

METHOD AND APPARATUS FOR COMPRESSION-MOLDING LIGHT-EMITTING DEVICE REFLECTOR

FIELD OF TECHNOLOGY

The present invention relates to a method and an apparatus for compression-molding a reflector of a light-emitting device, e.g., LED.

BACKGROUND TECHNOLOGY

An apparatus for transfer-molding a reflector of a surface-mounted light-emitting device, e.g., LED, with a mold resin has been proposed. For example, a low-fluidity resin (e.g., epoxy thermosetting resin) in which large grain fillers, whose grain diameter is 70 μm or less, and small grain fillers, whose grain diameter is 1 μm or less, are mixed, is used as a mold resin for molding the reflector. Therefore, air vents will be closed and unfilled areas will be easily formed, further resin leakage will easily occur if the air vents are widened. By varying the resin flow in a recessed cavity, air traps will be easily formed. To avoid this problem, bosses are formed in a bottom of the recessed cavity so as to reduce a flow rate of the resin, or air vents having different depths are overlapped (see Patent Document 1).

PRIOR ART DOCUMENT

PATENT DOCUMENT

Patent Document 1: Japanese Laid-open Patent
Publication No. 2011-121246

SUMMARY OF THE INVENTION

PROBLEMS TO BE SOLVED BY THE INVENTION

However, in case of using a transfer molding apparatus, molded scraps corresponding to resin paths (e.g., culls, runners) are discarded as disused resin, so a utilization rate of the mold resin must be low. Especially, the resin for molding the reflectors is five times or more as expensive as that for molding packages, so an extraction rate must be lowered.

Further, there is a possibility that resin flash will be formed in LED chip mount areas, thus if a workpiece (e.g., lead frame, plastic substrate) is tightly clamped with a mold, but indentations will be formed and quality of molded products will be lowered.

An object of the present invention is to provide a method and an apparatus for compression-molding a reflector of a light-emitting device, which are capable of solving the above described problems of the prior art, improving a utilization rate of a mold resin and improving quality of molded products without forming resin flash.

MEANS FOR SOLVING THE PROBLEMS

To achieve the object, the present invention has following structures.

The method for compression-molding a light-emitting device reflector, in which a workpiece is clamped by a mold, comprises the steps of: holding a release film on a clamping face of one of dies of the mold including a recessed cavity, which is enclosed by a clamper and which has a bottom part to which a pressing pin capable of moving upward and downward

is provided, by adsorption; supplying a mold resin into the recessed cavity, in which the release film is held, and filling the mold resin around the pressing pin; aligning the workpiece with the recessed cavity and placing the workpiece in contact with the clamber and the pressing pin through the release film; pressing the workpiece onto the other dies and pressing the clamber and the pressing pin onto the workpiece through the release film so as to clamp the workpiece by the one of dies and the other die; and compression-molding the reflector by moving the bottom part of the recessed cavity relative to the workpiece to bring the same closer to the workpiece by further clamping action of the mold.

By employing the above described method, a volume of molded scraps, which are formed by the expensive resin for molding the reflector, can be reduced and a utilization rate of the resin can be improved, and clamping force of the pressing pin can be reduced by moving the bottom part of the recessed cavity relative to the workpiece when the workpiece is compression-molded, so that no indentations are formed in the molded product. In comparison with a transfer molding method, no runners and no gates are formed by the present compression molding method, a step of breaking gates, etc. can be omitted, so that the production process can be simplified, no gates are formed, and no deformation of the workpiece occurs.

Preferably, in the compression-molding step, the surplus resin overflows into an overflow cavity from the recessed cavity when the bottom part of the recessed cavity is moved relative to the workpiece to bring the same closer to the workpiece.

By employing this step, insufficiently-filling the mold resin into the recessed cavity can be prevented, and the air can be discharged via the overflow cavity even if air is entrapped into the mold resin, so that molding quality can be improved.

In the method, the pressing pin may be pressed onto the workpiece, by actuating a drive source, when the mold clamps the workpiece, and the drive source may be actuated by further clamping action so as to evacuate the pressing pin in a state where the pressing pin contacts the workpiece.

With this method, the clamping force of the pressing pin applied to the workpiece can be adjusted so as not to apply excessive force, and forming resin flash in a light-emitting element mount area can be prevented.

In the method, the pressing pin may be pressed onto the workpiece together with the clasper when the mold clamps the workpiece, and the pressing pin may be evacuated, in a state where the pressing pin and the clasper contact the workpiece, by further clamping action.

With this method, upward and downward movements of the clasper and the pressing pin can be linked by the simple structure, and no dedicated drive sources are required, so that the structure of the molding apparatus can be simplified.

The method may further comprise the step of supplying the resin into the recessed cavity of a lower die, in which the release film is held, aligning a lead frame, and placing the lead frame in contact with the clasper and the pressing pin through the release film.

By this step, the mold resin and the lead frame, which is the workpiece, can be easily supplied to the lower die, and the

structure of the mold including an upper die can be simplified.

The compression molding apparatus for compression-molding a light-emitting device reflector, in which a workpiece is clamped by a mold, comprises: the mold having a pair of molding dies, the one of molding dies including a recessed cavity, which is enclosed by a clamber and has a bottom part to which a pressing pin capable of moving upward and downward is provided, and the other molding die clamping the workpiece, which is aligned with the recessed cavity and placed, with the one of molding dies; a release film being held on a clamping face of the one of molding dies including the recessed cavity by adsorption; and a pressing pin actuating section for pressing the clamber and the pressing pin onto the workpiece through the release film when the mold clamps the workpiece and evacuating the pressing pin, in a state where the pressing pin contacts the workpiece, relative to the bottom part of the recessed cavity, by further clamping action of the mold.

By employing this apparatus, the volume of the molded scraps, which are formed by the expensive resin for molding the reflector, can be reduced and the utilization rate of the resin can be improved, and the clamping force of the pressing pin can be reduced by moving the bottom part of the recessed cavity relative to the workpiece when the workpiece is compression-molded, so that no indentations are formed in the molded product. In comparison with the transfer molding method, no runners and no gates are required, so that no mold resin sticks on the molded product. Therefore, leftovers of gates, which are formed by a gate-breaking step, are not

formed, and no deformation of the workpiece occurs.

Preferably, an overflow cavity which is communicated with the recessed cavity is formed in the other molding die. With this structure, insufficiently-filling the mold resin into the recessed cavity can be prevented, and the air can be discharged through the overflow cavity even if air is entrapped into the mold resin, so that molding quality can be improved.

In the compression molding apparatus, the pressing pin may be supported by a wedge-shaped block which is slid by a drive source, the wedge-shaped block may be slid in a prescribed direction, by actuating the drive source, when the mold clamps the workpiece, so as to press the pressing pin onto the workpiece, and the wedge-shaped block may be slid in the opposite direction, by further clamping action for actuating the drive source, so as to evacuate the pressing pin, in a state where the pressing pin contacts the workpiece. With this structure, the clamping force of the pressing pin applied to the workpiece can be adjusted so as not to apply excessive force, and forming flash in the light-emitting element mount area can be prevented.

In the compression molding apparatus, the pressing pin and the clamper may be floating-supported by a coil spring, the pressing pin may be pressed onto the workpiece together with the clamper when the mold clamps the workpiece, and the pressing pin may be evacuated, in a state where the pressing pin contacts the workpiece, together with the clamper, by further clamping action for compressing the coil spring.

With this structure, upward and downward movements of the clamper and the pressing pin can be linked by the simple

structure, no dedicated drive sources are required, so that the structure of the apparatus can be simplified.

In the compression molding apparatus, the release film may be held on a clamping face of a lower molding die, including the recessed cavity, by adsorption, and a lead frame may be aligned with the recessed cavity and placed in contact with the clamper and the pressing pin through the release film. With this structure, the lead frame can be easily supplied to the lower die, and the structure of the mold including the upper die can be simplified.

In the molded product having the light-emitting device reflector which is resin-molded by the above described method or in the above described apparatus, no disused resin sticks onto the molded product, and no deformation of the molded product occurs, so that molding quality can be improved, and the following production steps, e.g., die-bonding a light-emitting element, forming a lens unit, dicing, can be simplified.

EFFECTS OF THE INVENTION

In the above described method and apparatus for compression-molding a reflector of a light-emitting device, the utilization rate of the mold resin can be improved and the molding quality can be improved such that no resin flash is formed.

BRIEF DESCRIPTION OF THE DRAWINGS

[Fig. 1] is a sectional explanation view of a compression molding apparatus of a first embodiment.

[Fig. 2] is a sectional explanation view of a compression molding apparatus of a second embodiment.

[Fig. 3] Figs. 3A-3E are explanation views of a lower die shown in Fig. 2.

[Fig. 4] Figs. 4A and 4B are a plan view of the lower die and a sectional explanation view of a mold, which show a molding process of a compression molding method.

[Fig. 5] Figs. 5A and 5B are a plan view of the lower die and a sectional explanation view of the mold, which show a molding process following the process shown in Figs. 4A and 4B.

[Fig. 6] Figs. 6A and 6B are a plan view of the lower die and a sectional explanation view of the mold, which show a molding process following the process shown in Figs. 5A and 5B.

[Fig. 7] Figs. 7A and 7B are a plan view of the lower die and a sectional explanation view of the mold, which show a molding process following the process shown in Figs. 6A and 6B.

[Fig. 8] Figs. 8A and 8B are a plan view of the lower die and a sectional explanation view of the mold, which show a molding process following the process shown in Figs. 7A and 7B.

[Fig. 9] Figs. 9A and 9B are a plan view of a lower die and a sectional explanation view of another mold.

[Fig. 10] Figs. 10A and 10B are a plan view and a side view of a lead frame.

[Fig. 11] Figs. 11A and 11B are a plan view and a side view of the compression-molded lead frame.

[Fig. 12] Figs. 12A-12C are a sectional view, a plan view and a right side view of an LED device (light-emitting device).

EMBODIMENTS OF THE INVENTION

Preferred embodiments of the present invention will now be described in detail with reference to the accompanying drawings.

Firstly, a schematic structure of a light-emitting device (LED device) will be explained with reference to Figs. 12A-12C.

A surface-mounted light-emitting device includes: a light-emitting element 1; a lead section 2 on which the light-emitting element 1 is mounted; a reflector 3 for preventing diffusion of a light irradiated from the light-emitting element 1; and a lens unit 4 covering the light-emitting element 1. The reflector 3 is integrally molded with a first lead 2a, on which the light-emitting element 1 is mounted, and a second lead 2b, which is electrically connected to the light-emitting element 1.

The light-emitting element 1 has a pair of electrodes, i.e., a positive electrode and a negative electrode, which are provided on the same side. In the following description, the positive and negative electrodes are provided on the same side, but they may be formed on the upper side and the lower side of the light-emitting element 1. In this case, the electrode on the lower side of the light-emitting element is connected to the first lead 2a, without using a wire, by an electrically-conductive die-bonding member.

The first lead 2a has an inner lead part and an outer lead

part, which are continuously formed. The light-emitting element 1 is die-bonded on the inner lead part. The light-emitting element 1 is connected to inner lead parts of the first and second leads 2a and 2b, by wire bonding with wires 5.

Note that, an insulation member 6 is provided to a part on the rear side, in which the first lead 2a and the second lead 2b (the inner lead parts) are located close to each other, so as to prevent short circuit between the first lead 2a and the second lead 2b. Further, in the present embodiment, number of the leads of the light-emitting device is two, but it may be three or more.

The reflector 3 is erected on the outer lead parts of the first and second leads 2a and 2b. A concave part of the reflector 3 is located on the outer lead parts. As will be described later, the reflector 3 is formed by compression molding with a thermosetting resin (e.g., epoxy resin, modified epoxy resin, silicone resin, modified silicone resin). An opening part of the reflector 3 is inclined so as to make an upper ends wider than a lower end. Preferably, the inclination angle with respect to a surface of the lead is 95-150 degrees, more preferably 100-120 degrees.

The lens unit 4 covers the light-emitting element 1 and fills the concave part of the reflector 3. The lens unit 4 is composed of a thermosetting resin (e.g., epoxy resin, modified epoxy resin, silicone resin, modified silicone resin) including a fluorescent substance (e.g., at least one substance selected from the group comprising: nitride phosphor mainly activated by a lanthanoid such as Eu and Ce; oxynitride phosphor; sialon phosphor; lanthanoid phosphor such as Eu; alkaline-earth

halogen apatite phosphor mainly activated by a transitional metal element such as Mn; alkaline-earth metal borate halogen phosphor; alkaline-earth metal aluminate phosphor; alkaline-earth silicate phosphor; alkaline-earth sulfide phosphor; alkaline-earth thiogallate phosphor; alkaline-earth silicon phosphor; germenate phosphor; rare-earth aluminate phosphor mainly activated by a lanthanoid such as Ce; and organic phosphor including organic complex mainly activated by rare-earth silicate or a lanthanoid element such as Eu). A specific gravity of the fluorescent substance is greater than the thermosetting resin, so the fluorescent substance settles in a bottom of the concave part (on the surfaces of the leads). The thermosetting resin may include at least one substance selected from the group comprising: filler; diffusing agent; colorant; fluorescent substance; and reflexible substance, so as to obtain heat resistance, weather resistance and light resistance. The reflector 3 and the lens unit 4 are composed of the thermosetting resin, and their physical characteristics are similar, so that they can be suitably bonded to each other.

Successively, an apparatus for compression molding the light-emitting device reflector will be explained.

The compression molding apparatus clamps a workpiece W with a mold and compression-molds the reflector 3. As shown in Figs. 10A and 10B, the workpiece W is a lead frame 7 having rows and columns of the lead sections 2. In each of the lead sections 2, the first lead 2a and the second lead 2b are faced each other with a gap. The workpiece W is not limited to the lead frame 7, so it may be, for example, a plastic substrate on which cable patterns are formed.

The compression molding apparatus will be explained with reference to Fig. 1.

A mold 8 includes a lower die 9 (one of dies) and an upper die 10 (the other die), which clamp the workpiece W by closing the mold. In the following description, the lower die 9 is a movable die, and the upper die 10 is a fixed die. Opening and closing the mold is performed by a publicly known open-close mechanism, e.g., toggle link, ball bearing screw driven by a drive source (e.g., electric motor).

In the lower die 9, a lower supporting block 12 is fixed on a lower base 11. A lower cavity block 13 is supported by the lower supporting block 12. A clamber block 14, which encloses the lower cavity block 13, is floating-supported, on the lower supporting block 12, by coil springs 15. A recessed cavity 16 is formed by an upper face of the lower cavity block 13 and chamfered inner side faces of the clamber block 14.

In the recessed cavity 16, pressing pins 17 are pierced through the lower supporting block 12 and the lower cavity block 13, so that the pressing pins can be moved upward and downward. The pressing pins 17 are erected on a pin supporting block 18. A planar shape of each of the pressing pins 17 is a circular shape, but it is not limited and it may be a rectangular shape. An upper end part of each of the pressing pins 17 is wedge-shaped. The taper angle corresponds to the inclination angle of the opening part of the reflector 3, so an upper end of the part is narrower than a lower end thereof. The pin supporting block 18 contacts a wedge-shaped block 19 provided on the lower base 11 in a state where their wedge-shaped faces contact each other. The pin supporting

block 18 and the wedge-shaped block 19 are accommodated in a space formed between the lower supporting block 12 and the lower base 11. The wedge-shaped block 19 can be slid on the lower base 11 by an actuator 20 (e.g., motor, cylinder unit). With this structure, the pin supporting block 18 is relatively slid along the wedge-shaped face of the wedge-shaped block, so that the pressing pins 17 can be moved upward and downward (a pressing pin actuating section).

A clamping face of the lower die including the recessed cavity 16, in which the pressing pins 17 are provided, is covered with a release film 21. The release film 21 is held by sucking air through a sucking path, which is a gap between the lower cavity block 13 and the clamber block 14 enclosing the lower cavity block. The release film 21 has enough heat resistance, and it is easily peelable from the surface of the mold and composed of a soft and extensible material, e.g., PTFE film, ETEF film, PET film, FEP film, fluorine-impregnated glass cloth, polypropylene film, polychlorinated vinylidene.

In the upper die 10, an upper chase block 23 and an upper insert block 24 are vertically stacked and held by an upper base 22. Air suction holes 24a are opened in a clamping face of the upper insert block 24. When the mold 8 clamps the lead frame 7, air in the recessed cavity 16 is sucked through the air suction holes 24a so as to perform decompression chamber. In the present embodiment, the lead frame 7 is set, on the upper die 10, by air suction, but the manner of setting the lead frame is not limited, so a lead frame clamber may be provided to the upper die 10. Further, the lead frame 7 need not be set on the

upper die 10, so the lead frame 7 may be set on the lower die 9.

A mold resin is supplied into the recessed cavity 16 of the lower die 9, in which the release film 21 has been held, and the lead frame 7 is mounted, then the lower die 9 is moved toward the upper die 10 so as to close the mold and perform the compression molding. When the mold 8 clamps the lead frame 7, the clamber block 14 is pressed onto the lead frame 7 and the pressing pins 17 are pressed onto light-emitting element mount surfaces (the lead sections 2) of the lead frame 7.

By further clamping action of the mold 8, pressing force of the clamber block 14 is increased, but excessive pressing force is released by compression of the coil springs 15; the excessive pressing force of the pressing pins 17 is released by driving the actuator 20 so as to slide the wedge-shaped block 19 on the lower base 11 and move the pin supporting block 18 downward

By employing the above described compression molding apparatus, a volume of molded scraps, which are formed by the expensive resin for molding the reflectors, can be highly reduced and a utilization rate of the mold resin can be improved, further the excessive clamping force applied to the workpiece (the lead frame 7) can be released by moving the bottom part of the recessed cavity 16 relative to the workpiece when the workpiece is compression-molded, so that no indentations are formed in the molded products. In comparison with the conventional transfer molding method, no runners and no gates are formed by the present compression molding method, so that no mold resin sticks on the molded products. Further, leftovers of gates, which are formed by a

gate-breaking step, are not formed, and no deformation of the workpiece occurs.

Overflow cavities 27 (see Figs. 9A and 9B), which are communicated with the recessed cavity 16, may be formed in a clamping face of the clamber block 14 of the lower die 9. With this structure, insufficiently-filling the mold resin into the recessed cavity 16 can be prevented, further even if air is entrapped into the mold resin, the air can be discharged via the overflow cavities 27, so that molding quality can be improved.

The pressing pins 17 are supported by the wedge-shaped block 19 which can be slid by the actuator 20, the actuator 20 is driven so as to move the wedge-shaped block 19 in a prescribed direction and press the pressing pins 17 onto the workpiece when the mold 8 clamps the workpiece, and the pressing pins 17 are evacuated, in the state where the pressing pin contacts the workpiece, by further clamping action for actuating the actuator 20 to move the wedge-shaped block 19 in the opposite direction. With this manner, the clamping force of the pressing pins 17 applied to the workpiece can be adjusted so as not to apply the excessive force, and forming flash in mount areas, on which the light-emitting elements 1 are mounted, can be prevented.

Next, another embodiment of the compression molding apparatus will be explained with reference to Fig. 2. In the present embodiment, the structure of the upper die 10 of the mold 8 is the same as that of the former embodiment, so the lower die 9 will be mainly explained.

In Fig. 1, the pressing pins 17 and the clamber block 14 are separately driven. On the other hand, in the present

embodiment, the pressing pins 17 and the clamper block 14 are linked and moved upward and downward together.

In Fig. 2, the lower supporting block 12 is fixed on the lower base 11. The lower cavity block 13 is fixed on the lower supporting block 12. The clamper block 14, which encloses the lower cavity block 13, is floating-supported, on the lower supporting block 12, by the coil springs 15.

As shown in Figs. 3A-3C, two pairs of connection plates 25 are arranged in X- and Y-directions and spanned a bottom hole 14a of the clamper block 14. The pressing pins 17 are respectively erected at four intersection points of the connection plates 25. Both ends of each of the connection plates 25 are fixed to the lower end of the clamper block 14 by screws. Further, the pressing pins 17 are fixed to the connection plates 25 by screws (see Fig. 3C).

As shown in Figs. 3D and 3E, grooves (stepped grooves) 13a, which absorb thickness of the connection plates 25 arranged in the cross shape, are formed in the bottom part of the lower cavity block 13, and four through holes 13b, through which the pressing pins 17 are pierced, are formed in the grooves 13a.

In Fig. 2, the pressing pins 17 are floating-supported, together with the clamper block 14, on the lower supporting block 12, by the coil springs 15. When the mold 8 clamps the workpiece (the lead frame 7), the pressing pins 17 and the clamper block 14 are jointly pressed onto the lead frame 7 through the release film 21; the pressing pins 17 and the clamper block 14 are jointly evacuated by further clamping action for compressing the coil springs 15 in a state where the

clamber block 14 and the pressing pins 17 contact the lead frame 7.

With this structure, the upward and downward movements of the clamber block 14 and the pressing pins 17 can be linked by the simple structure, and no dedicated drive sources are required, so that the structure of the apparatus can be simplified.

The method of molding the light-emitting device reflector performed in the above described compression molding apparatuses will be explained with reference to Figs. 4A-11B. Note that, in Figs. 1-3E, four pressing pins are shown for simplifying the explanation, but the pressing pins, which are arranged as five-by-six matrix, are shown in Fig. 4A and the following drawings.

As shown in Fig. 4A, the pressing pins 17 are pierced through the lower cavity block 13 and projected into the recessed cavity 16. As shown in Fig. 4B, the recessed cavity 16 is enclosed by the clamber block 14 and the pressing pins 17 can be moved upward and downward with respect to the bottom part of the recessed cavity, and the release film 21 is held, by adsorption, on the lower die 9, so as to cover the lower clamping face including the recessed cavity 16, when the mold 8 is opened.

As shown in Fig. 5A, air suction holes 13c are formed around each of the through holes 13b of the lower cavity block 13, through which the pressing pin 17 is pierced. As shown in Fig. 5B, in the recessed cavity 16, the release film 21 is held by sucking air through the air suction holes 13c and air suction holes 13d, which are formed between the lower cavity block 13

and the clamper block 14, in a state where the release film covers peripheries of the pressing pins 17.

Next, as shown in Figs. 6A and 6B, the mold resin 26 is supplied into the recessed cavity 16, in which the release film 21 has been held by adsorption, so as to fill the mold resin around the pressing pins 17. As described above, the mold resin 26 is the thermosetting resin (e.g., epoxy resin, modified epoxy resin, silicone resin, modified silicone resin). The mold resin 26 may be tablet resin, granular resin, powder resin, liquid resin, sheet-shaped resin, etc.

Next, as shown in Figs. 7A and 7B, the lead frame 7 is correctly positioned, in the recessed cavity 16 of the lower die 9, in contact with the clamper block 14 and the pressing pins 17 through the release film 21. The lead frame 7 is placed in a state where the pressing pins 17 contact the inner lead parts of the lead sections 2 (the first leads 2a and the second leads 2b).

As shown in Fig. 8B, the lower die 9 is moved upward by a known open-close mechanism, not shown, so as to bring the lead frame 7, which has been placed on the lower clamping face, into contact with the upper die 10 and clamp the lead frame. By further clamping the lead frame 7 with the mold 8, the bottom part of the recessed cavity 16 (the lower cavity block 13) is relatively moved close to the lead frame 7 so as to compression-mold the reflectors. Fig. 8A is a plan view of the molded lead frame 7. Guide pins (not shown) of the lower die 9 are fitted into guide pin holes 7a so as to correctly position the lead frame on the lower die.

In the compression molding apparatus shown in Fig. 1, the pressing pins 17 and the clamper block 14 are pressed onto

the lead frame 7 through the release film 21 when the mold 8 clamps the work (lead frame 7). When the compression molding is performed, the mold 8 further clamps, but the excessive pressing force of the clamber block 14 is released by compressing the coil springs 15 and the excessive pressing force of the pressing pins 17 is released by actuating the actuator 20 to slide the wedge-shaped block 19 on the lower base 11 and move the pin supporting block 18 downward.

In the compression molding apparatus shown in Fig. 2, when the compression molding is performed, the coil springs 15 are compressed, in the state where the clamber block 14 and the pressing pins 17 contact the lead frame 7, and the pressing pins 17 are evacuated, together with the clamber block 14, by the further clamping action.

By employing the above described compression molding method, the volume of the molded scraps, which are formed by the expensive mold resin for molding the reflectors, can be highly reduced and the utilization rate of the mold resin can be improved, further the excessive clamping force applied to the workpiece can be released, by relative movement of the bottom part of the recessed cavity, when the workpiece is compression-molded, so that no indentations are formed in the molded workpiece. In comparison with the transfer molding method, no runners and no gates are required, so that no mold resin sticks on the molded products. Therefore, leftovers of gates, which are formed by a gate-breaking step, are not formed, and no deformation of the workpiece occurs.

In the compression molding process, as shown in Fig. 9B, the surplus resin overflows into overflow cavities 27 from the

recessed cavity 16 when the bottom face of the recessed cavity 16 is relatively moved close to the lead frame 7. The overflow cavities 27, which are communicated with the recessed cavity 16, are formed in the clamping face of the clamber block 14. A plurality of the overflow cavities 27 may be formed beside each side of the rectangular recessed cavity 16, or one overflow cavity 27 may be formed beside each side thereof. Fig. 9A is a plan view of the molded lead frame 7.

By the above described compression molding method, insufficiently-filling the mold resin 26 into the recessed cavity 16 can be prevented, further even if air is entrapped into the mold resin 26, the air can be discharged via the overflow cavities 27, so that molding quality can be improved.

In the compression molding apparatus shown in Fig. 1, the pressing pins 17 may be pressed onto the lead frame 7 by actuating the actuator 20 when the mold 8 clamps the lead frame 7, and the pressing pins 17 may be evacuated, in the state where the pressing pins contact the lead frame 7, by the further clamping action for actuating the actuator 20.

With this manner, the clamping force of the pressing pins 17 applied to the lead frame 7 can be adjusted, without applying the excessive force, and forming flash in the light-emitting element mount areas can be prevented.

On the other hand, in the compression molding apparatus shown in Fig. 2, the pressing pins 17 and the clamber block 14 can be jointly pressed onto the lead frame 7 when the mold 8 clamps the lead frame 7, and the pressing pins 17 and the clamber block 14 can be jointly evacuated, in contact with the lead frame 7, by the further clamping action.

With this manner, the upward and downward movements of the clamber 14 and the pressing pins 17 can be linked by the simple structure, no dedicated drive sources are required, so that the structure of the molding apparatus can be simplified.

The molded products, in which the reflectors 3 are formed in the lead frame 7, are shown in Figs. 11A and 11B. The inside of the recessed cavity 16, except the lead sections 2 (the first leads 2a and the second leads 2b) where the pressing pins 17 contacted, is filled with the mold resin 26 so as to produce the molded products.

The surface-mounted light-emitting device shown in Fig. 12A is produced by further steps of: die-bonding the light-emitting elements 1 to the first leads 2a; connecting the first leads 2a and the second leads 2b by wire bonding; molding the light-emitting elements 1 with the thermosetting resin, which forms the lens units 4, by a suitable molding manner (e.g., compression molding, transfer molding); and dicing the molded workpiece.

In the molded products having the reflectors which have been produced by the above described compression molding method, no disused resin sticks onto the molded products, and no deformation of the molded products occur, so that molding quality can be improved, further the following production steps, e.g., die-bonding the light-emitting element, forming the lens unit, dicing, can be simplified.

In the above described embodiments, the mold includes the fixed upper die 10 and the movable lower die 9, but the fixed die and the movable die may be optionally selected. Further, the workpiece is for a so-called MAP-type product,

which can be collectively resin-molded, but the present invention can be applied to a matrix-type workpiece, in which the light-emitting devices (LED devices) are separately resin-molded.

CLAIMS

[Claim 1]

A method for compression-molding a light-emitting device reflector in which a workpiece is clamped by a mold, said method comprising the steps of:

holding a release film on a clamping face of one of dies of the mold including a recessed cavity, which is enclosed by a clamper and which has a bottom part to which a pressing pin capable of moving upward and downward is provided, by adsorption;

supplying a mold resin into the recessed cavity, in which the release film is held, and filling the mold resin around the pressing pin;

aligning the workpiece with the recessed cavity and placing the workpiece in contact with the clamper and the pressing pin through the release film;

pressing the workpiece onto the other die and pressing the clamper and the pressing pin onto the workpiece through the release film so as to clamp the workpiece by the one of dies and the other die; and compression-molding the reflector by moving the bottom part of the recessed cavity relative to the workpiece to bring the same closer to the workpiece by further clamping action of the mold.

[Claim 2]

The method for compression-molding a light-emitting device reflector according to claim 1, wherein, in said compression-molding step, the surplus resin overflows into an

overflow cavity from the recessed cavity when the bottom part of the recessed cavity is moved relative to the workpiece to bring the same closer to the workpiece.

[Claim 3]

The method for compression-molding a light-emitting device reflector according to claim 1 or 2, wherein the pressing pin is pressed onto the workpiece, by actuating a drive source, when the mold clamps the workpiece, and the drive source is actuated by further clamping action so as to evacuate the pressing pin in a state where the pressing pin contacts the workpiece.

[Claim 4]

The method for compression-molding a light-emitting device reflector according to claim 1 or 2, wherein the pressing pin is pressed onto the workpiece together with the clamber when the mold clamps the workpiece, and the pressing pin is evacuated, in a state where the pressing pin and the clamber contact the workpiece, by further clamping action.

[Claim 5]

The method for compression-molding a light-emitting device reflector according to any one of claims 1-4, further comprising the step of supplying the resin into the recessed cavity of a lower die, in which the release film is held, aligning a lead section of a lead frame, which is formed and exposed in a light-emitting element mount area, with the pressing pin, and placing the lead frame in contact with the clamber and the

pressing pin through the release film.

[Claim 6]

A compression molding apparatus for compression-molding a light-emitting device reflector in which a workpiece is clamped by a mold, said apparatus comprising:

the mold having a pair of molding dies, the one of molding dies including a recessed cavity, which is enclosed by a clamber and has a bottom part to which a pressing pin capable of moving upward and downward is provided, and the other molding die clamping the workpiece, which is aligned with the recessed cavity and placed, with the one of molding dies;

a release film being held on a clamping face of the one of molding dies including the recessed cavity by adsorption; and

a pressing pin actuating section for pressing the clamber and the pressing pin onto the workpiece through the release film when the mold clamps the workpiece and evacuating the pressing pin, in a state where the pressing pin contacts the workpiece, relative to the bottom part of the recessed cavity, by further clamping action of the mold.

[Claim 7]

The compression molding apparatus for compression-molding a light-emitting device reflector according to claim 6, wherein an overflow cavity which is communicated with the recessed cavity is formed in the other molding die.

[Claim 8]

The compression molding apparatus for compression-molding a light-emitting device reflector according to claim 6 or 7, wherein the pressing pin is supported by a wedge-shaped block which is slid by a drive source, the wedge-shaped block is slid in a prescribed direction, by actuating the drive source, when the mold clamps the workpiece, so as to press the pressing pin onto the workpiece, and the wedge-shaped block is slid in the opposite direction, by further clamping action for actuating the drive source, so as to evacuate the pressing pin, in a state where the pressing pin contacts the workpiece.

[Claim 9]

The compression molding apparatus for compression-molding a light-emitting device reflector according to claim 6 or 7, wherein the pressing pin and the clamber are floating-supported by a coil spring, the pressing pin is pressed onto the workpiece together with the clamber when the mold clamps the workpiece, and the pressing pin is evacuated, in a state where the pressing pin contacts the workpiece, together with the clamber, by further clamping action for compressing the coil spring.

[Claim 10]

The compression molding apparatus for compression-molding a light-emitting device reflector according to any one of claims 6-9, wherein the release film is held on a clamping face of a lower molding die, including the

recessed cavity, by adsorption, a lead frame is aligned with the recessed cavity, and the lead frame, which includes a lead section formed and exposed in a light-emitting element mount area, is placed in contact with the clamper and the pressing pin through the release film.

[Claim 11]

A molded product having the light-emitting device reflector and being produced by said method according to any one of claims 1-5 or in said apparatus according to any one of claims 6-10.