this case, since the surface layer removing step is not performed on cut region 3m, the manufacturing time can be shortened accordingly.

[0053] [Second Modification]

5 Fig. 20 is a cross-sectional view corresponding to Fig. 12 and illustrating a surface layer removing step according to the second modification of the embodiment. In the state after the surface layer removing step is performed and before lead frame 1 is cut, a portion in which the surface of cut region 3m and the surface of uncut region 3n are connected to each other (i.e., the portion means the surface of boundary portion 3t) may have a shape of a flat surface, and the flat surface may be substantially
10 orthogonal to the depth direction of groove portion 5 (the direction orthogonal to rear surface 1b). Also in this configuration, the occurrence of burrs in boundary portion 3t can be reduced.

[0054] Fig. 21 is a cross-sectional view corresponding to Fig. 12 and illustrating a

15 surface layer removing step according to the third modification of the embodiment.

As shown in Fig. 21, in the state after the surface layer removing step is performed and before lead frame 1 is cut, surface shape 3r of uncut region 3n (i.e., side portion 5b of groove portion 5) may extend to be substantially parallel to the depth direction of groove portion 5 (the direction orthogonal to rear surface 1b). By performing the
20 surface layer removing step to such an extent as shown in Fig. 21, a recess contributing to guiding and bonding of solder can be sufficiently formed. Further, a deeper recess ensures the solder wetting height of the mounting side surface at the time of mounting the semiconductor device, so that the inspection using an automatic inspection machine is more easily conducted.

25 [0055] Further, as in the case described with reference to Fig. 20, as shown in Fig. 21, a portion in which the surface of cut region 3m and the surface of uncut region 3n are connected to each other (the portion means the surface of boundary portion 3t) may have a shape of a flat surface, and the flat surface may be substantially orthogonal to the depth direction of groove portion 5 (the direction orthogonal to rear surface 1b).

In the configuration shown in Fig. 21, surface shape 3r of uncut region 3n (i.e., side portion 5b of groove portion 5) and surface shape 3p of cut region 3m (i.e., bottom portion 5a of groove portion 5) are orthogonal to each other. In even such a configuration, the occurrence of burrs in boundary portion 3t can be reduced.

5 [0056] [Fourth Modification]

As described above, regarding the method of manufacturing a processed product, preparing step ST10, surface layer removing step ST14, and plating step ST15 can constitute a method of manufacturing a processed product. In the case of the above-described embodiment (Fig. 2), surface layer removing step ST14 and plating

10 step ST15 are performed between resin removing step ST13 and cutting step ST16.
[0057] Fig. 22 is a diagram illustrating a method of manufacturing a processed product and a method of manufacturing a semiconductor device employing the same, according to the fourth modification of the embodiment. As shown in Fig. 22, after performing each of these steps (preparing step ST10, surface layer removing step ST14, and plating
15 step ST15) related to the method of manufacturing a processed product, resin sealing step ST12, resin removing step ST13, and cutting step ST16 may be performed. In the example shown in Fig. 22, surface layer removing step ST14 and plating step ST15 are performed before resin sealing step ST12. In the plating step in this case, for example, Palladium Pre Plated process (for example, Ni/Pd/Au plating), Pd plating on
20 the entire surface, or the like can be used.

[0058] As practicing entities, for example, a lead frame manufacturer can perform the steps up to plating step ST15, and a semiconductor device manufacturer can perform resin sealing step ST12 and all the steps subsequent thereto. Alternatively, a lead frame manufacturer may perform the steps up to surface layer removing step ST14 and
25 a semiconductor device manufacturer may perform plating step ST15 and the steps subsequent thereto.

[0059] [Fifth Modification]

Fig. 23 is a diagram illustrating a method of manufacturing a processed product and a method of manufacturing a semiconductor device employing the same, according

to the fifth modification of the embodiment. As shown in Fig. 23, these steps related to the method of manufacturing a processed product may not be continuously performed. After preparing step ST10 is performed, surface layer removing step ST14, resin sealing step ST12, resin removing step ST13, plating step ST15, and cutting step ST16 may be sequentially performed. In the example shown in Fig. 23, surface layer removing step ST14 is performed before resin sealing step ST12, and plating step ST15 is performed between resin removing step ST13 and cutting step ST16.

[0060] As practicing entities, for example, a lead frame manufacturer can perform the steps up to preparing step ST10, and a semiconductor device manufacturer can perform surface layer removing step ST14 and all the steps subsequent thereto. Alternatively, a lead frame manufacturer may perform the steps up to surface layer removing step ST14, and a semiconductor device manufacturer may perform the subsequent steps.

[0061] Although the embodiments have been described as above, the details of the above disclosure are illustrative and non-restrictive in every respect. The technical scope of the present invention is defined by the scope of the claims and is intended to include any modifications within the meaning and scope equivalent to the scope of the claims.

REFERENCE SIGNS LIST

[0062] 1 lead frame (workpiece), 1a, 3q, 9a front surface, 1b rear surface, 2 die pad, 3 lead portion, 3a thick portion, 3b thin portion, 3c surface layer portion, 3d side surface, 3m cut region, 3n uncut regions 3p, 3r surface shape, 3s upper end portion, 3t boundary portion, 3w gap, 4 tie bar, 5 groove portion, 5a bottom portion, 5b side portion, 5c opening end, 6 semiconductor chip, 7 bonding wire, 8 protective film, 9 resin material, 10 plating layer, 11 semiconductor device, 12 blade, 13 land, 14 solder, 20 processed product manufacturing apparatus, 21 stage, 22 workpiece, 23 emission unit, 24 scanning unit, 25 control unit, 26 plating treatment unit, H1, H2, HS height, L, L1, L2, L3 laser beam, ST10 preparing step, ST11 groove portion forming step, ST12 resin sealing step, ST13 resin removing step, ST14 surface layer removing step, ST15 plating

step, ST16 cutting step.

CLAIMS

[Claim 1] A method of manufacturing a processed product, the method comprising:

5 a preparing step of preparing a workpiece including at least a lead frame having a groove portion formed in advance along a position to be cut;

a surface layer removing step of, before cutting the workpiece, partially removing a surface layer portion forming the groove portion in the workpiece; and

10 a plating step of, before cutting the workpiece, performing a plating treatment on the workpiece from which the surface layer portion is partially removed, wherein in a state before the surface layer removing step is performed, the surface layer portion includes

a cut region to be removed by cutting the workpiece, and

15 an uncut region located between the cut region and an opening end of the groove portion, and

in the surface layer removing step, at least a part of the uncut region is removed.

[Claim 2] The method of manufacturing a processed product according to claim 1, wherein, in the surface layer removing step, in addition to the at least a part of
20 the uncut region, a portion of the cut region is also removed, the portion being located close to the uncut region.

[Claim 3] The method of manufacturing a processed product according to claim 1 or 2, wherein, in the state before the surface layer removing step is performed,
25 the uncut region has a surface shape curved to be located closer to a center position in a groove width direction than to the opening end of the groove portion toward a bottom portion of the groove portion.

[Claim 4] The method of manufacturing a processed product according to any

one of claims 1 to 3, wherein

in a state after the surface layer removing step is performed and before the workpiece is cut, the surface layer portion includes a boundary portion between the cut region and the uncut region, and

5 when a position of a surface of the surface layer portion in a depth direction of the groove portion is defined as a height,

in the state after the surface layer removing step is performed and before the workpiece is cut, a height of a surface of at least a part of the cut region is higher than a height of a surface of the boundary portion.

10

[Claim 5] The method of manufacturing a processed product according to any one of claims 1 to 4, wherein

in a state after the surface layer removing step is performed and before the workpiece is cut, a portion in which a surface of the cut region and a surface of the uncut region are connected to each other has a shape of a flat surface, and

15

the flat surface is substantially orthogonal to a depth direction of the groove portion.

[Claim 6] The method of manufacturing a processed product according to any one of claims 1 to 5, wherein the surface layer removing step is performed using a laser.

20

[Claim 7] The method of manufacturing a processed product according to any one of claims 1 to 6, wherein the workpiece prepared in the preparing step has the groove portion formed by wet etching.

25

[Claim 8] A method of manufacturing a semiconductor device employing the method of manufacturing a processed product according to any one of claims 1 to 7, the method of manufacturing a semiconductor device comprising:

a resin sealing step of sealing the lead frame and a semiconductor chip with a resin material in a state in which the semiconductor chip is bonded to the lead frame;
a resin removing step of removing the resin material inside the groove portion;
and

5 a cutting step of cutting the lead frame along the groove portion, wherein
as the method of manufacturing a processed product,

the surface layer removing step and the plating step are performed
between the resin removing step and the cutting step,

10 the surface layer removing step and the plating step are performed
before the resin sealing step, or

the surface layer removing step is performed before the resin sealing
step, and the plating step is performed between the resin removing step and the cutting
step.

15 [Claim 9] A processed product manufacturing apparatus that performs
processing on a workpiece including at least a lead frame having a groove portion
formed in advance along a position to be cut, the processed product manufacturing
apparatus comprising:

20 a surface layer removing unit that, in a state in which the workpiece is not cut,
partially removes a surface layer portion forming the groove portion in the workpiece;
and

a plating treatment unit that, in the state in which the workpiece is not cut,
performs a plating treatment on the workpiece from which the surface layer portion is
partially removed, wherein

25 in a state before the surface layer removing unit partially removes the surface
layer portion, the surface layer portion includes

a cut region to be removed by cutting the workpiece, and

an uncut region located between the cut region and an opening end of
the groove portion, and

the surface layer removing unit removes at least a part of the uncut region.