

DESCRIPTION

Method of Compression Molding for Electronic Part and Apparatus Therefor

5 TECHNICAL FIELD

The present invention relates to a method of compression molding for an electronic part such as an IC (Integrated Circuit) and an apparatus employed therefor.

BACKGROUND ART

10 In general, an electronic part 83 mounted on a substrate 82 is compression-molded with a mold assembly 81 and granular resin 84 in the following manner:

First, mold assembly 81 having an upper mold section 85 and a lower mold section 86 for compression-molding the electronic part is prepared. A cavity 87 is provided on lower mold section 86. Then, cavity 87 is covered with a mold release film 88. Then, granular resin 84 is fed into cavity 87. Thereafter granular resin 84 is heated. Thus, granular resin 84 melts. Then, upper mold section 85 and lower mold section 86 are closed. Thus, electronic part 83 mounted on substrate 82 is dipped in the melting resin in cavity 87. Consequently, electronic part 83 is sealed with a resin-molded body corresponding to the shape of cavity 87. Thus, the compression molding is completed.

20 In the aforementioned compression-molding method, a feeding mechanism 89 is employed for feeding granular resin 84 into cavity 87. Feeding mechanism 89 includes a shutter 90, as shown in Fig. 7. Further, feeding mechanism 89 includes a through-hole 91 having prescribed amount of granular resin 84. In use, feeding mechanism 89 is first inserted into the space between upper mold section 85 and lower mold section 86. Then, shutter 90 of feeding mechanism 89 is opened. Thus, granular resin 84 falls into cavity 87 from through-hole 91.

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DISCLOSURE OF THE INVENTION

PROBLEMS TO BE SOLVED BY THE INVENTION

In the aforementioned compression molding, part 92 of granular resin 84 may remain in through-hole 91 of feeding mechanism 89 when granular resin 84 is dropped into cavity 87 from through-hole 91 by opening shutter 90 of feeding mechanism 89.

5 Thus, insufficiency is easily caused in the amount of the resin fed into cavity 87. Therefore, such a problem arises that the reliability of the amount of the resin fed into cavity 87 is inferior. This problem also arises when another resin material such as powdery resin, powdered resin or liquid resin is employed in place of the granular resin.

10 An object of the present invention is to provide a method of compression molding for an electronic part improved in reliability of the amount of a resin material fed into a cavity.

MEANS FOR SOLVING THE PROBLEMS

15 In the method of compression molding for an electronic part according to the present invention, a mold assembly including a lower mold section having a cavity is prepared. Then, a plate including a resin accommodation space having an opening corresponding to the cavity is prepared. A resin material is fed into the resin accommodation space. A mold release film is placed on the plate to cover the resin accommodation space. Movement of the resin material is suppressed by the mold release film by sucking the mold release film toward the plate. Thereafter the plate is
20 reversed. Then, the plate is moved to a position above the cavity. The pressure state in the resin accommodation space is so changed that the cavity is covered with the mold release film. At this time, the resin material falls into the cavity covered with the mold release film from the resin accommodation space.

BRIEF DESCRIPTION OF THE DRAWINGS

25 Fig. 1 is a perspective view schematically showing a plate for accommodating resin employed in a method of compression molding for an electronic part according to Example 1 and a mechanism feeding the resin material, showing a state of feeding the resin material to the plate.

Fig. 2 is a sectional view schematically showing the plate according to Example 1, showing a state where the plate into which the resin material is introduced is covered with a mold release film.

5 Fig. 3 is a sectional view schematically showing the plate according to Example 1, showing a state where the plate covered with the mold release film shown in Fig. 2 is reversed.

Fig. 4 is a sectional view schematically showing a mold assembly according to Example 1, showing a state where the plate shown in Fig. 3 is transferred to the mold assembly.

10 Fig. 5 is a sectional view schematically showing the mold assembly according to Example 1, showing a state immediately after the resin material falls into the cavity from a through-hole of the plate.

Fig. 6 is a sectional view schematically showing the mold assembly according to Example 1, showing a state where the mold assembly is closed.

15 Fig. 7 is a longitudinal sectional view schematically showing a mold assembly employed in a conventional method of compression molding for an electronic part.

Fig. 8 shows a state immediately before a mold release film is held by a frame in a method of compression molding for an electronic part according to Example 2.

20 Fig. 9 shows a state immediately after a resin material is introduced into a resin accommodation state of a plate in the method of compression molding for an electronic part according to Example 2.

Fig. 10 shows a state where an opening of the plate is closed with the mold release film held by the frame in the method of compression molding for an electronic part according to Example 2.

25 Fig. 11 shows a state where the mold release film held by the frame is in close contact with granular resin in the method of compression molding for an electronic part according to Example 2.

Fig. 12 shows a state where the plate covered with the mold release film by

adsorption is set on an inloader in the method of compression molding for an electronic part according to Example 2.

5 Fig. 13 shows a state where the plate mounted on the inloader is placed on a lower mold section in a state where the mold release film is interposed in a state where the mold assembly is opened in the method of compression molding for an electronic part for an electronic part according to Example 2.

10 Fig. 14 shows a state immediately after the resin material is fed to a cavity of the lower mold section from the resin accommodation space of the plate in the method of compression molding for an electronic part for an electronic part according to Example 2.

Fig. 15 shows a state of vibrating the plate after the resin material is fed to the lower mold section from the plate in the method of compression molding for an electronic part for an electronic part according to Example 2.

15 Fig. 16 shows a state where the mold assembly is closed in the method of compression molding for an electronic part for an electronic part according to Example 2.

Fig. 17 is a plan view schematically showing a preheating mechanism employed for illustrating a method of compression molding for an electronic part according to an embodiment.

20 Fig. 18 shows a state where a preheating mechanism is used in a method of compression molding for an electronic part for an electronic part according to Example 3.

25 Fig. 19 shows a state where a preliminarily heated resin material is set in a frame on a mold release film in the method of compression molding for an electronic part for an electronic part according to Example 3.

Fig. 20 shows a state where a resin material having a uniform thickness remains on the mold release film in the method of compression molding for an electronic part for an electronic part according to Example 3.

Fig. 21 shows a mold assembly employed in a method of compression molding for an electronic part according to another example.

5 Fig. 22 is a sectional view showing a mold assembly employed in another conventional method of compression molding for an electronic part, showing a state immediately after a resin material is fed to a cavity.

Fig. 23 is a sectional view schematically showing a molding mechanism according to Example 4, showing a state immediately before a recess is formed on a mold release film.

10 Fig. 24 is a sectional view schematically showing the molding mechanism according to Example 4, showing a state where the recess is formed on the mold release film.

Fig. 25 is a sectional view schematically showing the molding mechanism according to Example 4, showing a state immediately after the recess is formed on the mold release film.

15 Fig. 26 is a sectional view schematically showing a mechanism introducing a resin material in a compression molding apparatus for an electronic part according to Example 4.

20 Fig. 27 is a sectional view schematically showing a mechanism flattening the resin material by vibration in the compression molding apparatus for an electronic part according to Example 4.

Fig. 28 is a sectional view schematically showing Roots flattening the resin material by pressing in the compression molding apparatus for an electronic part according to Example 4.

25 Fig. 29 shows a state immediately before an inloader adsorbs the mold release film having the flattened granular resin in the recess in the compression molding apparatus for an electronic part according to Example 4.

Fig. 30 shows a state immediately after the inloader adsorbs the mold release film having the flattened granular resin in the recess in the compression molding

apparatus for an electronic part according to Example 4.

Fig. 31 shows a state where the inloader is arranged on a position above a cavity in the compression molding apparatus for an electronic part according to Example 4.

5 Fig. 32 shows a state where the recess of the mold release film adsorbed to the inloader is inserted into the cavity in the compression molding apparatus for an electronic part according to Example 4.

Fig. 33 shows a state where a mold assembly according to Example 4 is opened.

Fig. 34 shows a state where the mold assembly according to Example 4 is closed.

10 Fig. 35 shows a state where an inloader is arranged on a position above a cavity in a compression molding apparatus for an electronic part according to Example 5.

Fig. 36 shows a state where a recess of a mold release film adsorbed to the inloader is inserted into the cavity in the compression molding apparatus for an electronic part according to Example 5.

15 Fig. 37 shows a state where an inloader is arranged on a position above a cavity in a compression molding apparatus for an electronic part according to Example 6.

Fig. 38 shows a state where a recess of a mold release film adsorbed to the inloader is inserted into the cavity in the compression molding apparatus for an electronic part according to Example 6.

20 Fig. 39 shows a procedure of assembling a feeding mechanism in a compression molding apparatus for an electronic part according to Example 7.

Fig. 40 shows a state where an introduction mechanism introduces a resin material into a through-hole of a plate in the compression molding apparatus for an electronic part according to Example 7.

25 Fig. 41 shows a flattened resin material in the through-hole of the plate in the compression molding apparatus for an electronic part according to Example 7.

Fig. 42 shows a state immediately before an inloader adsorbs a mold release film having a planar shape, i.e., a mold release film having no recess in the compression molding apparatus for an electronic part according to Example 7.

Fig. 43 shows a state where the inloader adsorbs the mold release film having the planar shape in the compression molding apparatus for an electronic part according to Example 7.

5 Fig. 44 shows a state where the inloader moves the mold release film having the planar shape while holding the same by adsorption in the compression molding apparatus for an electronic part according to Example 7.

Fig. 45 shows a state where the inloader is arranged on a position above the cavity in the compression molding apparatus for an electronic part according to Example 7.

10 Fig. 46 shows a state where the mold release film having the planar shape adsorbed by the inloader is inserted into the cavity in the compression molding apparatus for an electronic part according to Example 7.

Fig. 47 shows a state immediately after a feeding mechanism feeds the resin material into the cavity in the conventional compression molding apparatus for an electronic part.

DESCRIPTION OF THE REFERENCE SIGNS

1 mold assembly, 2 upper mold section, 3 lower mold section, 4 substrate set portion, 5 cavity, 6 granular resin, 7 electronic part, 8 substrate, 9 inloader, 9a stop portion, 9b substrate receiving portion, 10 opening, 11 mold release film, 20 12 resin compact, 21 plate, 22 resin accommodation space, 23 opening, 24 peripheral portion, 25 plate, 31 feeding mechanism, 31a delivery mechanism, 31b receiving mechanism, 32 introduction mechanism, 33 feeder measuring mechanism, 34 hopper, 35 linear vibration feeder, 36 plate measuring mechanism, 1001 mold assembly (apparatus), 1002 upper mold section, 1003 lower mold section, 1004 25 electronic part, 1005 substrate, 1006 substrate set portion, 1007 opening, 1008 cavity, 1009 pressing member (cavity bottom surface member), 1010 granular resin, 1011 resin compact, 1012 mold release film, 1013 inloader (feeding mechanism), 1014 moving mechanism, 1015 rod, 1016 air cylinder, 1017 moving mechanism,

1018 rod, 1019 air cylinder, 1021 frame, 1021a upper frame portion, 1021b lower frame portion, 1022 film-holding frame, 1023 stopper, 1025 body, 1026 attachable/detachable base, 1027 substrate receiving portion, 1028 set portion, 1029 base portion, 1031 plate, 1032 resin accommodation space, 1033 opening, 1034 peripheral portion, 1041 feeding mechanism, 1042 measuring/introducing portion, 1043 plate receiving portion, 1050 compression molding apparatus for electronic part, 1051 preheating mechanism, 1052 granular resin, 1053 heating portion, 1054 frame, 1055 mold release film, 1056 heated surface (set surface), 1057 lid member, 1058 heating mechanism, 1059 inloader, 2001 compression molding apparatus for electronic part, 2002 inloader, 2003 upper mold section, 2004 lower mold section, 2005 electronic part, 2006 substrate, 2007 granular resin, 2008 substrate set portion, 2009 opening, 2010 cavity, 2011 bottom surface member, 2012 resin compact, 2013 mold release film, 2014 recess, 2015 recessed film, 2016 flattened resin receiving film, 2021 feeding mechanism (base), 2022 molding mechanism, 2023 introduction mechanism, 2024 die, 2025 punch, 2026 recess, 2027 molding surface, 2028 presser/flattener, 2031 body, 2032 lower surface, 2041 compression molding apparatus for electronic part, 2042 inloader, 2043 through-hole, 2044 body, 2045 lid member, 2046 lower surface, 2047 lower surface, 2051 resin-sealed molding apparatus for electronic part, 2052 inloader, 2053 through-hole, 2054 body, 2055 pressing/flattening mechanism, 2056 lower surface, 2057 film fixture, 2058 pressing/flattening member, 2059 elastic member, 2060 resin release layer, 2061 compression molding apparatus for electronic part, 2062 feeding mechanism (base), 2063 inloader, 2064 film receiving member, 2065 frame, 2066 through-hole, 2067 plate, 2068 resin accommodation space, 2069 opening, 2070 peripheral portion, 2071 film-holding plate, S interval.

BEST MODES FOR CARRYING OUT THE INVENTION

Compression molding methods for electronic parts according to embodiments of the present invention and apparatuses employed therefor are now described.

Example 1

A compression molding method for an electronic part according to Example 1 of the present invention and an apparatus employed therefor are now described with reference to the drawings.

5 (As to Apparatus including Mold Assembly for Compression-Molding Electronic Part)

First, an apparatus including a mold assembly employed in the method of compression molding for an electronic part according to the present invention is described.

10 As shown in Figs. 4 to 6, a mold assembly 1 includes a fixed upper mold section 2 and a movable lower mold section 3 opposed to upper mold section 2. A substrate set portion 4 is provided on the molding surface of upper mold section 2. A cavity 5 for compression molding is provided on lower mold section 3.

The compression molding apparatus according to this Example comprises an
15 inloader 9, an outloader (not shown), a heating mechanism (not shown) and a mold clamping mechanism (not shown). Inloader 9 simultaneously or individually feeds granular resin 6 and a substrate 8 (substrate before molding) mounted with an electronic part 7 into the space between upper mold section 2 and lower mold section 3. The outloader unloads substrate 8 compression-molded, i.e., resin-sealed in mold assembly 1
20 from the mold assembly. The heating mechanism heats mold assembly 1 to a prescribed temperature. The mold clamping mechanism closes upper mold section 2 and lower mold section 3 with prescribed pressure.

Electronic part 7 is set on substrate set portion 4 in a downwardly directed state. An opening 10 of cavity 5 is directed toward upper mold section 2. Lower mold
25 section 3 is provided with a suction mechanism for adsorbing a mold release film 11 to cavity 5. The suction mechanism includes a suction hole, a vacuum path and an evacuation mechanism, for example. The suction hole is so provided in lower mold section 3 as to reach the molding surface of lower mold section 3 and the surface of

cavity 5.

Inloader 9 includes a stop portion 9a on a lower portion thereof. Stop portion 9a is a member for stopping a plate 21 for resin accommodation shown in Fig. 2.

Further, inloader 9 includes a substrate receiving portion 9b on an upper portion thereof.

5 Substrate 8 is so placed on substrate receiving portion 9b that electronic part 7 is directed downward.

In the compression molding apparatus according to this Example, mold release film 11 shown in Fig. 2 is employed. The molding surface of lower mold section 3 and the surface of cavity 5 are covered with mold release film 11. Inloader 9 can feed
10 granular resin 6 into cavity 5 covered with mold release film 11. Further, inloader 9 can set substrate 8 mounted with electronic part 7 on substrate set portion 4.

Mold assembly 1 is closed by the mold clamping mechanism with the prescribed pressure. Cavity 5 is heated by the heating mechanism. Resin material 6 melts in cavity 5. Therefore, it follows that electronic part 7 is dipped in melting resin material
15 6. The prescribed pressure is applied to resin material 6 in cavity 5. According to the apparatus of this Example, electronic part 7 is sealed in a resin compact 12 corresponding to the shape of cavity 5. Plate 21 for resin accommodation described with reference to Figs. 1 to 3 is employed as the mechanism feeding granular resin 6 to mold assembly 1.

20 (As to Structure of Plate for Resin Accommodation)

As shown in Figs. 1 to 3, plate 21 for resin accommodation, i.e., a tray includes a resin accommodation space (recess) 22 capable of accommodating prescribed amount of granular resin 6. Resin accommodation space 22 has an opening 23. A peripheral portion 24 is provided around opening 23. Resin accommodation space 22 is a
25 concavity corresponding to cavity 5. Granular resin 6 fed to resin accommodation space 22 has a sheet shape as a whole, and hence the same conforms to the shape of cavity 5 when falling.

When compression molding is executed, prescribed amount of granular resin 6 is

first accommodated in resin accommodation space 22 of plate 21, as shown in Fig. 1. Then, peripheral portion 24 and opening 23 are covered with mold release film 11 having a prescribed size, as shown in Fig. 2. Thus, opening 23 of resin accommodation space 22 accommodating granular resin 6 is closed with mold release film 11.

5 (As to Structure of Evacuation Mechanism in Plate)

Although not shown, an evacuation mechanism is provided on plate 21. The evacuation mechanism forcibly discharges air outward from the inner portion of resin accommodation space 22 closed with mold release film 11. The evacuation mechanism includes a vacuum pump or the like, an on-off valve provided on the body of plate 21 and a vacuum path such as a vacuum tube making the on-off valve and the vacuum pump or the like communicate with each other, for example. The vacuum tube is provided to be attachable to and detachable from the on-off valve.

First, the on-off valve is opened, so that the evacuation mechanism is used. Then, air is forcibly discharged outward from resin accommodation space 22 by the vacuum pump through the vacuum path. Thereafter the on-off valve is closed. Thus, the space in resin accommodation space 22 is set to a prescribed degree of vacuum. Consequently, mold release film 11 covers plate 21 and is fixed. Thus, a plate 25 fed with resin is formed. Thereafter the vacuum tube may be detached from the on-off valve of plate 25. In the present invention, plate 25 fed with the resin is reversed and thereafter inserted into the space between upper mold section 2 and lower mold section 3 as described later, as understood from Figs. 2 and 3.

A large number of suction holes are provided on peripheral portion 24. Air in resin accommodation space 22 is forcibly discharged from the suction holes by the evacuation mechanism. Mold release film 11 may be so adsorbed to peripheral portion 24 that opening 23 of plate 21 is covered with mold release film 11. Covering of plate 21 with mold release film 11 may be implemented by both of evacuation through suction holes extending up to resin accommodation space 22 in plate 21 and evacuation from suction holes passing through peripheral portion 24 and reaching the molding surface.

The evacuation in resin accommodation space 22 of plate 21 or through the suction holes passing through peripheral portion 24 and reaching the molding surface may be continuously executed until reversed plate 25 fed with the resin is inserted into the space between upper mold section 2 and lower mold section 3 as described later.

5 (As to Structure of Feeding Mechanism for Resin Material)

In order to feed prescribed amount of granular resin 6 to plate 21, a feeding mechanism 31 is employed, as shown in Fig. 1. Feeding mechanism 31 can measure granular resin 6. Further, feeding mechanism 31 can feed granular resin 6 to resin accommodation space 22 of plate 21 with a uniform thickness, i.e., by a constant
10 amount of resin per unit area. Feeding mechanism 31 includes a receiving mechanism 31a capable of receiving the granular resin and a delivery mechanism 31b capable of delivering the granular resin.

Receiving mechanism 31a includes an introduction mechanism 32 introducing prescribed amount of granular resin 6 to resin accommodation space 22 of plate 21 and
15 a feeder measuring mechanism (load cell) 33 measuring prescribed amount of granular resin 6 introduced into plate 21. As shown in Fig. 1, introduction mechanism 32 includes a hopper 34 for the granular resin and a linear vibration feeder 35 introducing the granular resin into plate 21 while vibrating and moving the same.

Delivery mechanism 31b includes a plate receiving portion (not shown), a
20 vibration uniformizing mechanism (not shown) and a plate measuring mechanism (load cell) 36. Plate 21 is placed on the plate receiving portion. The vibration uniformizing mechanism vibrates granular resin 6 in resin accommodation space 22 by vibrating plate 21. Thus, granular resin 6 is moved in a direction X and a direction Y. Consequently, the thickness of granular resin 6 is uniformized in resin accommodation space 22.
25 Consequently, prescribed amount of granular resin per unit area is formed. In other words, granular resin 6 is flattened. Plate measuring mechanism 36 measures granular resin 6 to be introduced into plate 21.

Granular resin 6 may be measured by both of a measuring step with feeder

measuring mechanism 33 of receiving mechanism 31a and a measuring step with plate measuring mechanism 36 of receiving mechanism 31b for the resin material.

Alternatively, only one of these measuring steps may be carried out.

5 When granular resin 6 is introduced into resin accommodation space 22 of plate 21 from linear vibration feeder 35, plate 21 may be moved by the plate receiving mechanism.

If irregularities remain in granular resin 6 in resin accommodation space 22 of plate 21, the thickness of granular resin 6 can be uniformized by applying a vibration action to plate 21 or by flattening the irregularities of granular resin 6 with a squeegee.

10 (Method of Compression Molding for Electronic Part)

The method of compression molding for an electronic part according to the present invention is now detailedly described with reference to the drawings.

In the method of compression molding for an electronic part according to the present invention, feeding mechanism 31 first drops granular resin 6 into resin
15 accommodation space 22 of plate 21 from linear vibration feeder 35 while vibrating the same little by little, as shown in Fig. 1. Then, feeding mechanism 31 moves granular resin 6 in resin accommodation space 22 in the direction X or the direction Y while continuously vibrating the same. Thus, granular resin 6 is formed in the constant amount of resin per unit area. Consequently, the thickness of granular resin 6 is
20 uniformized. Granular resin 6 is measured by the respective ones of feeder measuring mechanism 33 and plate measuring mechanism 36 in the state introduced into resin accommodation space 22. Therefore, prescribed amount of granular resin 6 is flatly formed in resin accommodation space 22.

Then, mold release film 11 is placed on plate 21 fed with granular resin 6 to
25 close opening 23, as shown in Fig. 2. Thereafter air is forcibly discharged outward from a space around peripheral portion 24 and resin accommodation space 22 through the suction holes of plate 21 by the evacuation mechanism. Consequently, the degree of vacuum of the space in resin accommodation space 22 is set to the prescribed value.

Thus, opening 23 is covered with mold release film 11, while mold release film 11 comes into close contact with peripheral portion 24. Therefore, plate 21 covered with mold release film 11 and provided with resin material 6 introduced therein, i.e., plate 25 fed with the resin is formed. Movement of resin material 6 is suppressed by mold release film 11 in plate 25.

Then, plate 25 fed with the resin is reversed, as shown in Fig. 3. Thereafter stop portion 9a of inloader 9 stops reversed plate 25. At this time, substrate 8 mounted with electronic part 7 is placed on substrate receiving portion 9b of inloader 9 in the state where electronic part 7 is directed downward.

Then, upper mold section 2 and lower mold section 3 are opened and inloader 9 is inserted into the space therebetween, as shown in Fig. 4. At this time, inloader 9 is arranged on a position above cavity 5. Further, substrate 8 is set on substrate set portion 4 of upper mold section 2 in the state where electronic part 7 is directed downward. Then, plate 25 comes into contact with the molding surface of lower mold section 3 to cover opening 10 of cavity 5. At this time, mold release film 11 comes into close contact with the molding surface of lower mold section 3 to close opening 10 of cavity 5 in the state covering plate 21. The outer peripheral portion of mold release film 11 is adsorbed to the molding surface of lower mold section 3. Thus, the outer peripheral portion of mold release film 11 is held by the molding surface of lower mold section 3 and peripheral portion 24. At this time, opening 10 of cavity 5 and opening 23 of plate 21 are positioned in substantially identical planes.

Then, the on-off valve is so opened that the state of resin accommodation space 22 of plate 25 changes from an atmospheric pressure state to a vacuum state. At this time, air around lower mold section 3 is forcibly discharged outward through the suction holes extending up to the respective ones of the surface of cavity 5 and the molding surface of lower mold section 3 in lower mold section 3. Therefore, mold release film 11 comes into close contact with the molding surface of lower mold section 3 and the surface of cavity 5, as shown in Fig. 5. At this time, a portion of mold release film 11

corresponding to opening 10 of cavity 5 moves into cavity 5. Therefore, the surface of cavity 5 is covered with mold release film 11. In this state, granular resin 6 falls into cavity 5 of the lower position from resin accommodation space 22 of the upper position, and is fed into cavity 5 with which mold release film 11 is in close contact.

5 When resin accommodation space 22 of plate 21 is positioned above cavity 5 as shown in Fig. 5, granular resin 6 is held in the sheet shape having the uniform thickness in resin accommodation space 22. Therefore, all of prescribed amount of granular resin 6 can be fed from resin accommodation space 22 to cavity 5.

10 Then, inloader 9 is unloaded from mold assembly 1. Thereafter mold assembly 1 is closed with the prescribed pressure, as shown in Fig. 6. Thus, the prescribed pressure is applied to the resin in cavity 5. At this time, electronic part 7 mounted on substrate 8 is dipped in the melting resin in cavity 5. Thus, electronic part 7 is sealed with resin compact 12 corresponding to the shape of cavity 5.

15 While a thermosetting resin material is employed in the method of compression molding for an electronic part according to Example, a thermoplastic resin material may be employed in a method of manufacturing an electronic part according to the present invention.

20 While the granular resin is employed in the method of compression molding for an electronic part according to Example, other various shapes such as those of powdery resin having a prescribed particle size distribution or powdered resin may be employed. In the aforementioned Example, liquid resin liquefied in an atmosphere of room temperature and atmospheric pressure may be employed in place of the granular resin.

25 In the method of compression molding for an electronic part according to Example, a silicon-based resin material or an epoxy-based resin material may be employed, for example. In the method of compression molding for an electronic part according to Example, further, various resin materials such as a resin material having transparency, a resin material having semitransparency and a resin material containing a phosphorescent material or a fluorescent material may be employed.

In the method of compression molding for an electronic part according to Example, the step of measuring the resin material may be carried out while feeding the resin material into plate 21 or before feeding the resin material into plate 21.

5 As prior art similar to the prior art described in the above section of the background art, a method of compression-molding, i.e., resin-sealing an electronic part 1103 mounted on a substrate 1102 with granular resin 1104 by employing a compression molding apparatus 1101 for an electronic part is employed, as shown in Fig. 22. This method is carried out as follows:

10 First, compression molding apparatus 1101 for an electronic part is prepared. A mold assembly is loaded on compression molding apparatus 1101. The mold assembly has an upper mold section 1105 and a lower mold section 1106. Lower mold section 1106 is provided with cavity 1107. Then, granular resin 1104 is fed into cavity 1107. Thereafter granular resin 1104 melts by heating.

15 Then, upper mold section 1105 and lower mold section 1106 are closed. Thus, electronic part 1103 is dipped in melting granular resin 1104. At this time, a pressing member 1108 constituting the bottom surface of cavity 1107 applies pressure to granular resin 1104 in cavity 1107. Thus, a resin compact corresponding to the shape of cavity 1107 is formed. Further, electronic part 1103 is encapsulated in the resin compact.

20 As shown in Fig. 22, granular resin 1104 is fed into cavity 1107. At this time, a feeding mechanism 1109 is employed. Feeding mechanism 1109 includes a through-hole 1110 receiving the resin material from an upper opening and a shutter 1111 provided on a lower portion thereof. When feeding mechanism 1109 is inserted into the space between upper mold section 1105 and lower mold section 1106, shutter 1111
25 is pulled. Thus, a lower opening of through-hole 1110 is opened. Therefore, granular resin 1104 falls by the distance from the position of through-hole 1110 to the position of cavity 1107. Consequently, granular resin 1104 is fed to cavity 1107.

In the conventional method of compression molding for an electronic part

described with reference to Fig. 22, granular resin 1104 or powder adhering to granular resin 1104 scatters and thereafter adheres to the molding surface of lower mold section 1106 when granular resin 1104 is fed into cavity 1107. Therefore, foreign matter (hardened matter) 1112 such as a resin residue is easily formed after upper mold section 1105 and lower mold section 1106 are closed.

Therefore, cleaning is required for removing the foreign matter adhering to the molding surface. Further, an inconvenience resulting from foreign matter adhering to the substrate arises. Consequently, such a problem arises that the yield of products is deteriorated. In other words, productivity of the products cannot be improved. In order to solve this problem, employment of the following mold release film is examined:

The mold release film is fed to the mold assembly by a feeding mechanism. The feeding mechanism has a mold release film delivery roller and a mold release film take-up roller. These rollers so rotate that the mold release film is fed to the space between upper mold section 1105 and lower mold section 1106. Thus, the molding surface of lower mold section 1106 and the surface of cavity 1107 are covered with the mold release film. Further, granular resin 1104 is fed to cavity 1107 covered with the mold release film.

However, granular resin 1104 adheres to the mold release film covering the molding surface of lower mold section 1106. Therefore, foreign matter 1112 such as a resin residue easily adheres to substrate 1102. Therefore, the productivity of the products cannot be improved, similarly to the case where no mold release film is employed.

According to the conventional compression molding apparatus for an electronic part described with reference to Fig. 22, shutter 1111 is so pulled that the lower opening of through-hole 1110 is opened. Thus, part of granular resin 1104 may adhere to the inner peripheral surface of through-hole 1110 of feeding mechanism 1109 when granular resin 1104 falls into cavity 1107. Consequently, the amount of the resin material fed to cavity 107 may be insufficient. Therefore, reliability of the amount of the resin fed into

the cavity cannot be improved.

According to the conventional compression molding apparatus for an electronic part described with reference to Fig. 22, further, granular resin 1104 falls up to cavity 1107 from through-hole 1110. At this time, granular resin 1104 scatters due to collision with the surface of cavity 1107, and hence the same is not formed in a uniform thickness in cavity 1107. For example, granular resin 1104 is easily formed in a shape such as a convex shape or an angular shape having a nonuniform thickness. In this case, granular resin 1104 is not uniformly heated in cavity 1107. Therefore, such a defect easily arises that part separated from another part remains in the resin compact.

The aforementioned problem arises also in a case where another resin material such as powdery resin, powdered resin or liquid resin is employed in place of the granular resin.

The invention disclosed in Examples 2 and 3 described below has been proposed in order to solve the problem of the conventional apparatus and method described with reference to Fig. 22, and one object of this invention is to efficiently improve productivity of products. Another object of this invention is to improve reliability of the amount of resin fed into a cavity. Still another object of this invention is to feed granular resin into the cavity with a uniform thickness.

Example 2

A method of compression molding for an electronic part according to Example 2 and an apparatus employed therefor are now described with reference to the drawings.

(As to Structure of Mold Assembly for Compression Molding for Electronic Part)

First, a compression molding apparatus 1001 (hereinafter referred to also as "apparatus 1001") for an electronic part is described with reference to Figs. 14 to 20.

Apparatus 1001 includes a mold assembly, an inloader 1013 and an unloader (not shown). Inloader 1013 feeds a substrate 1005 mounted with an electronic part 1004 before molding and a resin material to the mold assembly. The unloader unloads

the substrate after the molding from the mold assembly. The mold assembly includes an upper mold section 1002 whose position is fixed and a movable lower mold section 1003 opposed to upper mold section 1002. The mold assembly further includes a mechanism (not shown) for heating the resin and another mechanism (not shown) for clamping upper mold section 1002 and lower mold section 1003 with prescribed pressure.

The molding surface of upper mold section 1002 includes a substrate set portion 1006. Substrate 1005 is set on substrate set portion 1006 in a state where electronic part 1004 is directed downward. Lower mold section 1003 includes a cavity 1008. Cavity 1008 has an upwardly directed opening 1007. A member constituting the bottom surface of cavity 1008 can press the resin in cavity 1008 upward. This member is referred to as a pressing member 1009.

Granular resin 1010 as an example of the resin material is fed to cavity 1008 of lower mold section 1003. Upper mold section 1002 and lower mold section 1003 are closed by the mold clamping mechanism with prescribed pressure. Thus, electronic part 1004 is dipped in the resin material melting in cavity 1008 by heating. Granular resin 1010 is molten by a mechanism heating lower mold section 1003. The molten resin in cavity 1008 is pressed by pressing member 1009. Prescribed resin pressure is caused at this time. Finally, electronic part 1004 is sealed in a resin compact 1011 corresponding to the shape of cavity 1008. In other words, the electronic part is compression-molded.

Although not shown, a large number of suction holes communicating with the molding surface of lower mold section 1003 and the surface of cavity 1008 are provided on lower mold section 1003. An evacuation mechanism such as a vacuum pump forcibly discharges air outward from these suction holes. Thus, a mold release film 1012 described later is adsorbed to the molding surface of lower mold section 1003 and the surface of cavity 1008.

Inloader 1013 can feed substrate 1005 to substrate set portion 1006, while

feeding prescribed amount of granular resin 1010 into cavity 1008. The feeding of granular resin 1010 to cavity 1008 by inloader 1013 and the feeding of substrate 1005 to substrate set portion 1006 by inloader 1013 may be simultaneously performed, or separately performed. An outloader (not shown) can unload resin compact 1011 in cavity 1008 and substrate 1005 from the space between upper mold section 1002 and lower mold section 1003.

Lower mold section 1003 includes a frame 1021 for holding the mold release film described later and a moving mechanism 1014 vertically moving frame 1021. Moving mechanism 1014 includes a rod 1015 on whose forward end a stopper 1023 is mountable and an air cylinder (driving mechanism) 1016 vertically moving rod 1015.

(As to Mold Release Film and Frame for Holding Mold Release Film)

Frame 1021 holding mold release film 1012 is now described with reference to Fig. 8.

As shown in Fig. 8, frame 1021 has a through-hole on the inside thereof, and includes an upper frame portion 1021a and a lower frame portion 1021b opposed to upper frame portion 1021a.

Mold release film 1012 is held by upper frame portion 1021a and lower frame portion 1021. Thus, mold release film 1012 is pulled with prescribed force. Frame 1021 holding mold release film 1012 is hereinafter referred to as a film-holding frame 1022. Mold release film 1012 may extend outward from film-holding frame 1022. Film-holding frame 1022 is mounted with stopper 1023 stopping the peripheral edge portion thereof.

Further, stopper 1023 is formed to be attachable to and detachable from the respective ones of a moving mechanism 1017 (forward end of a rod 1018) of inloader 1013 and moving mechanism 1014 (forward end of rod 1015) of lower mold section 1003.

When apparatus 1001 is used, stopper 1023 is transferred from moving mechanism 1017 of inloader 1013 to moving mechanism 1014 of lower mold section

1003. Thus, stopper 1023 and film-holding frame 1022 move downward along rod 1015.

Mold release film 1012 is prepared by cutting a film drawn out from a film in the form of a roll into a prescribed size. Mold release film 1012 is cut into the minimum
5 necessary size corresponding to the size of the molding surface of lower mold section 1003 having cavity 1008. The size of mold release film 1012, which may be a size for completely covering the molding surface of lower mold section 1003, is decided in consideration of the size of the portion held by upper frame portion 1021a and lower frame portion 1021b. Therefore, the size of mold release film 1012 is slightly larger
10 than the size of the molding surface of lower mold section 1003.

In the method of compression molding for an electronic part according to Example 2, therefore, the size of the mold release film necessary for single resin molding can be reduced as compared with such a roll feeding system that a mold release film is delivered from a delivery roller to a mold assembly and taken up by a take-up roller.

15 More specifically, most parts of the mold release film present between the delivery roller and the mold assembly and the mold release film present between the mold assembly and the take-up roller necessary in the roll feeding system become unnecessary. Therefore, the consumption of the mold release film can be reduced.

(As to Plate for Resin Accommodation)

20 Plate 1031 (tray) feeding granular resin 1010 into cavity 1008 is now described with reference to Fig. 9.

Plate 1031 includes a resin accommodation space (recess) 1032 in which prescribed amount of granular resin 1010 is accommodated. Resin accommodation space 1032 has an opening 1033. Plate 1031 has a peripheral portion 1034 enclosing
25 opening 1033.

Prescribed amount of granular resin 1010 is introduced into resin accommodation space 1032 of plate 1031 by a feeding mechanism 1041 described later, as shown in Fig. 9. Granular resin 1010 has a uniform thickness in plate 1031.

Further, granular resin 1010 has shape retention at room temperature in resin accommodation space 1032, to have the uniform thickness. In other words, granular resin 1010 has a sheet shape. However, granular resin 1010 is an aggregate of a large number of granules not welded to each other. Therefore, communication holes are formed between the granules. In other words, granular resin 1010 is spongy. Resin accommodation space 1032 is a recess corresponding to cavity 1008. Therefore, prescribed amount of granular resin 1010 is fed from resin accommodation space 1032 to cavity 1008 while maintaining the state having the uniform thickness, as described later.

When plate 1031 is reversed, granular resin 1010 having the uniform thickness in plate 1031 falls from the position of the molding surface of lower mold section 1003 up to the position of the bottom surface of cavity 1008, as described later. At this time, granular resin 1010 is fed in the state maintaining the uniform thickness. Therefore, granular resin 1010 is molten at a uniform speed from the lower surface toward the upper surface in cavity 1008 as compared with a case where granular resin 1010 has a concave shape in cavity 1008.

Further, air and moisture contained in individual granular resin 1010 itself uniformly and naturally move from the lower surface side to the upper surface side of granular resin 1010 through the communication holes (communication paths) between the granules constituting granular resin 1010. Therefore, resin compact 1011 molded in cavity 1008 can be prevented from formation of voids or the like.

As shown in Fig. 11, peripheral portion 1034 and opening 1033 are covered with mold release film 1012. Thus, resin accommodation space 1032 in which granular resin 1010 is accommodated is closed with mold release film 1012. Mold release film 1012 and film-holding frame 1022 are reversed, and thereafter moved by moving mechanism 1017 provided on inloader 1013, as shown in Fig. 12.

Inloader 1013 can place reversed plate 1031 on lower mold section 1003 so that cavity 1008 and resin accommodation space 1032 are adjacent to each other through

mold release film 1012, as shown in Fig. 13. Further, opening 1033 of reversed plate 1031, mold release film 1012 and opening 1007 of cavity 1008 superpose with each other substantially on the same position, as shown in Fig. 13. In addition, mold release film 1012 enters a state held by lower mold section 1003 and reversed plate 1031.

5 Thus, resin accommodation space 1032 and the space in cavity 1008 form a closed space. The closed space is partitioned by mold release film 1012. Thereafter mold release film 1012 is adsorbed to cavity 1008, to have a shape along the shape of cavity 1008. In other words, mold release film 1012 moves from the position of opening 1003 up to the position of the surface of cavity 1008.

10 Following the movement of mold release film 1012, further, granular resin 1010 falls from resin accommodation space 1032 into cavity 1008. Thus, granular resin 1010 is prevented from scattering outward from resin accommodation space 1032 and cavity 1008. Therefore, granular resin 1010 is prevented from adhering onto the molding surface or the like due to scattering resulting from an impact at the time when
15 the same falls onto the molding surface of lower mold section 1003 or onto substrate 1005. Consequently, foreign matter such as a resin residue is prevented from remaining on the molding surface or the like. Consequently, productivity of products can be improved.

(As to Structure of Evacuation Mechanism)

20 An evacuation mechanism bringing the mold release into close contact with the plate is now described.

 Although not shown, an evacuation mechanism forcibly discharging air outward from resin accommodation space 1032 closed with mold release film 1012 is provided on plate 1031 for resin accommodation. The evacuation mechanism includes a vacuum
25 pump, for example. Resin accommodation space 1032 of plate 1031 is provided with an on-off valve. The on-off valve and the evacuation mechanism communicate with each other through a vacuum path such as a vacuum tube. The on-off valve is attachably and detachably provided on the vacuum tube.

When the on-off valve of plate 1031 is opened, the evacuation mechanism forcibly discharges air outward from resin accommodation space 1032 through the vacuum tube and the on-off valve. When the on-off valve is thereafter closed, resin accommodation space 1032 is set to a prescribed degree of vacuum. Thus, mold release film 1012 covers plate 1031 and is fixed. Then, the vacuum tube may be detached from plate 1031 and the on-off valve.

In the state where opening 1033 of plate 1031 is covered with mold release film 1012, evacuation is performed on resin accommodation space 1032. Thus, resin accommodation space 1032 fed with granular resin 1010 is set to the prescribed degree of vacuum. Consequently, mold release film 1012 comes into close contact with granular resin 1010 in resin accommodation space 1032, as shown in Fig. 11.

Although not shown, a prescribed number of suction holes may be provided on peripheral portion 1034, so that a method of forcibly discharging air around peripheral portion 1034 outward through the suction holes by the evacuation mechanism (including the vacuum tube and the on-off valve) is employed. According to this, opening 1033 of plate 1031 can be closed with mold release film 1012 by adsorbing mold release film 1012 to peripheral portion 1034. Further, both of the method of performing evacuation on resin accommodation space 1032 and the method of performing evacuation through the suction holes provided on peripheral portion 1034 may be employed, in order to adsorb mold release film 1012 to plate 1031. The step of adsorbing mold release film 1012 to plate 1031 by performing evacuation through the suction holes of peripheral portion 1034 may be continuously executed until inloader 1013 advances into the space between upper mold section 1002 and lower mold section 1003. If mold release film 1012 can be fixed to plate 1031 by adsorption so that movement of granular resin 1010 can be suppressed, the suction holes may communicate with only cavity 1008, and may not communicate with the space around peripheral portion 1034.

(As to Structure of Inloader)

Inloader (feeding mechanism for the material before molding) 1013 for feeding granular resin 1010 into cavity 1008 is now described.

Inloader 1013 includes a body 1025 and an attachable/detachable base 1026 attachably and detachably provided on body 1025, as shown in Figs. 11 to 14. Body 1025 includes a substrate receiving portion 1027 receiving substrate 1005 mounted with electronic part 1004. Attachable/detachable base 1026 includes a set portion 1028 on which plate 1031 is set, moving mechanism 1017 vertically moving film-holding frame 1022 and a base portion 1029 on which body 1025 is attachably and detachably provided. Inloader 1013 can feed substrate 1005 mounted with electronic part 1004 and granular resin 1010 to upper mold section 1002 and lower mold section 1003.

Moving mechanism 1017 includes rod 1018 mounted with stopper 1023 and an air cylinder (driving mechanism) 1019 vertically moving rod 1018. Moving mechanism 1017 can insert the forward end of rod 1018 into stopper 1023. Air cylinder 1019 can vertically move stopper 1023.

Plate 1031 is mounted on set portion 1028 of attachable/detachable base 1026 in a state where resin accommodation space 1032 is directed downward. Moving mechanism 1017 can bring mold release film 1012 into contact with plate 1031 to close opening 1033.

When granular resin 1010 is fed to cavity 1008, stopper 1023 stops film-holding frame 1022, and is received from moving mechanism 1017 (rod 1018) to moving mechanism 1014 (rod 1015), as described later. When granular resin 1010 is fed to cavity 1008, stopper 1023 is moved downward along with film-holding frame 1022.

Attachable/detachable base 1026 detached from inloader 1013 is now described. Attachable/detachable base 1026 includes set portion 1028 on which plate 1031 is set on one main surface. Further, attachable/detachable base 1026 includes base portion 1029 detachably provided with body 1025 on another main surface. In addition, attachable/detachable base 1026 is set on base portion 1029 in a state where set portion 1028 is directed upward, as shown in Fig. 10.

Thereafter mold release film 1012 is so moved downward by moving mechanism 1017 as to close opening 1033 of plate 1031 into which granular resin 1010 is introduced, as shown in Fig. 11. Thus, mold release film 1012 covers plate 1031 in a state where prescribed tensile force is applied.

5 After attachable/detachable base 1026 is mounted on inloader 1013, set portion 1028 is mounted on the lower surface of inloader 1013, as shown in Fig. 12. When inloader 1013 is inserted into the space between upper mold section 1002 and lower mold section 1003, opening 1007 of cavity 1008 and opening 1033 of plate 1031 are opposed to each other, as shown in Fig. 13.

10 Therefore, inloader 1013 is moved downward. Thus, opening 1033 of plate 1031 is adjacent to opening 1007 of lower mold section 1003 in a state where mold release film 1012 is interposed. At this time, resin accommodation space 1023 has granular resin 1010.

(As to Structure of Feeding Mechanism for Resin Material)

15 Feeding mechanism 1041 shown in Fig. 9 is now described.

Feeding mechanism 1041 feeds prescribed amount of granular resin 1010 to resin accommodation space 1032 of plate 1031. Feeding mechanism 1041 includes a measuring/introducing portion 1042 measuring prescribed amount of granular resin 1010 and introducing the same into plate 1031. Feeding mechanism 1041 further includes a plate receiving portion 1043. Attachable/detachable base 1026 mounted with plate 1031 is placed on plate receiving portion 1043. Measuring/introducing portion 1042 measures prescribed amount of granular resin 1010, and introduces the same into resin accommodation space 1032 of plate 1031 while vibrating and moving the same. Plate receiving portion 1043 vibrates attachable/detachable base 1026.

20 Thus, granular resin 1010 in resin accommodation space 1032 of plate 1031 is formed in the uniform thickness. In other words, prescribed amount of granular resin 1010 is flattened in resin accommodation space 1032 of plate 1031.

As to granular resin 1010 having the uniform thickness in plate 1031, granules

thereof are not welded to each other, dissimilarly to heated granular resin 1052 having a constant shape shown in Example 3 described later. Granular resin 1010 in plate 1031 may be formed in the uniform thickness with a "squeegee", in place of the operation of plate receiving portion 1043 uniformizing the thickness of granular resin 1010 by vibration.

(Method of Compression Molding for Electronic Part with Granular Resin in Plate)

First, the step in which film-holding frame 1022 is formed is described.

As shown in Fig. 8, mold release film 1012 having a prescribed size is placed on lower frame portion 1021b. Then, upper frame portion 1021a is placed on mold release film 1012. Thereafter upper frame portion 1021a and lower frame portion 1021b hold mold release film 1012 with prescribed pressure. Thus, film-holding frame 1022 is formed. At this time, mold release film 1012 held by upper frame portion 1021a and lower frame portion 1021b is pulled with prescribed force. Mold release film 1012 may have a size for completely covering the molding surface of lower mold section 1003 and including a portion necessary for holding frame 1021. Mold release film 1012 may jut outward from frame 1021. Upper frame portion 1021a and lower frame portion 1021b are stopped by stopper 1023.

Then, the step of feeding granular resin 1010 to plate 1031 for resin accommodation is described.

As shown in Fig. 9, attachable/detachable base 1026 is detached from inloader 1013, and placed on plate receiving portion 1043 while directing set portion 1028 upward. Then, plate 1031 is mounted on set portion 1028 in a state where opening 1033 is directed upward.

Then, necessary amount of granular resin 1010 is measured, and thereafter introduced into resin accommodation space 1032 of plate 1031 from measuring/introducing portion 1042. Thus, plate 1031 fed with granular resin 1010 is completed.

At this time, plate receiving portion 1043 applies vibration to plate 1031. Thus, the thickness of granular resin 1010 in resin accommodation space 1032 is uniformized. Thus, granular resin 1010 is formed in a sheet shape. At this time, the large number of granules constituting granular resin 1010 are not welded to each other.

5 Then, the step in which opening 1033 of plate 1031 into which granular resin 1010 is introduced is covered with mold release film 1012 is described.

First, the upper surface of plate 1031 into which granular resin 1010 is introduced is covered with mold release film 1012 held by film-holding frame 1022, as shown in Fig. 10. At this time, stopper 1023 mounted on film-holding frame 1022 is
10 inserted into the forward end of rod 1018 of moving mechanism 1017 of inloader 1013 (1025).

Then, air cylinder 1019 of moving mechanism 1017 moves downward. Thus, mold release film 1012 moves up to opening 1033 of plate 1031 fed with granular resin 1010. Consequently, opening 1033 is closed with mold release film 1012.

15 After plate 1031 is covered with mold release film 1012, evacuation may be performed on the space in plate 1031 covered with mold release film 1012. Thus, resin accommodation space 1032 is set to a prescribed degree of vacuum. Consequently, mold release film 1012 is adsorbed to plate 1031.

Evacuation for adsorbing mold release film 1012 to peripheral portion 1034
20 through the suction holes of peripheral portion 1034 may be performed simultaneously with the aforementioned evacuation. Alternatively, only the evacuation for adsorbing mold release film 1012 to peripheral portion 1034 through the suction holes of peripheral portion 1034 may be performed.

Then, attachable/detachable base 1026 is detached from plate receiving portion
25 1043. At this time, attachable/detachable base 1026 includes film-holding frame 1022 and plate 1031 into which prescribed amount of granular resin 1010 is introduced and subjected to the evacuation, as shown in Fig. 11.

Then, the step in which attachable/detachable base 1026 is mounted on body

1025 of inloader 1013 in the state having plate 1031 fed with granular resin 1010 and film-holding frame 1022 holding the mold release film.

First, attachable/detachable base 1026 shown in Fig. 11 is reversed. At this time, the surface of plate 1031 covered with mold release film 1012 is positioned on the lower side of attachable/detachable base 1026. Then, base portion 1029 of attachable/detachable base 1026 is mounted on body 1025 in a state where plate 1031 is reversed. Thus, inloader 1013 shown in Fig. 12 is formed. At this time, granular resin 1010 is present in resin accommodation space 1032 whose opening 1033 is closed with mold release film 1012 in the state having the uniform thickness.

The step in which the granular resin is fed into the cavity is now described with reference to Figs. 13 and 14.

As shown in Fig. 13, inloader 1013 is first inserted into the space between upper mold section 1002 and lower mold section 1003. Then, inloader 1013 moves upward. Thus, substrate 1005 is set on substrate set portion 1006 of upper mold section 1002 in the state where electronic part 1004 is directed downward. Then, inloader 1013 moves downward. Thus, the lower surface of inloader 1013 comes into contact with the molding surface of lower mold section 1003. Further, opening 1033 of plate 1031, opening 1007 of cavity 1008 and mold release film 1012 are positioned in substantially identical planes.

Then, stopper 1023 is detached from the forward end of rod 1018 of inloader 1013 and mounted on the forward end of rod 1015 in moving mechanism 1014 in the state stopping film-holding frame 1022, as shown in Fig. 14. In other words, stopper 1023 is transferred from rod 1018 to rod 1015.

Further, moving mechanism 1014 moves downward. Thus, mold release film 1012 covers the molding surface of lower mold section 1003 in the state where the prescribed tensile force is applied. Thereafter air is forcibly discharged from cavity 1008. Thus, mold release film 1012 comes into close contact with the surface of cavity 1008. At this time, the evacuation with the vacuum pump provided on plate 1031 is so

stopped that resin accommodation space 1032 of plate 1031 changes from the vacuum state to an atmospheric pressure state.

Thus, granular resin 1010 falls into cavity 1008 from resin accommodation space 1032 in the state where the surface of cavity 1008 is covered with mold release film 1012, as shown in Fig. 14. Granular resin 1010 falls up to the bottom surface of cavity 1008 along with mold release film 1012, in the state having the uniform thickness. Then, inloader 1013 moves upward, and is thereafter unloaded from the space between upper mold section 1002 and lower mold section 1003, as shown in Fig. 15.

If granular resin 1010 remaining in resin accommodation space 1032 must be removed, plate 1031 may be horizontally or vertically vibrated in a state where a prescribed space is formed between the molding surface of lower mold section 1003 and the lower surface of plate 1031. Thus, substantially all granular resin 1010 falls into cavity 1008 from resin accommodation space 1032. In this case, inloader 1032 may have a mechanism applying vibration to plate 1031.

Then, upper mold section 1002 and lower mold section 1003 are closed, as shown in Fig. 16. At this time, granular resin 1010 melts by heating in cavity 1008 covered with mold release film 1012. Therefore, electronic part 1004 mounted on substrate 1005 is dipped in the molten resin. Thereafter pressing member 1009 applies prescribed pressure to the molten resin in cavity 1008.

After a time necessary for hardening the molten resin elapses, upper mold section 1002 and lower mold section 1003 are opened. Thus, resin compact 1011 corresponding to the shape of cavity 1008 is formed in cavity 1008. Electronic part 1004 is sealed in resin compact 1011. Thus, compression molding is completed. Then, the unloader unloads the molded substrate, i.e., substrate 1005 and resin compact 1011 from apparatus 1001.

According to the aforementioned method, granular resin 1010 moves from resin accommodation space 1032 to cavity 1008 in the closed space formed by lower mold section 1003 and plate 1031, whereby granular resin 1010 does not scatter to adhere to

regions other than resin accommodation space 1032 and cavity 1008. Therefore, granular resin 1010 is prevented from remaining on the molding surface of lower mold section 1003 or substrate 1005 as foreign matter 1112 such as a resin residue. Thus, productivity of resin compact 1011 as a product can be improved.

5 According to the aforementioned method, granular resin 1010 is fed to cavity 1008 while the shape thereof is held. Therefore, reliability in the amount of the resin fed to cavity 1008 can be improved.

 According to the aforementioned method, granular resin 1010 is fed to cavity 1008 in the state having the uniform thickness. Therefore, granular resin 1010 can be efficiently uniformly molten in the thickness direction.

 According to the aforementioned method, granular resin 1010 has the communication holes in resin accommodation space 1032. When granular resin 1010 is molten by heating in cavity 1008, therefore, air and moisture contained in granular resin 1010 are naturally discharged outward through the communication holes.

15 Consequently, the resin compact is prevented from residual of voids or the like. It is presumed that the large number of communication holes as clearances between the large number of granules disappear after individual granular resin 1010 is pressed.

Example 3

 A method of compression molding for an electronic part according to Example 3 of the present invention is now described with reference to the drawings.

(As to Structure of Mold Assembly)

 First, basic elements, particularly members constituting a mold assembly are identical to those of the mold assembly described with reference to Example 2 (refer to Figs. 13 to 16) in a compression molding apparatus 1050 for an electronic part, as shown in Fig. 21. Therefore, these members are denoted by reference numerals identical to each other, and description of these members is not repeated.

(As to Preheating Mechanism)

 As shown in Figs. 17 and 18, compression molding apparatus 1050 for an

electronic part according to this Example comprises a preheating mechanism 1051. Preheating mechanism 1051 uniformizes the thickness of overall granular resin 1010 by heating granular resin 1010 without pressing granular resin 1010 before feeding granular resin 1010 to a cavity 1008.

5 As shown in Figs. 17 and 18, preheating mechanism 1051 includes a heating portion 1053 and a heated surface 1056 heated by heating portion 1053. A mold release film 1055 on which a frame 1056 is placed is provided on heated surface 1056. Preheating mechanism 1051 further includes a lid member 1057 closing an upper opening of frame 1056. Heated surface 1056 of heating portion 1053 heats granular
10 resin 1010 having a uniform thickness fed into frame 1054 on mold release film 1055 through mold release film 1055. Consequently, granular resin 1052 having a uniform thickness is formed.

 As described later, granular resin 1010 or 1052 and lid member 1057 are provided at a prescribed interval. Therefore, lid member 1057 does not come into
15 contact with granular resin 1052. Although not shown, preheating mechanism 1051 includes a mechanism for introducing granular resin 1010 into frame 1054 on mold release film 1055.

(As to Granular Resin)

 Granular resin 1010 in frame 1054 is formed in the uniform thickness by a
20 flattening mechanism. A mechanism utilizing vibration or a "squeegee" can be employed as the mechanism flattening the resin material. As shown in Figs. 17 and 18, granular resin 1010 is set on heated surface 1056 in a state where mold release film 1055 is interposed. Granular resin 1010 in frame 1054 is heated preliminarily, i.e., at a temperature capable of remolding the same by reheating. At this time, granular resin
25 1010 in frame 1054 is formed in the uniform thickness. Consequently, sheetlike granular resin 1052 is formed.

 Thus, the thickness of granular resin 1052 is so uniform that the whole of granular resin 1052 uniformly melts. Further, granular resin 1052 is such an aggregate

that parts of the surfaces of granules are welded to each other by heating. Therefore, granular resin 1052 is spongy. Spongy granular resin 1052 is characterized by having communication holes therein, dissimilarly to a resin material melting by heating, a resin material solidified by pressing and a resin material kneaded with powdery resin or the like.

Granular resin 1052 having the uniform thickness may be fed onto mold release film 1055 in compression molding apparatus shown in Fig. 21 in a state not employing frame 1054, as shown in Fig. 20. Further, granular resin (aggregate) 1052 may be preliminarily heated up to such a temperature that the same can be remolten by reheating, and may be preliminarily heated to such a temperature that an electronic part 1004 mounted on a substrate 1005 can be compression-molded.

When granular resin 1010 is heated, the upper opening of frame 1054 may be covered with lid member 1057. In this case, granular resin 1010 is uniformly heated in frame 1054 from a lower layer portion up to an upper layer portion.

In place of lid member 1057, a heating portion 1058 may be provided on the upper opening of frame 1054. Further, granular resin 1010 in frame 1054 may be heated by the heating portion at a prescribed interval. In this case, granular resin 1010 in frame 1054 is uniformly heated from the lower layer portion up to the upper layer portion thereof, similarly to the case where lid member 1057 is employed.

(Method of Compression-Molding Electronic Part with Heated Granular Resin)

A method of executing compression molding with granular resin 1052 is now described, as shown in Fig. 21.

First, an end of mold release film 1055 is held by an inloader 1059, as shown in Fig. 21. At this time, granular resin 1052 is present on mold release film 1055 and in frame 1054 placed on mold release film 1055. Then, inloader 1059 is inserted into the space between upper mold section 1002 and lower mold section 1003. Thereafter inloader 1059 moves downward. Thus, mold release film 1055 comes into contact with the surface of cavity 1008. At the same time, frame 1054 is placed on the

molding surface of lower mold section 1003 in the state where mold release film 1055 is interposed.

Then, air is forcibly discharged from the molding surface of lower mold section 1003 and the space in cavity 1008 by evacuation. Mold release film 1055 comes into
5 close contact with the molding surface of lower mold section 1003 and the surface of cavity 1008. At this time, granular resin 1052 falls from the molding surface of lower mold section 1003 up to the bottom surface of cavity 1008 in the state placed on mold release film 1005.

Then, upper mold section 1002 and lower mold section 1003 are closed. Thus,
10 electronic part 1004 mounted on substrate 1005 is dipped in the resin material melting by heating in cavity 1008. Thereafter upper mold section 1002 and lower mold section 1003 are opened after a time necessary for hardening the molten resin elapses. Thus, electronic part 1004 is sealed in a resin compact 1011 corresponding to the shape of cavity 1008 in cavity 1008.

15 Also according to the aforementioned method of compression molding for an electronic part of Example 3, effects similar to those of the method of compression molding for an electronic part according to Example 2 can be attained.

Mold release film 1005 employed in Example 3 has a size corresponding to the size of the molding surface of lower mold section 1003 having cavity 1008, similarly to
20 Example 2. Further, mold release film 1055 is created by drawing and cutting a mold release film in the form of a roll.

(As to Granular Resin According to other Example)

In place of the granular resin in the aforementioned Examples, a resin material held in a constant shape (thickness) at room temperature may be employed. This resin
25 material can also be uniformized by vibration. The thickness of the resin material may be uniformized with a squeegee or the like. When the resin material held in the constant shape at room temperature is employed, preheating may not be performed with preheating mechanism 1051, dissimilarly to the case where the resin material not held in

a constant shape at room temperature is employed. Also in the case of employing the resin material held in the constant shape at room temperature, effects similar to the effects attained when the resin material not held in a constant shape at room temperature is employed can be attained.

5 In each Example, a thermoplastic resin material may be employed in place of the thermosetting resin. In each Example, further, various materials such as a powdery resin material or a powdered resin material having a prescribed particle size distribution may be employed in place of the granular resin material. In each Example, in addition, a silicon-based resin material or an epoxy-based resin material may be employed as the
10 resin material. As the resin material, any resin material such as a resin material having transparency, a resin material having semitransparency or a resin material containing a phosphorescent material and a fluorescent material may be employed. In each aforementioned Example, liquid resin liquefied in an atmosphere of room temperature and atmospheric pressure may be employed in place of the granular resin.

15 As prior art similar to the prior art described in the above section of background art, a method of compression-molding an electronic part mounted on a substrate with a resin material by employing a mold assembly of a compression molding apparatus for an electronic part is carried out, as shown in Fig. 47.

In this method, a mold assembly loaded on a compression molding apparatus
20 2101 for an electronic part is employed. The mold assembly includes an upper mold section 2102 and a lower mold section 2103. In this apparatus, granular resin 2106 is fed into a cavity 2105 covered with a mold release film 2104. In this state, granular resin 2106 is molten by heating. Thereafter upper mold section 2102 and lower mold section 2103 are closed. Thus, an electronic part 2122 mounted on a substrate 2121 is
25 dipped in the molten resin material in cavity 2105. Further, pressure is applied to the molten resin in cavity 2105 by a bottom surface member 2107. Thus, a resin compact corresponding to the shape of cavity 2105 is formed. Consequently, the electronic part is sealed with the resin compact.

Further, a feeding mechanism 2108 is employed for feeding granular resin 2106 into cavity 2105, as shown in Fig. 47. Feeding mechanism 2108 includes a through-hole 2109 and a shutter 2110 provided on the lower side thereof. Feeding mechanism 2108 so opens shutter 2110 that granular resin 2106 falls into cavity 2105 from a space in through-hole 2109.

According to the conventional compression molding apparatus shown in Fig. 47, the distance between feeding mechanism 2108 and the bottom surface of cavity 2105 is considerably large. When granular resin 2106 collides with the bottom surface of cavity 2105, therefore, powder having adhered to granular resin 2106 is easily blown up. Further, granular resin 2106 or the powder having adhered to granular resin 2106 scatters by colliding with the bottom surface of cavity 2105, to adhere to mold release film 2104 covering the molding surface of lower mold section 2103 and a part of lower mold section 2103 not covered with the mold release film. Consequently, foreign matter (hardened matter) such as a resin residue remains on the molding surface of lower mold section 2103 and substrate 2121. Therefore, the foreign matter adhering to lower mold section 2103 must be removed by cleaning. Further, the yield of products lowers due to the foreign matter adhering to the substrate. Consequently, the productivity of the products lowers.

Further, shutter 2110 may not operate due to adhesion of granular resin 2106. Therefore, it may be necessary to interrupt the use of the compression molding apparatus. Consequently, the productivity of the products lowers.

In addition, part 2106a of granular resin 2106 may remain on the peripheral surface of through-hole 2109. Therefore, granular resin 2106 cannot be fed to cavity 2105 with high accuracy. Consequently, reliability with respect to the amount of granular resin 2106 fed to the cavity cannot be improved.

Further, the thickness of granular resin 2106 in cavity 2105 may become nonuniform. For example, granular resin 2106 may be formed in a convex shape or the like. In this case, granular resin 2106 cannot be uniformly heated in cavity 2105.

Therefore, such a defect is caused that a part separated from another part remains in the resin material.

The aforementioned problems also arise in a case where another resin material such as powdery resin, powdered resin or liquid resin is employed in place of the granular resin.

The invention disclosed in Examples 4 to 7 described below has been proposed in order to solve the problems of the conventional apparatus and method described with reference to the aforementioned Fig. 47, and an object of this invention is to improve productivity of products obtained by compression molding. Another object of the present invention is to provide reliability in the amount of a resin material fed to a cavity. Still another object of the present invention is to feed the resin material into the cavity with a uniform thickness. A further object of the present invention is to improve the quality and reliability of a resin compact compression-molded in the cavity.

Example 4

A method of compression molding for an electronic part according to Example of the present invention and an apparatus employed therefor are now described in detail with reference to the drawings.

(As to Structure of Compression Molding Apparatus for Electronic Part)

First, a mold assembly of a compression molding apparatus 2001 (hereinafter also simply referred to as "apparatus 2001") for an electronic part is described with reference to Figs. 31 to 34.

Apparatus 2001 comprises the mold assembly and an inloader 2002 simultaneously or separately feeding a substrate 2006 mounted with an electronic part 2005 and granulated granular resin 2007 to the mold assembly. Apparatus 2001 further comprises an unloader (not shown) unloading substrate 2006 from the mold assembly.

The mold assembly includes an upper mold section 2003 whose position is fixed and a movable lower mold section 2004 opposed to upper mold section 2003.

Apparatus 2001 comprises a mechanism (not shown) heating upper mold section 2003 and lower mold section 2004 to a prescribed temperature. Apparatus 2001 further comprises a mold clamping mechanism (not shown) capable of closing upper mold section 2003 and lower mold section 2004 with prescribed pressure.

5 Upper mold section 2003 includes a substrate set portion 2008 on which substrate 2006 mounted with electronic part 2005 is set in a state where electronic part 2005 is directed downward. Lower mold section 2004 includes a cavity 2010 having an upwardly directed opening 2009. The bottom surface of cavity 2010 is constituted of a bottom surface member 2011 pressing granular resin 2007 in cavity 2010 upward.

10 In apparatus 2001, substrate 2006 is set on substrate set portion 2008 of upper mold section 2003 in the state where electronic part 2005 is directed downward. Further, granular resin 2007 is fed into cavity 2010 of lower mold section 2004. In addition, upper mold section 2003 and lower mold section 2004 are closed with the prescribed pressure. Thus, electronic part 2005 is dipped in the resin material melting
15 in cavity 2010.

 The molten resin in cavity 2010 is pressed by bottom surface member 2011. Thus, the prescribed pressure is applied to the molten resin in cavity 2010. Further, a resin compact 2012 corresponding to the shape of cavity 2010 is formed in cavity 2010. Electronic part 2005 is sealed in resin compact 2010.

20 Although not shown, lower mold section 2004 includes a prescribed number of suction holes whose both ends communicate with cavity 2010 and a vacuum tube respectively. The vacuum tube is an example of a vacuum path. Lower mold section 2004 further includes a vacuum pump forcibly discharging air in cavity 2010 outward through the suction holes. The vacuum pump is an example of an evacuation
25 mechanism. The evacuation mechanism forcibly discharges air to an external space from the space in cavity 2010 through the suction holes. Thus, a recess 2014 of a recessed film 2015 is adsorbed to cavity 2010. Consequently, recess 2014 is inserted into cavity 2010. At this time, granular resin 2007 is flattened in recess 2014.

(As to Feeding Mechanism)

Apparatus 2001 further comprises a feeding mechanism 2021 feeding granular resin 2007 to recess 2014 of recessed film 2015 outside the mold assembly, as shown in Figs. 23 to 28.

5 Feeding mechanism 2021 includes a molding mechanism 2022, an introduction mechanism 2023 and a mechanism (not shown) flattening granular resin 2007 by vibration.

Molding mechanism 2022 molds recess 2014 corresponding to the shape of cavity 2010 on a mold release film 2013, as shown in Figs. 23 to 25. Introduction
10 mechanism 2023 measures granular resin 2007 and thereafter feeds prescribed amount of granular resin 2007 to recess 2014, as shown in Fig. 26. The mechanism flattening granular resin 2007 by vibration vibrates granular resin 2007 in recess 2014 by vibrating a die 2024, as shown in Fig. 27. Thus, granular resin 2007 is flattened in recess 2014. Prescribed amount of granular resin 2007 in recess 2014 enters a state having a uniform
15 thickness.

(As to Molding Mechanism)

Molding mechanism 2022 forms recessed film 2015 having recess 2014 corresponding to the shape of cavity 2010 on mold release film 2013. As shown in Figs. 23 to 25, molding mechanism 2022 includes die 2024 on which mold release film
20 2013 is set and a punch 2025 molding mold release film 2013 by pressing. Die 2024 is set on a base of feeding mechanism 2021. Die 2024 includes a recess 2026 for molding mold release film 2013. Die 2024 forms a molding surface 2027.

In molding mechanism 2022, punch 2025 presses mold release film 2013 into recess 2026 as shown in Fig. 24, in a state where mold release film 2013 is set on
25 molding surface 2027 as shown in Fig. 23. Thus, recess 2014 corresponding to recess 2026 of die 2024 is formed on mold release film 2013, as shown in Fig. 25. In other words, press molding of mold release film 2013 is executed. Recess 2014 has a shape corresponding to cavity 2010, as shown in Fig. 25.

As described later, recessed film 2015 fed with granular resin 2007 is inserted into cavity 2010. At this time, granular resin 2007 has a constant shape in the flattened state. Recess 2014 extends and contracts due to adsorption by evacuation in cavity 2010, and hence the same is desirably slightly smaller than the shape of cavity 2010.

5 Although not shown, suction holes communicating with external space extend from the surface of recess 2026 and molding surface 2027 through the inner portion of die 2024. Molding mechanism 2022 has an evacuation mechanism forcibly discharging air from the space in recess 2026 to an external space through the suction holes. Mold release film 2013 is formed into recessed film 2015 having recess 2014 corresponding to
10 the shape of recess 2026 due to the function of this evacuation mechanism.

(As to Introduction Mechanism)

Feeding mechanism 2021 includes introduction mechanism 2023 measuring granular resin 2007 and feeding prescribed amount of granular resin 2007 to recess 2014, as shown in Fig. 26. Feeding mechanism 2021 may have a measuring mechanism (not
15 shown) measuring granular resin 2007 fed to recess 2014 of die 2024 along with recessed film 2015.

(As to Mechanism Flattening Granular Resin by Vibration)

Although not shown, apparatus 2001 comprises a mechanism horizontally or vertically vibrating the base of feeding mechanism 2021. As shown in Fig. 27, this
20 mechanism vibrates the base. Thus, die 2024 vibrates. Consequently, granular resin 2007 vibrates to be flattened in recess 2014 of recessed film 2015. Consequently, prescribed amount of granular resin 2007 having a uniform thickness is formed in recess 2014.

As shown in Fig. 28, granular resin 2007 may be so pressed by a presser/flattener
25 2028 that granular resin 2007 in recess 2014 is formed in the uniform thickness. A "squeegee" may be employed as a tool flattening granular resin 2007.

(As to Inloader)

Apparatus 2001 comprises inloader 2002 feeding granular resin 2007 to the

mold assembly. Inloader 2002 functions as a mechanism feeding the resin material to the cavity. Inloader 2002 includes a body 2031 in the form of a flat plate and a mechanism (not shown) for adsorbing mold release film 2013 to a lower surface 2032 of body 2031, as shown in Fig. 29. Therefore, recessed film 2015 is adsorbed to lower surface 2032 of body 2031, as shown in Fig. 30.

The mechanism for adsorbing mold release film 2013 includes a suction hole extending from lower surface 2032 of body 2031 to pass through the inner portion thereof, a vacuum pump forcibly discharging air through the suction hole and a vacuum tube or the like making the suction hole and the vacuum pump communicate with each other, although not shown. These are evacuation mechanisms. The evacuation mechanisms forcibly discharge air from a space around lower surface 2032 of body 2031 to another space through the suction hole and the vacuum tube. Thus, recessed film 2015 is adsorbed to lower surface 2032 of body 2031.

Although not shown, body 2031 includes a mechanism flattening granular resin 2007 by vibrating body 2031. Therefore, this mechanism can vibrate granular resin 2007 in recess 2014 by vibrating body 2031. According to this, granular resin 2007 in recess 2014 is flattened. Consequently, granular resin 2007 having the uniform thickness is formed in recess 2007. If the thickness of granular resin 2007 becomes nonuniform when recessed film 2015 on which granular resin 2007 is placed is transported by inloader 2002, the aforementioned mechanism may so vibrate mold release film 2013 that granular resin 2007 is flattened.

(As to Method of Feeding Resin Material)

First, the step in which molding mechanism 2022 provided on the base of feeding mechanism 2021 forms recessed film 2015 is described, as shown in Figs. 23 to 25.

As shown in Fig. 23, mold release film 2013 is set on die 2024. Then, punch 2025 presses mold release film 2013, as shown in Fig. 24. Thus, mold release film 2013 is held by recess 2026 of die 2024 and punch 2025 corresponding to recess 2026. Consequently, recess 2014 is formed on mold release film 2013, as shown in Fig. 25.

In place of the operation in which the film is molded with molding mechanism 2022 as shown in Fig. 23 to 25, the film may be molded only with die 2024. Further, recess 2014 corresponding to the shape of recess 2026 may be formed by forcibly discharging air from the space in recess 2026 to the external space through a suction
5 hole extending in the inner portion of die 2024 in the state where mold release film 2013 is set on molding surface 2027 of die 2024.

Then, introduction mechanism 2023 introduces granular resin 2007 into recess 2014, as shown in Fig. 26. Then, the mechanism for flattening the granular resin provided on apparatus 2001 vibrates the base of feeding mechanism 2021, die 2024 and
10 recessed film 2015, as shown in Fig. 27. Thus, vibration is applied to granular resin 2007 in recess 2014. Consequently, granular resin 2007 is flattened in recess 2014. Therefore, granular resin 2007 has the uniform thickness in recess 2014. Recessed film 2015 including recess 2014 fed with granular resin 2007 having the uniform thickness may hereinafter be also referred to as a flattened resin receiving film 2016.

15 (As to Transportation of Resin Material)

The step in which inloader 2002 feeds flattened resin receiving film 2016 to the mold assembly is now described, as shown in Figs. 29 to 32.

As shown in Fig. 29, inloader 2002 is moved downward. Thus, recessed film 2015 in close contact with die 2024 is adsorbed to lower surface 2032 of body 2031 of
20 inloader 2002. Then, inloader 2002 moves upward in the state where recessed film 2015 is fixed to lower surface 2032 of inloader 2002, as shown in Fig. 30. Then, inloader 2002 to which flattened resin receiving film 2016 is fixed is transported to cavity 2010, as shown in Fig. 31. At this time, inloader 2002 to which flattened resin receiving film 2016 is adsorbed is inserted into the space between upper mold section
25 2003 and lower mold section 2004. Thus, inloader 2002 is positioned above cavity 2010 of lower mold section 2004.

Then, recess 2014 of recessed film 2015 is fitted into cavity 2010, as shown in Fig. 32. Then, inloader 2002 terminates the adsorption of recessed film 2015.

Thereafter inloader 2002 moves upward, as shown in Fig. 33. Thus, the step of covering cavity 2010 and the molding surface of lower mold section 2004 with recessed film 2015 terminates.

(As to Compression Molding)

5 The step in which electronic part 2005 mounted on substrate 2006 is compression-molded with the resin material in cavity 2010 is now described with reference to Fig. 34. Granular resin 2007 melts by heating in cavity 2010 covered with recess 2014. Thereafter upper mold section 2003 and lower mold section 2004 are closed, as shown in Fig. 34. Thus, electronic part 2005 mounted on substrate 2006 is
10 dipped in the melting resin material in cavity 2010 in the state where substrate 2006 is set on upper mold section 2003. Thereafter bottom surface member 2011 of the cavity presses the molten resin in cavity 2010. Thus, the prescribed pressure is applied to the molten resin in cavity 2010. After a time necessary for hardening the molten resin elapses, upper mold section 2003 and lower mold section 2004 are opened. Thus,
15 electronic part 2005 mounted on substrate 2006 is sealed in resin compact 2012 corresponding to the shape of cavity 2010.

(As to Function/Effect)

According to the method of compression molding for an electronic part according to this Example, granular resin 2007 is fed to cavity 2010 in the state placed
20 on mold release film 2013. Therefore, granular resin 2007 does not remain on the mechanism feeding the resin material to the cavity. Consequently, reliability in the amount of granular resin 2007 fed to cavity 2010 is high.

Further, granular resin 2007 having the uniform thickness can be fed to cavity 2010. Therefore, granular resin 2007 can be uniformly heated/molten in cavity 2010.
25 Consequently, the resin material in cavity 2010 is prevented from formation of a part separated from another part. Therefore, the quality and reliability of resin compact 2012 improve.

In the method of compression molding for an electronic part according to this

Example, inloader 2002 so moves mold release film 2013 on which granular resin 2007 is placed to cavity 2010 from the position above cavity 2010 that granular resin 2007 is fed to cavity 2010. According to the method of compression molding for an electronic part according to this Example, therefore, scattering of granular resin 2007 or the like caused when granular resin 2007 collides with cavity 2010 is not caused, dissimilarly to the conventional method dropping granular resin 2007 into cavity 2010. Thus, foreign matter is prevented from remaining on the lower mold section or the surface of the substrate. Consequently, no cleaning of foreign matter is necessary, and reduction of the yield of products resulting from foreign mater adhering to the substrate is prevented. Therefore, productivity of resin compact 2012 constituting part of the product improves.

Further, no mechanism such as a shutter may be provided on a conventional mechanism for feeding granular resin 2007, whereby occurrence of such an inconvenience that the shutter does not operate due to adhesion of the granular resin is prevented. Therefore, the productivity of the products can be improved.

In addition, granular resin 2007 in cavity 2010 has the uniform thickness. Therefore, heat conducts from the lower surface up to the upper surface of granular resin 2007 at a uniform speed. Thus, communication holes are present between the granules constituting granular resin 2007, whereby air and moisture contained in granular resin 2007 are discharged outward through the communication holes.

Therefore, formation of voids in a fat compact is prevented.

Example 5

A method of compression molding for an electronic part according to Example 5 and an apparatus employed therefor are now described with reference to Figs. 35 and 36.

A mold assembly of a compression molding apparatus for an electronic part shown in Figs. 35 and 36 and the mold assembly according to Example 4 shown in Fig. 33 etc. are basically identical in structure to each other. Therefore, signs identical to each other are assigned to these identical structures, and description thereof is not repeated.

As shown in Figs. 35 and 36, an apparatus 2041 comprises a lower mold section 2004. Lower mold section 2004 has a cavity 2010. The bottom surface of cavity 2010 is constituted of a bottom surface member 2011. A recess 2014 of a recessed film 2015 is fitted into cavity 2010. Recess 2014 is fed with granular resin 2007.

5 Granular resin 2007 is flattened, and has a uniform thickness. Recessed film 2015 is inserted into cavity 2010 by an inloader 2042.

Inloader 2042 includes a body 2044 having a through-hole 2043 and a lid member 2045 capable of closing through-hole 2043 and preventing resin from scattering. As shown in Figs. 35 and 36, lid member 2045 is fitted into through-hole 2043.

10 Similarly to Example 4, body 2044 of inloader 2042 has a suction hole extending from a lower surface 2047 to pass through the inner portion of body 2044, although not shown. A flattened resin receiving film 2016 (recessed film 2015) is in close contact with cavity 2010, since air in cavity 2010 is sucked through the suction hole communicating with cavity 2010.

15 Inloader 2042 including lid member 2045 according to this Example is desirably employed when the bottom surface of cavity 2010 is considerably large in order to collectively compression-mold a plurality of electronic parts in single cavity 2010.

When inloader 2042 adsorbs flattened resin receiving film 2016, an interval S is present between lower surface 2047 of lid member 2045 and the upper surface of flattened granular resin 2007, as shown in Fig. 36. In other words, lower surface 2047 of lid member 2045 and the upper surface of granular resin 2007 are not in contact with each other. Therefore, granular resin 2007 is prevented from adhering to lower surface 2047 of lid member 2045.

20 According to the apparatus of Example 4, granular resin 2007 in recess 2014 may scatter and adhere to lower surface 2032 of body 2031 when inloader 2002 adsorbs flattened resin receiving film 2016. According to the apparatus of Example 5, however, granular resin 2007 is prevented from adhering to lower surface 2047 of lid member 2045 due to the presence of aforementioned interval S. Lower surface 2047 of lid

member 2045 corresponds to lower surface 2032 of body 2031 of inloader 2002 shown in Example 4.

As to the others, effects similar to those attained by the apparatus according to Example 4 can be attained by the method of compression molding for an electronic part according to this Example and the apparatus employed therefor.

Example 6

A compression molding apparatus for an electronic part and a method according to Example 6 are now described with reference to Figs. 37 and 38. A mold assembly of the compression molding apparatus for an electronic part shown in Figs. 37 and 38 and the mold assembly according to Example 4 shown in Fig. 33 etc. are basically identical in structure to each other. Therefore, signs identical to each other are assigned to these identical structures, and description thereof is not repeated.

As shown in Figs. 37 and 38, an apparatus 2051 according to this Example comprises a lower mold section 2004 and an inloader 2052. Lower mold section 2004 has a cavity 2010. The bottom surface of cavity 2010 is constituted of a bottom surface member 2011. Inloader 2052 transports a recessed film 2015 fed with granular resin 2007 in a recess 2014. Inloader 2052 includes a body 2054, a pressing/flattening mechanism 2055 and a film fixture 2057. Body 2054 has a through-hole 2053. Pressing/flattening mechanism 2055 flattens granular resin 2007 in recess 2014 by pressing. Film fixture 2057 fixes recessed film 2015 fed with granular resin 2007 in recess 2014 to a lower surface 2056 of body 2054.

Pressing/flattening mechanism 2055 includes a pressing/flattening member 2058 vertically moving in through-hole 2053 and an elastic member 2059 such as a spring provided between body 2054 and pressing/flattening member 2058. A pressing surface of pressing/flattening member 2058 flattens granular resin 2007 in recess 2014 by pressing. Consequently, the thickness of granular resin 2007 is uniformized. The pressing surface of pressing/flattening member 2058 may be provided with a resin release layer 2070 having excellent releasability with respect to resin such as Teflon

(registered trademark), for example. Recessed film 2015 may be brought into close contact with lower surface 2056 of body 2054 of inloader 2052 in a pulled state.

According to the compression molding apparatus for an electronic part according to the aforementioned Example, effects similar to those attained by the compression molding apparatus for an electronic part according to Example 4 can be attained.

In this Example, pressing/flattening member 2058 may so press granular resin 2007 in recess 2014 that granular resin 2007 is flattened when inloader 2052 transports recessed film 2015. If granular resin 2007 gets out of shape when inloader 2052 transports recessed film 2015 or when inloader 2052 feeds granular resin 2007 into cavity 2010 in this Example, pressing/flattening member 2058 may so press granular resin 2007 in recess 2014 that granular resin 2007 is flattened.

Example 7

A compression molding apparatus for an electronic part and a method according to Example 7 are now described with reference to Figs. 39 to 46.

Figs. 39 to 41 show a mechanism for feeding a resin material, Figs. 42 to 44 show an inloader, and Figs. 45 and 46 show the compression molding apparatus for an electronic part.

A mold assembly of the compression molding apparatus for an electronic part shown in Figs. 39 and 46 and the mold assembly according to Example 4 shown in Fig. 33 etc. are basically identical in structure to each other. Therefore, signs identical to each other are assigned to these identical structures, and description thereof is not repeated. The method according to Example 7 is different from the aforementioned methods of Examples 4 to 6 in a point that a recess 2014 is not formed on a mold release film 2013 before granular resin 2007 is fed.

More specifically, mold release film 2013 having a planar shape is sucked toward a cavity 2010 when granular resin 2007 is fed to cavity 2010 in the method of compression molding for an electronic part according to this Example. Thus, mold

release film 2013 comes into close contact with cavity 2010. Consequently, a recess equivalent to recess 2014 corresponding to the shape of cavity 2010 is molded on mold release film 2013.

(As to Compression Molding Apparatus for Electronic Part)

5 A compression molding apparatus 2061 (hereinafter also referred to simply as "apparatus 2061") for an electronic part according to this Example comprises an upper mold section 2003 and a lower mold section 2004 similar to those shown in Figs. 33 and 34. Apparatus 2061 further comprises a cutting mechanism (not shown) cutting mold release film 2013 having a planar shape of a prescribed size from a mold release film in a rolled state.

10 Apparatus 2061 further comprises a feeding mechanism (base) 2062 outside the mold assembly, as shown in Figs. 39 to 43. Feeding mechanism (base) 2062 flattens granular resin 2007 on mold release film 2013 after introducing granular resin 2007 onto mold release film 2013. Apparatus 2061 further comprises an inloader 2063 transporting granular resin 2007 placed on mold release film 2013 to the mold assembly.

(As to Mold Assembly)

20 Lower mold section 2004 of this Example includes cavity 2010, as shown in Figs. 45 and 46. Cavity 2010 has an opening 2009. The bottom surface of cavity 2010 is constituted of a bottom surface member 2011. Apparatus 2061 comprises an evacuation mechanism (not shown) for forcibly discharging air from the space in cavity 2010 outward in order to cover cavity 2010 with mold release film 2013, although not shown. The evacuation mechanism can bring mold release film 2013 into close contact with cavity 2010 due to a sucking function thereof.

(As to Feeding Mechanism)

25 Feeding mechanism 2062 of this Example includes a film receiving member 2064, a base, a frame 2065, an introduction mechanism 2023 and a mechanism (not shown) for flattening granular resin 2007. Mold release film 2013 is placed on film receiving member 2064. Film receiving member 2064 is placed on the base. Frame 2065 is

placed on mold release film 2013. Introduction mechanism 2023 measures granular resin 2007 and introduces the same into frame 2065. The mechanism for flattening granular resin 2007 vibrates the base.

Frame 2065 has a through-hole 2066. Through-hole 2066 is a space fed with granular resin 2007. Therefore, through-hole 2066 corresponds to the shape of cavity 2010. Through-hole 2066 includes an upper opening and a lower opening. As shown in Fig. 40, the lower opening of through-hole 2066 is closed with mold release film 2013.

Similarly to Examples 4 to 6, the mechanism flattening granular resin 2007 applies vibration to granular resin 2007 in through-hole 2066 by vibrating the base of feeding mechanism 2062, film receiving member 2064, mold release film 2013 and frame 2065. Consequently, granular resin 2007 is flattened. The flattening mechanism may be a mechanism flattening granular resin 2007 in through-hole 2066 by pressing the same. The thickness of granular resin 2007 is uniformized by these flattening mechanisms. Granular resin 2007 remains on mold release film 2013 in the flattened state after frame 2065 is removed.

(As to Inloader)

As hereinabove described, apparatus 2061 according to this Example comprises inloader 2063 feeding granular resin 2007 into cavity 2010 similarly to the apparatuses according to Examples 4 to 6, as shown in Figs. 42 to 44. Inloader 2063 includes a body and a plate 2067 fixed to the lower surface of the body. A resin accommodation space 2068 as a recess corresponding to the shape of cavity 2010 is provided on a lower portion of plate 2067. Therefore, the lower portion of plate 2067 is constituted of an opening 2069 of resin accommodation space 2068 and a peripheral portion 2070 enclosing opening 2069. When inloader 2063 holding plate 2067 moves downward, the lower surface of plate 2067, i.e., peripheral portion 2070 is brought into contact with mold release film 2013 on which flattened granular resin 2007 is placed, as shown in Figs. 42 and 43. Thus, granular resin 2007 is accommodated in resin accommodation space 2068 of plate 2067. In other words, granular resin 2007 is

encapsulated with mold release film 2013 and plate 2067. Therefore, it is impossible that granular resin 2007 scatters when plate 2067 and granular resin 2007 are transported to cavity 2010. Granular resin 2007 is transported in the state accommodated in resin accommodation space 2068, whereby flatness thereof is maintained.

Although not shown, peripheral portion 2070 is provided with a suction hole for adsorbing mold release film 2013. The suction hole communicates with a vacuum pump through a vacuum tube. The vacuum pump is an example of an evacuation mechanism, and the vacuum tube is an example of a vacuum path. Therefore, mold release film 2013 is adsorbed to peripheral portion 2070 of plate 2067 through suction by the vacuum pump. Thus, opening 2069 is closed with mold release film 2013. Therefore, a filmed plate 2071 encapsulating granular resin 2007 is transported to cavity 2010 by inloader 2063.

When mold release film 2013 is adsorbed to plate 2067, air in resin accommodation space 2068 may be discharged outward through the suction hole communicating with resin accommodation space 2068 of plate 2067. According to this, the adsorption of mold release film 2013 to plate 2067 is assisted.

The vacuum tube communicating with the suction hole of plate 2071 is provided with an on-off valve. The on-off valve is detachably provided on the vacuum tube. After evacuation terminates, therefore, the on-off valve is closed, and the vacuum tube is detached from the on-off valve. When evacuation is executed, on the other hand, the on-off valve is opened. Thus, inloader 2063 can transport filmed plate 71 to cavity 2010 while holding the same by adsorption through the function of the vacuum pump.

As shown in Fig. 45, filmed plate 2071 is brought into contact with lower mold section 2004 by inloader 2063. Thus, the space in cavity 2010 and resin accommodation space 2068 are closed with lower mold section 2004 and plate 2071. At this time, plate 2071 holding granular resin 2007 is so placed on the molding surface of lower mold section 2004 as to close opening 2009 in a state where mold release film

2013 is held therebetween. Opening 2069 of plate 2067, opening 2009 of cavity 2010 and mold release film 2013 are positioned in substantially identical planes.

In this state, air in the space in cavity 2010 is discharged outward by evacuation. Thus, mold release film 2013 moves in cavity 2010. Consequently, mold release film 2013 is adsorbed to the surface of cavity 2010, to correspond to the shape of cavity 2010. At this time, granular resin 2007 in resin accommodation space 2068 falls up to the bottom surface of cavity 2010 along with mold release film 2013. Consequently, granular resin 2007 having a uniform thickness is fed into cavity 2010 covered with mold release film 2013.

(As to Method of Compression Molding for Electronic Part)

The method of compression molding for an electronic part according to this Example is now described. First, mold release film 2013 is prepared, as shown in Fig. 39. Then, mold release film 2013 is placed on the upper surface of film receiving member 2064 placed on feeding mechanism 2062. Thereafter frame 2065 is set on mold release film 2013. Then, introduction mechanism 2023 measures granular resin 2007, and introduces granular resin 2007 into through-hole 2066 of frame 2065, as shown in Fig. 40. At this time, granular resin 2007 is formed in a convex shape, for example. Then, a mechanism (not shown) for flattening vibration flattens granular resin 2007 in through-hole 2066 of frame 2065 by vibration, as shown in Fig. 41. Consequently, granular resin 2007 having the uniform thickness is formed.

Then, frame 2065 is removed from the position on mold release film 2013. Granular resin 2007 remains on mold release film 2013 in the state having the uniform thickness. Then, inloader 2063 holding plate 2067 is moved downward, as shown in Figs. 42 and 43. Thus, opening 2069 of plate 2067 is positioned in a plane substantially identical to mold release film 2013. Further, peripheral portion 2070 of plate 2067 and mold release film 2013 come into contact with each other. Consequently, granular resin 2007 is encapsulated with mold release film 2013 and plate 2067. At this time, granular resin 2007 maintains the flattened state in resin

accommodation space 2068 of plate 2067.

Then, air is discharged outward from the space between mold release film 2013 and peripheral portion 2070 through the suction hole of peripheral portion 2070 of plate 2067. Consequently, mold release film 2013 is adsorbed to peripheral portion 2070.

5 Thus, plate 2071 holding granular resin 2007 is formed.

Then, inloader 2063 moves upward. Thus, filmed plate 2071 is inserted into the space between the upper mold section and lower mold section 2004 in the state held by inloader 2063, as shown in Fig. 44.

10 Then, inloader 2063 moves downward from the position above cavity 2010, as shown in Fig. 45. Thus, plate 2071 holding granular resin 2007 comes into contact with lower mold section 2004, to close cavity 2010. At this time, opening 2069 of plate 2067, opening 2009 of cavity 2010 and mold release film 2013 are positioned in substantially identical planes.

15 Then, air in cavity 2010 is discharged outward by the evacuation mechanism. Thus, mold release film 2013 is adsorbed to the surface of cavity 2010 correspondingly to the shape of cavity 2010, as shown in Fig. 46. Consequently, mold release film 2013 having a recess corresponding to recesses 2014 of recessed films 2015 shown in the aforementioned Examples 4 to 6 is formed.

20 At this time, granular resin 2007 falls from resin accommodation space 2068 of plate 2067 up to the bottom surface of cavity 2010 in a state where the shape thereof is maintained on mold release film 2013. In other words, granular resin 2007 falls while maintaining the state having the uniform thickness. That is, the flatness of granular resin 2007 is maintained before and after the fall. When the flatness of granular resin 2007 is lost in cavity 2010, the mechanism for flattening the granular resin by vibration may so vibrate inloader 2063 that granular resin 2007 is flattened in cavity 2010.

25 Then, the evacuation for adsorbing mold release film 2013 to plate 2067 is stopped. Thereafter inloader 2063 moves upward, and thereafter horizontally moves outward from the space between the upper mold section and lower mold section 2004.

Then, lower mold section 2004 is heated, similarly to Examples 4 to 6. Thus, granular resin 2007 receives heat from the bottom surface of cavity 2010. This heat conducts from the lower surface up to the upper surface of granular resin 2007 at a uniform speed. Clearances are present between granules of flattened granular resin 2007. These clearances function as communication holes. Therefore, air and moisture contained in granular resin 2007 are discharged outward through the communication holes. Voids are prevented from remaining in resin compact 2012 compression-molded in cavity 2010.

Then, the upper mold section and lower mold section 2004 are closed. At this time, substrate 2006 is set on substrate set portion 2008 of the upper mold section. Therefore, electronic part 2005 mounted on substrate 2006 is dipped in the melting resin material. Then, bottom surface member 2011 applies pressure to the molten resin in cavity 2010. When a time necessary for hardening thereafter elapses, electronic part 2005 mounted on substrate 2006 is sealed in resin compact 2012 corresponding to the shape of cavity 2010.

According to the compression molding apparatus for an electronic part and the method according to the aforementioned Example, effects similar to those of the compression molding apparatuses for electronic parts and the methods according to the aforementioned Examples can be attained.

In this Example, granular resin 2007 may be flattened by pressing, in place of flattening granular resin 2007 by applying vibration to granular resin 2007 in resin accommodation space 2068 of plate 2067 or in place of flattening granular resin 2007 by applying vibration to granular resin 2007 in cavity 2010 covered with mold release film 2013.

While the thermosetting resin material is employed in each Example, a thermoplastic resin material may be employed in place thereof. While the granular resin material is employed in each Example, a resin material having any shape such as a powdery resin material having a prescribed particle size distribution or a powdered resin

material may be employed in place thereof. In each Example, a silicone-based resin material or an epoxy-based resin material may be employed, for example. In each Example, a resin material having transparency, a resin material having semitransparency, or a fat material containing a phosphorescent material and a fluorescent material may be employed. In each aforementioned Example, liquid resin liquefied in an atmosphere of room temperature and atmospheric pressure may be employed in place of the granular resin.

CLAIMS

1. A method of compression molding for an electronic part, comprising the steps of:

preparing a lower mold section (2004) having a cavity (2010);

preparing a plate (2067) having a resin accommodation space (2068);

preparing a mold release film (2013);

placing a frame (2065) on said mold release film;

introducing a resin material (2007) onto said mold release film in said frame;

leaving said resin material on said mold release film by detaching said frame from said mold release film;

covering said resin material on said mold release film with said plate so that said resin material is inserted into said resin accommodation space;

encapsulating said resin material with said plate and said mold release film by adsorbing said mold release film to said plate;

transporting said plate and said mold release film encapsulating said resin material toward said cavity; and

bringing said mold release film into close contact with said cavity and dropping said resin material from said resin accommodation space of said plate into the space in said cavity.

2. The method of compression molding for an electronic part according to claim 1, further comprising the step of flattening said resin material in said frame on said mold release film.

3. The method of compression molding for an electronic part according to claim 1, wherein

said resin material is powdery resin having a prescribed particle size distribution.

4. The method of compression molding for an electronic part according to claim 1, wherein

said resin material is granular resin.

5. The method of compression molding for an electronic part according to claim 1, wherein

said resin material is powdered resin.

6. The method of compression molding for an electronic part according to claim 1, wherein

said resin material is a liquid resin material.

7. A compression molding apparatus for an electronic part, comprising:

a lower mold section (2004) having a cavity (2010);

a mold release film (2013) for covering the surface of said cavity;

a frame (2065) placed on said mold release film;

a mechanism (2023) introducing a resin material (2007) onto said mold release film in said frame;

a plate (2067) encapsulating said resin material in association with said mold release film by adsorbing said mold release film;

a mechanism (2063) transporting said plate encapsulating said resin material toward said cavity in association with said mold release film; and

an evacuation mechanism (2004) bringing said mold release film into close contact with said cavity.

8. The compression molding apparatus for an electronic part according to claim 7, further comprising a mechanism (2062, 2063) flattening said resin material introduced into said frame on said mold release film.

9. The compression molding apparatus for an electronic part according to claim 8, wherein

the mechanism flattening said resin material is a mechanism (2001, 2002, 2016, 2052, 2062, 2063) applying vibration to said resin material.

10. The compression molding apparatus for an electronic part according to claim 8, wherein

the mechanism flattening said resin material is a mechanism (2028, 2058) pressing said resin material.