# DESCRIPTION

## Title of Invention: RESIN MOLDING APPARATUS AND METHOD FOR MANUFACTURING RESIN MOLDED PRODUCT

### Technical Field

[0001] The present invention relates to a resin molding apparatus and a method for manufacturing a resin molded product.

### Background Art

[0002] JP 2023-3677A (Patent Document 1) discloses a compression molding apparatus. The compression molding apparatus performs resin encapsulation molding on a workpiece by using an encapsulation molding die that includes an upper die and a lower die. The workpiece includes a base material and electronic components placed on the base material. In the compression molding apparatus, the workpiece is held on a lower surface of the upper die. The electronic components are located under the base material in a state in which the workpiece is held on the lower surface of the upper die (see Patent Document 1).

### Citation List

#### Patent Document

[0003] Patent Document 1: JP 2023-3677A

### Summary of Invention

#### Technical Problem

[0004] In the compression molding apparatus disclosed in Patent Document 1 above, for example, an electronic component may fall from the base material. For example, if compression molding is performed in a state in which an electronic component has fallen onto the lower die, defects such as damage to the lower die or

the base material may occur.

[0005] The present invention has been made to solve such problems, and aims to provide a resin molding apparatus having a configuration for preventing defects that may occur due to compression molding continuing when an electronic component has fallen from the substrate, and a method for manufacturing a resin molded product using the resin molding apparatus.

Solution to Problem

[0006] A resin molding apparatus according to one aspect of the present invention performs compression molding. This resin molding apparatus includes a molding die, a clamping mechanism, and a sensor. The molding die includes an upper die and a lower die facing the upper die. The clamping mechanism clamps the molding die. Clamping is performed in a state in which an object to be molded is placed on a lower surface of the upper die and a resin is placed on an upper surface of the lower die. The object to be molded includes a substrate and a plurality of electronic components placed on the substrate. The plurality of electronic components are located under the substrate in a state in which the object to be molded is placed on the lower surface of the upper die. The sensor detects that at least one of the electronic components has fallen downward from the substrate in a state in which the object to be molded is placed on the lower surface of the upper die.

[0007] In a method for manufacturing a resin molded product according to another aspect of the present invention, the resin molding apparatus is used. The method for manufacturing a resin molded product includes placing the object to be molded on the lower surface of the upper die, placing a resin on the upper surface of the lower die, and clamping the molding die.

Advantageous Effects of Invention

[0008] According to the present invention, it is possible to provide a resin

molding apparatus having a configuration for preventing defects that may occur due to compression molding continuing when an electronic component has fallen from the substrate, and a method for manufacturing a resin molded product using the resin molding apparatus.

## Brief Description of Drawings

[0009] FIG. 1 is a schematic plan view of a resin molding apparatus.

FIG. 2 is a schematic plan view of a portion of a resin molding portion.

FIG. 3 is a schematic view of a portion of a cross-section taken along line III-III in FIG. 2.

FIG. 4 is a schematic view of a portion of a cross-section taken along line IV-IV in FIG. 2.

FIG. 5 is a schematic view of a portion of a cross-section taken along line V-V in FIG. 2.

FIG. 6 is a schematic view of a portion of a cross-section taken along line VI-VI in FIG. 4.

FIG. 7 is a schematic diagram showing an exemplary light path extending in a left-right direction.

FIG. 8 is a schematic view of a cross-section taken along line VIII-VIII in FIG. 2.

FIG. 9 is a flowchart showing a basic operating procedure of the resin molding apparatus.

FIG. 10 is a flowchart showing a procedure for starting and stopping detection of the fall of electronic components.

FIG. 11 is a flowchart showing a procedure for detecting the fall of electronic components.

## Description of Embodiments

[0010] An embodiment according to one aspect of the present invention (hereinafter also referred to as "the present embodiment") will be described below in detail with reference to the drawings. In the drawings, identical or corresponding parts are denoted by the same reference numerals, and descriptions thereof will not be repeated. Each drawing is schematically illustrated with omissions or exaggerations of objects as appropriate for ease of understanding. Also, the following description will be given with the directions indicated by arrows U, D, F, B, L, and R being defined as upward, downward, forward, backward, left, and right, respectively in each diagram.

[0011] [1. Configuration of Resin Molding Apparatus]

<1-1. Overall configuration of resin molding apparatus>

FIG. 1 is a schematic plan view of a resin molding apparatus 1 according to the present embodiment. The resin molding apparatus 1 is configured to perform resin encapsulation on a substrate (object O1 to be molded before resin molding) on which electronic components such as semiconductor chips are mounted, and to manufacture a resin molded product (object O1 to be molded after resin molding). In the resin molding apparatus 1, the compression molding method is employed as the resin molding method. In the resin molding apparatus 1, a component mounting surface of a substrate on which electronic components are mounted is resin-encapsulated.

[0012] Examples of substrates include semiconductor substrates such as silicon wafers, lead frames, print circuit boards, metal substrates, resin substrates, glass substrates, and ceramic substrates. The substrate may also be a carrier used in FOWLP (Fan Out Wafer Level Packaging) or FOPLP (Fan Out Panel Level Packaging). Wiring may already be formed on the substrate, but need not necessarily be formed yet.

[0013] As shown in FIG. 1, the resin molding apparatus 1 includes a substrate carry-in/out module 10, a substrate deliver module 20, two molding modules 30, a

resin supply module 40, and a control portion 50. The control portion 50 includes, for example, a central processing unit (CPU), a random access memory (RAM), a read only memory (ROM), and the like. The control portion 50 is configured to control, for example, the substrate carry-in/out module 10, the substrate deliver module 20, the two molding modules 30, and the resin supply module 40, according to a control program.

[0014] Each of the substrate carry-in/out module 10, the substrate deliver module 20, the molding modules 30, and the resin supply module 40 is attachable to, detachable from, and exchangeable with other modules. In the resin molding apparatus 1, the number of substrate carry-in/out modules 10, substrate deliver modules 20, molding modules 30, and resin supply modules 40 can be increased or reduced.

[0015] The substrate carry-in/out module 10 is configured to carry in a substrate (object O1 to be molded before resin molding) on which electronic components are mounted, and to carry out a resin molded product (object O1 to be molded after resin molding). For example, the shape of the substrate is a rectangular shape, with each side of the substrate having a length of 600 mm. The substrate carry-in/out module 10 includes a carry-in portion 11, a carry-out portion 12, an inspection portion 13, and an arm mechanism 14.

[0016] The carry-in portion 11 houses the object O1 to be molded before resin molding. The carry-out portion 12 houses the object O1 to be molded after resin molding (resin molded product). Each of the carry-in portion 11 and the carry-out portion 12 can house a plurality of objects O1 to be molded. The inspection portion 13 inspects the resin molded products. In the inspection portion 13, the resin molded product is placed and inspected.

[0017] The arm mechanism 14 moves the object O1 to be molded to a predetermined position. The arm mechanism 14 includes an adsorption hand portion 14a, an arm portion 14b, and a drive portion 14c. The adsorption hand portion 14a

can hold the object O1 to be molded by adsorbing the object O1 to be molded. The adsorption hand portion 14a is attached to the arm portion 14b. The drive portion 14c drives the arm portion 14b. The drive portion 14c enables, for example, the rotation of the arm portion 14b and the movement of the arm portion 14b.

[0018] The substrate deliver module 20 is configured to deliver the object O1 to be molded between the substrate carry-in/out module 10 and the molding module 30. The substrate deliver module 20 includes a loader 21 and an unloader 22.

[0019] The loader 21 receives the object O1 to be molded before resin molding from the arm mechanism 14 and conveys the object O1 to be molded to a resin molding portion 300 (described later) of the molding module 30. The unloader 22 receives the resin molded product from the resin molding portion 300 and conveys the resin molded product to the substrate carry-in/out module 10. Each of the loader 21 and the unloader 22 is movable along a rail L1 that extends in the left-right direction. In the present embodiment, the loader 21 and the unloader 22 are connected to each other, and the loader 21 and the unloader 22 move together as a single unit.

[0020] The molding module 30 is configured to perform resin molding on the object O1 to be molded by using a resin material supplied from the resin supply module 40. In the present embodiment, two molding modules 30 are arranged adjacent to each other. By performing resin molding in parallel in the two molding modules 30, the manufacturing efficiency of resin molded products is improved. Each molding module 30 includes a resin molding portion 300. The resin molding portion 300 will be described in detail later.

[0021] The resin supply module 40 is configured to supply a resin material to the resin molding portion 300 of the molding module 30. The resin supply module 40 includes two resin material housing devices 100, two small trays 41, two small tray conveying mechanisms 42, a large tray 43, and a large tray conveying mechanism 44.

[0022] Each resin material housing device 100 stores a resin material. The resin material housing devices 100 are associated with the respective small trays 41. The

small trays 41 are capable of holding the resin materials on the upper surfaces thereof. In a plan view, the size of each small tray 41 is, for example, about one-quarter the size of the large tray 43. The resin material housing devices 100 supply the resin materials to the associated small trays 41. The two resin material housing devices 100 supply the resin materials, in parallel, for example, to the associated small trays 41.

[0023] The small trays 41 are associated with the respective small tray conveying mechanisms 42. The small tray conveying mechanisms 42 move the associated small trays 41 between the resin material housing devices 100 and the large tray 43. After the small tray 41 moves to a position above the large tray 43, the resin material is supplied from the small tray 41 to the large tray 43. The large tray 43 is capable of holding the resin material on the upper surface thereof. The planar shape of the large tray 43 is, for example, substantially the same as the planar shape (for example, a rectangular shape) of a cavity (described later) in the resin molding portion 300.

[0024] The resin material is supplied to the large tray 43 by the small tray 41 multiple times, thereby supplying the amount of resin material necessary for one resin molding operation to the upper surface of the large tray 43. By controlling the position at which the resin material is supplied by the small tray 41 to the large tray 43 each time, uneven distribution of the resin material on the large tray 43 is suppressed.

[0025] The large tray conveying mechanism 44 moves the large tray 43. The large tray conveying mechanism 44 moves along the rail L1. After the large tray 43 moves to a predetermined position in the resin molding portion 300, the resin material is supplied from the large tray 43 into the cavity in the resin molding portion 300.

[0026] <1-2. Configuration of resin molding portion>

FIG. 2 is a schematic plan view of a portion of the resin molding portion 300. As shown in FIG. 2, the resin molding portion 300 includes a molding die 305, and optical sensors 352, 354, 356, and 358. In a plan view, the shape of the molding die

305 is a rectangular shape. The molding die 305 has a side SD1 and a side SD2 that face each other, and a side SD3 and a side SD4 that face each other. The optical sensor 352 is disposed along the side SD1, and the optical sensor 354 is disposed along the side SD2. The optical sensor 356 is disposed along the side SD3, and the optical sensor 358 is disposed along the side SD4. The molding die 305 is surrounded by the optical sensors 352, 354, 356, and 358. The optical sensors 352, 354, 356, and 358 will be described in detail later.

[0027] FIG. 3 is a schematic view of a portion of a cross-section taken along line III-III in FIG. 2. As shown in FIG. 3, the resin molding portion 300 includes a fixed platen 310, a molding die 305, a moving platen 340, a clamping mechanism 350, and a base 360.

[0028] The fixed platen 310, the moving platen 340, and the base 360 are plate-shaped members having a rectangular shape in a plan view. Tie bars (not shown) extend downward from the four corners of the fixed platen 310. The moving platen 340 is located below the fixed platen 310. The tie bars pass through the four corners of the moving platen 340, and the moving platen 340 is movable in an up-down direction relative to the tie bars. The clamping mechanism 350 is fixed on the base 360 and moves the moving platen 340 in the up-down direction. The clamping mechanism 350 is achieved, for example, by a combination of a servomotor and a ball screw, a combination of a hydraulic cylinder and a link mechanism, or the like.

[0029] The molding die 305 includes an upper die 320 and a lower die 330. The molding die 305 is disposed between the fixed platen 310 and the moving platen 340. More specifically, the upper die 320 is fixed to a lower surface of the fixed platen 310, and the lower die 330 is fixed to an upper surface of the moving platen 340. As a result of the moving platen 340 moving in the up-down direction, the lower die 330 also moves in the up-down direction together with the moving platen 340. The moving platen 340 rises to clamp the molding die 305, and the moving platen 340 lowers to open the molding die 305.

[0030] The lower die 330 includes a base plate 334, a bottom member 331, springs 333, and a side member 332. The base plate 334 is a plate-shaped member having a rectangular shape in a plan view. The base plate 334 is fixed to the upper surface of the moving platen 340. The bottom member 331 is a block-shaped member having a rectangular shape in a plan view. The bottom member 331 is fixed to an upper surface of the base plate 334 and is located at a substantially central portion of the base plate 334. The side member 332 is a frame-shaped member that surrounds the periphery of the bottom member 331. The side member 332 is fixed to the base plate 334 via a plurality of springs 333.

[0031] An upper surface of the side member 332 is located above an upper surface of the bottom member 331, and a cavity (recess) is formed in an upper surface of the lower die 330. A release film F1 is placed in this cavity, and a resin material R1 is placed on the release film F1. The object O1 to be molded is placed on the lower surface of the upper die 320. The object O1 to be molded includes a substrate P1 and a plurality of electronic components C1 mounted on the substrate P1. The plurality of electronic components C1 are located under the substrate P1 in a state in which the object O1 to be molded is placed on the lower surface of the upper die 320. By clamping the molding die 305 in a state in which the release film F1, on which the resin material R1 is placed, is placed in the cavity of the lower die 330 and the object O1 to be molded is placed on the lower surface of the upper die 320, the component mounting surface of the object O1 to be molded is resin-encapsulated.

[0032] In this manner, the plurality of electronic components C1 are located under the substrate P1 in a state in which the object O1 to be molded is placed on the lower surface of the upper die 320. For example, when a foreign object is lodged between the substrate P1 and an electronic component C1, the electronic component C1 may fall from the substrate P1. When compression molding is performed in a state in which an electronic component C1 has fallen onto the lower die 330, defects such as damage to the lower die 330 or the substrate P1 may occur.

[0033] To suppress the occurrence of such defects, in the resin molding portion 300, optical sensors 352, 354, 356, and 358 are arranged around the molding die 305. As will be described in more detail later, the optical sensors 352, 354, 356, and 358 detect that at least one of the plurality of electronic components C1 has fallen downward from the substrate P1. For example, the optical sensors 352 and 356 have the same configuration, and the optical sensors 354 and 358 have the same configuration.

[0034] FIG. 4 is a schematic view of a portion of a cross-section taken along line IV-IV in FIG. 2. As shown in FIG. 4, the optical sensor 352 includes a plurality of light emitters 362 and a plurality of light receivers 364. Each of the plurality of light emitters 362 includes a plurality of light-emitting elements arranged in the front-back direction, and each light-emitting element emits light to the space between the upper die 320 and the lower die 330. Each of the plurality of light emitters 362 is associated with any one of the plurality of light receivers 364 (described later) included in the optical sensor 354, and emits light to the associated light receiver 364. Each of the plurality of light receivers 364 includes a plurality of light-receiving elements arranged in the front-back direction, and each light-receiving element receives light. Each of the plurality of light receivers 364 is associated with any one of the plurality of light emitters 362 (described later) included in the optical sensor 354, and receives light emitted by the associated light emitter 362. The fall of the electronic component C1 is detected when the amount of light received per unit time in at least one of the plurality of light receivers 364 is a predetermined amount or less. The plurality of light emitters 362 are arranged in one line in the front-back direction. The plurality of light receivers 364 are arranged in one line in the front-back direction. In the optical sensor 352, the plurality of light emitters 362 are located above the plurality of light receivers 364.

[0035] Also, the plurality of light emitters 362 and the plurality of light receivers 364 are arranged in a staggered pattern. In other words, the plurality of light emitters

362 and the plurality of light receivers 364 are arranged such that, in the front-back direction, a light receiver 364 is located between two adjacent light emitters 362, and a light emitter 362 is located between two adjacent light receivers 364. Note that the light-emitting element may be constructed using a light-emitting diode, a laser diode, or the like. The light-receiving element may be constructed using a photodiode, a phototransistor, or the like.

[0036] FIG. 5 is a schematic view of a portion of a cross-section taken along line V-V in FIG. 2. As shown in FIG. 5, the optical sensor 354 includes a plurality of light emitters 362 and a plurality of light receivers 364. The plurality of light emitters 362 emit light to the space between the upper die 320 and the lower die 330. More specifically, each of the plurality of light emitters 362 is associated with any one of the plurality of light receivers 364 included in the optical sensor 352, and emits light to the associated light receiver 364. Each of the plurality of light receivers 364 is associated with any one of the plurality of light emitters 362 included in the optical sensor 352, and receives light emitted by the associated light emitter 362. The fall of the electronic component C1 is detected when the amount of light received in each light receiver 364 is a predetermined amount or less. The plurality of light emitters 362 are arranged in one line in the front-back direction. The plurality of light receivers 364 are arranged in one line in the front-back direction. In the optical sensor 354, the plurality of light emitters 362 are located below the plurality of light receivers 364.

[0037] For example, light emitters 362A and 362B (see FIG. 4) in the optical sensor 352 are associated with light receivers 364C and 364D in the optical sensor 354, respectively, and light receivers 364A and 364B (see FIG. 4) in the optical sensor 352 are associated with light emitters 362C and 362D in the optical sensor 354, respectively. In other words, a light path extending from the optical sensor 352 to the optical sensor 354 is formed between the light emitter 362A and the light receiver 364C, and between the light emitter 362B and the light receiver 364D. A light path

extending from the optical sensor 354 to the optical sensor 352 is formed between the light emitter 362C and the light receiver 364A, and between the light emitter 362D and the light receiver 364B.

[0038] Referring to FIG. 2 again, in the space between the upper die 320 and the lower die 330, in a plan view, a plurality of light paths LP1 between the optical sensors 352 and 354 and a plurality of light paths LP1 between the optical sensors 356 and 358 intersect with each other. As a result, in the space between the upper die 320 and the lower die 330, the plurality of light paths LP1 are formed in a mesh-like structure. It is detected that at least one of the plurality of electronic components C1 has fallen downward from the substrate P1, based on the results of light reception by each light receiver 364,. Therefore, with the resin molding apparatus 1, even when any of the electronic components C1 has fallen with its long side parallel to one light path LP1 (for example, the light path LP1 between optical sensors 352 and 354), the electronic component C1 can block another light path LP1 (for example, the light path LP1 between optical sensors 356 and 358), thus suppressing the occurrence of detection failures caused by the falling orientation of the electronic component C1.

[0039] As described above, in the resin molding apparatus 1, the plurality of light emitters 362 included in the optical sensor 352 and the plurality of light receivers 364 included in the optical sensor 352 are arranged in a staggered pattern, and the plurality of light emitters 362 included in the optical sensor 354 and the plurality of light receivers 364 included in the optical sensor 354 are arranged in a staggered pattern. Therefore, with the resin molding apparatus 1, because the width between adjacent light paths LP1 is relatively narrow, the fall of the electronic component C1 can be detected with relatively high accuracy. Also, with the resin molding apparatus 1, there is a certain amount of space between adjacent light emitters 362 and between adjacent light receivers 364, and each light receiver 364 is less likely to receive light emitted by light emitters other than the corresponding light emitter 362, thereby suppressing the occurrence of false detections related to the fall of the electronic

component C1.

[0040] FIG. 6 is a schematic view of a portion of a cross-section taken along line VI-VI in FIG. 4. As shown in FIG. 6, in the optical sensor 352, a portion of the light emitter 362 is covered by a cover 382, and a portion of the light receiver 364 is covered by a cover 384. Each of the covers 382 and 384 has an L-shape. A slit S1 is formed in the surface of the cover 382 facing the light-emitting element of the light emitter 362. Light emitted by the light emitter 362 enters the space between the upper die 320 and the lower die 330 through the slit S1. Also, a slit S2 is formed in the surface of the cover 384 facing the light-receiving element of the light receiver 364. The light receiver 364 receives the light that has passed through the slit S2. Note that in the optical sensor 354 as well, the light emitter 362 and the light receiver 364 are covered by the covers 382 and 384, respectively.

[0041] FIG. 7 is a schematic diagram showing an exemplary light path LP1 extending in the left-right direction. As shown in FIG. 7, for example, the spread of light emitted by the light emitters 362 included in the optical sensor 352 is suppressed by the slit S1 in the cover 382. If the cover 382 is not provided, there is a possibility that the light emitted by the light emitters 362 is reflected from the lower surface of the upper die 320 or the upper surface of the lower die 330.

[0042] When such reflection occurs, light emitted by a light emitter 362 other than the light emitter 362 associated with a certain light receiver 364 included in the optical sensor 354 becomes more likely to enter this light receiver 364. This increases the likelihood of false detection of the fall of the electronic component C1. In the resin molding apparatus 1, the spread of light emitted by the light emitter 362 is suppressed by the slit S1 formed in the cover 382, thereby suppressing light reflection on both the upper die 320 and the lower die 330.

[0043] Furthermore, in the resin molding apparatus 1, the light emitted by a light emitter 362 included in the optical sensor 352 passes through the slit S2 and is received by a corresponding light receiver 364 included in the optical sensor 354.

Therefore, with the resin molding apparatus 1, since the angle at which light enters each light receiver 364 is limited, it is possible to suppress the entry of light reflected from the upper die 320 and the lower die 330 into each light receiver 364.

[0044] FIG. 8 is a schematic view of a cross-section taken along line VIII-VIII in FIG. 2. As shown in FIG. 8, between the optical sensors 356 and 358, a portion of each light path LP1 is inclined with respect to the lower surface of the upper die 320 and the upper surface of the lower die 330, respectively. The optical sensor 356 is disposed such that the light emitters 362 and the light receivers 364 included in the optical sensor 356 each face backward and diagonally upward, and the optical sensor 358 is disposed such that the light emitters 362 and the light receivers 364 included in the optical sensor 358 each face downward. The optical sensor 358 is, for example, disposed along a side surface of the upper die 320. A mirror 370 is disposed in the light path between the optical sensors 356 and 358, the mirror 370 reflecting the light emitted by the light emitters 362 included in the optical sensor 356 toward the light receivers 364 included in the optical sensor 358, and also reflecting the light emitted by the light emitters 362 included in the optical sensor 358 toward the light receivers 364 included in the optical sensor 356.

[0045] As the optical sensor 358 and the mirror 370 are disposed on the upper side, an entry path and an exit path for the loader 21, the large tray conveying mechanism 44, and the like are secured in the space between the upper die 320 and the lower die 330. Thus, with the resin molding apparatus 1, even if there are constraints on the size of the space between the upper die 320 and the lower die 330, it is possible to easily secure the entry and exit paths for various mechanisms (for example, the loader 21, the unloader 22, and the large tray conveying mechanism 44, etc.) into the space, compared to the case where the entire light path LP1 between the optical sensors 356 and 358 is parallel to the lower surface of the upper die 320 and the upper surface of the lower die 330, respectively.

[0046] [2. Operation]

<2-1. Basic operation>

FIG. 9 is a flowchart showing a basic operating procedure of the resin molding apparatus 1. The processing shown in this flowchart is repeatedly executed at predetermined intervals by the control portion 50, for example.

[0047] Referring to FIG. 9, the control portion 50 controls the arm mechanism 14 to convey the object O1 to be molded, which is housed in the carry-in portion 11, to the loader 21 (step S100). The control portion 50 controls the loader 21 to place the object O1 to be molded on the upper surface of the upper die 320 (step S110). Specifically, the control portion 50 controls the loader 21 to enter the space between the upper die 320 and the lower die 330, controls the loader 21 to position the object O1 to be molded on the upper surface of the upper die 320, and controls the loader 21 to exit from the space between the upper die 320 and the lower die 330.

[0048] The control portion 50 executes processing for placing the release film F1 on the upper surface of the lower die 330 (step S120). The control portion 50 controls the large tray conveying mechanism 44 and the large tray 43 such that the resin material R1 is placed on the upper surface of the lower die 330 (on the release film F1) (step S130). Specifically, the control portion 50 controls the large tray conveying mechanism 44 to enter the space between the upper die 320 and the lower die 330, controls the large tray conveying mechanism 44 and the large tray 43 to position the resin material R1 on the upper surface of the lower die 330, and controls the large tray conveying mechanism 44 to exit from the space between the upper die 320 and the lower die 330. Prior to step S130, the supply of the resin material R1 from the resin material housing device 100 to the small tray 41 and the supply of the resin material R1 from the small tray 41 to the large tray 43 are carried out in parallel.

[0049] The control portion 50 controls a heating portion (not shown) to melt the resin material R1 placed on the upper surface (inside the cavity) of the lower die 330 (step S140). When the resin material R1 melts, the control portion 50 controls the clamping mechanism 350 to clamp the molding die 305 (step S150). When

compression molding is complete, the control portion 50 controls the clamping mechanism 350 to open the molding die 305 (step S160).

[0050] The control portion 50 controls the unloader 22 to hold the manufactured resin molded product and controls the arm mechanism 14 to receive the resin molded product from the unloader 22 (step S170). The control portion 50 controls the arm mechanism 14 to convey the resin molded product to the inspection portion 13, and controls the inspection portion 13 to inspect the conveyed resin molded product (step S180). The control portion 50 controls the arm mechanism 14 to convey the inspected resin molded product to the carry-out portion 12 (step S190). The resin molded product is manufactured through such a procedure.

[0051] <2-2. Fall detection operation>

FIG. 10 is a flowchart showing a procedure for starting and stopping detection of the fall of the electronic components C1. The processing shown in this flowchart is repeatedly executed at predetermined intervals by the control portion 50, for example.

[0052] Referring to FIG. 10, the control portion 50 determines whether the loader 21 has finished exiting from the space between the upper die 320 and the lower die 330 after the object O1 to be molded has been placed on the lower surface of the upper die 320 (step S200). If it is determined that the loader 21 has not yet exited (NO in step S200), the control portion 50 executes the processing in step S200 again.

[0053] On the other hand, if it is determined that the loader 21 has finished exiting (YES in step S200), the control portion 50 executes the processing for starting detection of the fall of the electronic components C1 (step S210). Specifically, the control portion 50 controls each of the optical sensors 352, 354, 356, and 358 such that the emission of light by each light emitter 362 is started, and starts acquiring the results of light reception by the light receivers 364 from the optical sensors 352, 354, 356, and 358.

[0054] The control portion 50 determines whether or not the timing for the large

tray conveying mechanism 44 to enter the space between the upper die 320 and the lower die 330 has arrived (step S220). If it is determined that the timing for the large tray conveying mechanism 44 to enter the space has not yet arrived (NO in step S220), the control portion 50 continues the fall detection processing and executes the processing in step S220.

[0055] On the other hand, if it is determined that the timing for the large tray conveying mechanism 44 to enter the space has arrived (YES in step S220), the control portion 50 executes the processing for stopping detection of the fall of the electronic components C1 (step S230). Specifically, the control portion 50 controls each of the optical sensors 352, 354, 356, and 358 such that the emission of light by each light emitter 362 is stopped.

[0056] Thus, in the resin molding apparatus 1, the detection of the fall of the electronic components C1 is not executed while the loader 21 or the like is entering the space between the upper die 320 and the lower die 330. Therefore, with the resin molding apparatus 1, it is possible to suppress the occurrence of false detections of the fall of the electronic components C1 due to light blocking caused by the entry of the loader 21 or the like.

[0057] FIG. 11 is a flowchart showing a procedure for detecting the fall of the electronic components C1. The processing shown in this flowchart is executed by the control portion 50, for example, while the processing for detecting the fall of the electronic components C1 is being executed.

[0058] Referring to FIG. 11, the control portion 50 determines whether the amount of light received per unit time by any of the plurality of light receivers 364 included in the optical sensors 352, 354, 356, and 358 has decreased to a predetermined amount or less (step S300). Note that the predetermined amount is determined in advance through experiments, and information regarding the predetermined amount is stored in a memory (not shown) of the control portion 50. If it is determined that the amount of light received per unit time by each light receiver

364 is greater than the predetermined amount (NO in step S300), the control portion 50 executes the processing in step S300 again.

[0059] On the other hand, if it is determined that the amount of light received per unit time by any of the plurality of light receivers 364 is less than or equal to the predetermined amount (YES in step S300), the control portion 50 executes the processing for stopping the compression molding in the resin molding portion 300 (step S310).

[0060] Thus, in the resin molding apparatus 1, compression molding is stopped when it is detected that at least one of the plurality of electronic components C1 has fallen downward from the substrate P1. Therefore, with the resin molding apparatus 1, compression molding is stopped when any of the electronic components C1 has fallen from the substrate P1. This makes it possible to suppress damage to the substrate P1 and the lower die 330 caused by the continuation of compression molding when the electronic component C1 has fallen from the substrate P1.

[0061] [3. Features]

As described above, in the resin molding apparatus 1 according to the present embodiment, in a state in which the object O1 to be molded is placed on the lower surface of the upper die 320, the fall of at least one of the plurality of electronic components C1 downward from the substrate P1 is detected by the optical sensors 352, 354, 356, and 358. Therefore, with the resin molding apparatus 1, appropriate measures can be taken when an electronic component C1 has fallen from the substrate P1. Thus, for example, it is possible to suppress the occurrence of defects that may occur due to compression molding continuing when the electronic component C1 has fallen from the substrate P1.

[0062] The resin molding apparatus 1 is an example of the “resin molding apparatus” in the present invention. The upper die 320 is an example of the “upper die” in the present invention, and the lower die 330 is an example of the “lower die” in the present invention. The molding die 305 is an example of the “molding die” in

the present invention. The clamping mechanism 350 is an example of the "clamping mechanism" in the present invention. The optical sensors 352, 354, 356, and 358 are examples of the "sensor" in the present invention. The control portion 50 is an example of the "control portion" in the present invention. The configuration constituted by the plurality of light emitters 362 included in the optical sensors 352, 354, 356, and 358 is an example of the "light-emitting portion" in the present invention. The configuration constituted by the plurality of light receivers 364 included in the optical sensors 352, 354, 356, and 358 are examples of the "light-receiving portion" in the present invention.

[0063] [4. Other Embodiments]

The concept of the above-described embodiment is not limited to the embodiment described above. Examples of other embodiments to which the concept of the above embodiment can be applied will be described below.

[0064] <4-1>

In the above embodiment, the fall of the electronic components C1 is detected by the optical sensors 352, 354, 356, and 358. However, the fall of the electronic components C1 does not necessarily have to be detected by the optical sensor. For example, the space between the upper die 320 and the lower die 330 may be continuously imaged from the side by an image sensor, and the fall of the electronic components C1 may be detected based on moving image data.

[0065] <4-2>

In the above embodiment, the mirror 370 was placed in the light path between optical sensors 356 and 358. However, the mirror 370 does not necessarily have to be placed in the light path between optical sensors 356 and 358. For example, the optical sensor 358 may be disposed to face forward and diagonally downward, thereby ensuring entry and exit paths for the loader 21, the large tray conveying mechanism 44, and the like. In the optical sensor 356, the light emitter 362 and the light receiver 364 do not necessarily have to be covered by the covers 382 and 384, respectively.

In the optical sensor 358, the light emitter 362 and the light receiver 364 do not necessarily have to be covered by the covers 382 and 384, respectively.

[0066] <4-3>

In the above embodiment, when the fall of the electronic components C1 is detected, the compression molding in the resin molding apparatus 1 is stopped. However, when the fall of the electronic components C1 is detected, the compression molding in the resin molding apparatus 1 does not necessarily have to be stopped immediately. For example, a configuration may be adopted in which a buzzer sounds when the fall of the electronic components C1 is detected, or a configuration may be adopted in which a screen is displayed on a display asking an operator whether the compression molding can be stopped.

[0067] <4-4>

In the above embodiment, the light emitted by each light emitter 362 may be continuous light or pulsed light.

[0068] <4-5>

In the above embodiment, in the molding die 305, there is no intermediate die between the upper die 320 and the lower die 330. However, an intermediate die may be provided between the upper die 320 and the lower die 330. The intermediate die is a frame-shaped member having a rectangular hole in the center, and is configured to sandwich the release film F1 together with the lower die 330. For example, the tension on the release film F1 increases when the intermediate die and the lower die 330 sandwich the release film F1.

[0069] <4-6>

In the above embodiment, each light emitter 362 includes a plurality of light-emitting elements. However, the configuration of each light emitter 362 is not limited to this. For example, the number of light-emitting elements included in the light emitter 362 may be one. In this case, the light emitter 362 may further include a branching member that branches the path of light emitted by one light-emitting

element into a plurality of paths, and the branched light may be guided to a plurality of light-emitting openings. In this case, the light-emitting element and the branching member may be connected by a single optical fiber, and the branching member and the plurality of light-emitting openings may be connected by a plurality of optical fibers.

[0070] In the above embodiment, each light receiver 364 includes a plurality of light-receiving elements. However, the configuration of each light receiver 364 is not limited to this. For example, the number of light-receiving elements included in the light receiver 364 may be one. In this case, the light receiver 364 may further include a light-collecting member that collects the light guided through a plurality of light-receiving openings, or the collected light may be received by a single light-receiving element. In this case, a plurality of light-receiving openings and the light-collecting member may be connected by a plurality of optical fibers, and the light-collecting member and the light-receiving elements may be connected by a single optical fiber.

[0071] The embodiments of the present invention have been described as examples above. In other words, detailed descriptions and accompanying drawings are disclosed for illustrative purposes. Therefore, some of the constituent elements described in the detailed descriptions and accompanying drawings may not be essential for solving the problem. Therefore, the mere fact that these non-essential constituent elements are described in the detailed descriptions and accompanying drawings does not automatically mean that they should be considered essential.

[0072] The above embodiments are merely examples of the present invention in all respects. Various improvements and modifications can be made to the above embodiment within the scope of the present invention. For example, at least a portion of the configuration of any one of the embodiments may be combined with at least a portion of the configuration of any other embodiment. In other words, in implementing the present invention, specific configurations can be adopted as

appropriate depending on the embodiment.

[0073] [5. Supplementary Notes]

<Technique 1>

(Configuration)

A resin molding apparatus configured to perform compression molding, comprising:

a molding die including an upper die and a lower die facing the upper die; and

a clamping mechanism configured to clamp the molding die,

wherein the clamping is performed in a state in which an object to be molded is placed on a lower surface of the upper die and a resin is placed on an upper surface of the lower die,

the object to be molded includes a substrate and a plurality of electronic components placed on the substrate,

the plurality of electronic components are located under the substrate in a state in which the object to be molded is placed on the lower surface, and

the resin molding apparatus further comprises a sensor configured to detect that at least one of the plurality of electronic components has fallen downward from the substrate in a state in which the object to be molded is placed on the lower surface.

(Effects etc.)

In the resin molding apparatus, the sensor detects that at least one of the plurality of electronic components has fallen downward from the substrate in a state in which the object to be molded is placed on the lower surface of the upper die. Therefore, according to the resin molding apparatus, appropriate measures can be taken when an electronic component has fallen from the substrate. Thus, for example, it is possible to suppress the occurrence of defects that may occur due to compression molding continuing when the electronic component has fallen from the substrate.

[0074] <Technique 2>

(Configuration)

The resin molding apparatus according to Technique 1, further comprising a control portion configured to execute processing for stopping the compression molding when the sensor detects that at least one of the plurality of electronic components has fallen downward from the substrate.

(Effects etc.)

In the resin molding apparatus, compression molding is stopped when the sensor detects that at least one of the plurality of electronic components has fallen downward from the substrate. Therefore, according to the resin molding apparatus 1, compression molding is stopped when an electronic component has fallen from the substrate. This makes it possible to suppress damage to the substrate and the lower die caused by, for example, the continuation of compression molding when the electronic component has fallen from the substrate.

[0075] <Technique 3>

(Configuration)

The resin molding apparatus according to Technique 1 or 2,

wherein the sensor includes:

a light-emitting portion configured to emit light to a space between the upper die and the lower die in a state in which the clamping is not performed; and

a light-receiving portion configured to receive light emitted by the light-emitting portion, and

the sensor detects that at least one of the plurality of electronic components has fallen downward from the substrate based on a result of light reception by the light-receiving portion.

(Effects etc.)

In the resin molding apparatus, it is detected that at least one of the plurality of electronic components has fallen downward from the substrate, based on the result

of light reception by the light-receiving portion. Therefore, according to the resin molding apparatus, appropriate measures can be taken when an electronic component has fallen from the substrate. Thus, for example, it is possible to suppress the occurrence of defects that may occur due to compression molding continuing when the electronic component has fallen from the substrate.

[0076] <Technique 4>

(Configuration)

The resin molding apparatus according to Technique 3, wherein at least a portion of a light path between the light-emitting portion and the light-receiving portion is inclined with respect to the lower surface and the upper surface.

(Effects etc.)

In the resin molding apparatus, at least a portion of the light path between the light-emitting portion and the light-receiving portion is inclined with respect to the lower surface of the upper die and the upper surface of the lower die. Therefore, with the resin molding apparatus, even if there are constraints on the size of the space between the upper die and the lower die, it is possible to easily secure entry and exit paths for various mechanisms (for example, the object to be molded or the resin conveying mechanism) into the space, compared to the case where the entire light path between the light-emitting portion and the light-receiving portion is parallel to the lower surface of the upper die and the upper surface of the lower die, respectively.

[0077] <Technique 5>

(Configuration)

The resin molding apparatus according to Technique 3 or 4, wherein the light-emitting portion includes a first light-emitting portion and a second light-emitting portion,

the light-receiving portion includes a first light-receiving portion and a second light-receiving portion,

in a plan view, a shape of the molding die is a rectangular shape,

the rectangular shape includes a first side and a second side that face each other, and a third side and a fourth side that face each other,

the first light-emitting portion is formed along the first side,

the first light-receiving portion is formed along the second side,

the second light-emitting portion is formed along the third side, and

the second light-receiving portion is formed along the fourth side.

(Effects etc.)

In the resin molding apparatus, the light path between the first light-emitting portion and the first light-receiving portion intersects with the light path between the second light-emitting portion and the second light-receiving portion. Therefore, according to the resin molding apparatus, even when an electronic component has fallen with its long side parallel to one light path, the electronic component can block another light path, thus suppressing the occurrence of detection failures caused by the falling orientation of the electronic component.

[0078] <Technique 6>

(Configuration)

The resin molding apparatus according to Technique 3 or 4,

wherein the light-emitting portion includes a first light-emitting portion and a second light-emitting portion,

each of the first light-emitting portion and the second light-emitting portion includes a plurality of light emitters,

the light-receiving portion includes a first light-receiving portion and a second light-receiving portion,

each of the first light-receiving portion and the second light-receiving portion includes a plurality of light receivers,

in a plan view, a shape of the molding die is a rectangular shape,

the rectangular shape includes a first side and a second side that face each other,

the plurality of light emitters included in the first light-emitting portion are arranged in a line along the first side,

the plurality of light receivers included in the first light-receiving portion are arranged in a line along the first side,

the plurality of light emitters included in the first light-emitting portion are located above the plurality of light receivers included in the first light-receiving portion,

the plurality of light emitters included in the first light-emitting portion and the plurality of light receivers included in the first light-receiving portion are arranged in a staggered pattern,

the plurality of light emitters included in the second light-emitting portion are arranged in a line along the second side,

the plurality of light receivers included in the second light-receiving portion are arranged in a line along the second side,

the plurality of light emitters included in the second light-emitting portion are located below the plurality of light receivers included in the second light-receiving portion, and

the plurality of light emitters included in the second light-emitting portion and the plurality of light receivers included in the second light-receiving portion are arranged in a staggered pattern.

(Effects etc.)

In the resin molding apparatus, the plurality of light emitters included in the first light-emitting portion and the plurality of light receivers included in the first light-receiving portion are arranged in a staggered pattern, and the plurality of light emitters included in the second light-emitting portion and the plurality of light receivers included in the second light-receiving portion are arranged in a staggered pattern. Therefore, according to the resin molding apparatus, because the width between light paths is relatively narrow, the fall of the electronic components can be detected with

relatively high accuracy. Also, according to the resin molding apparatus, there is a certain amount of space between adjacent light emitters and between adjacent light receivers, and each light receiver is less likely to receive light emitted by light emitters other than the corresponding light emitter, thereby suppressing the occurrence of false detections related to the fall of the electronic components.

[0079] <Technique 7>

(Configuration)

The resin molding apparatus according to Technique 6,

wherein at least a portion of each of the plurality of light emitters is covered by a first cover having a first slit, and

each of the plurality of light emitters emits light into the space through the first slit.

(Effects etc.)

In the resin molding apparatus, light emitted by each of the plurality of light emitters enters the space between the upper die and the lower die through the first slit. Therefore, with this resin molding apparatus, the spread of light is suppressed by the first slit, thus suppressing light reflection on both the upper die and the lower die.

[0080] <Technique 8>

(Configuration)

The resin molding apparatus according to Technique 6 or 7,

wherein at least a portion of each of the plurality of light receivers is covered by a second cover having a second slit, and

each of the plurality of light receivers receives light emitted by the light-emitting portion through the second slit.

(Effects etc.)

In the resin molding apparatus, light emitted by the light-emitting portion enters each of the plurality of light receivers through the second slit. Therefore, according to the resin molding apparatus, since the angle at which light enters each

light receiver is limited, it is possible to suppress the entry of light reflected from the upper die and the lower die into each light receiver.

[0081] <Technique 9>

(Configuration)

A method for manufacturing a resin molded product using the resin molding apparatus according to any one of Techniques 1 to 8, the method including:

placing the object to be molded on the lower surface;

placing a resin on the upper surface; and

clamping the molding die.

(Effects etc.)

In the method for manufacturing a resin molded product, the sensor detects that at least one of the plurality of electronic components has fallen downward from the substrate in a state in which the object to be molded is placed on the lower surface of the upper die. Therefore, according to the method for manufacturing the resin molding apparatus, appropriate measures can be taken when an electronic component has fallen from the substrate. Thus, for example, it is possible to suppress the occurrence of defects that may occur due to compression molding continuing when the electronic component has fallen from the substrate.

List of Reference Numerals

[0082]

| | |
|---|---|
| 1 | Resin molding apparatus |
| 10 | Substrate carry-in/out module |
| 11 | Carry-in portion |
| 12 | Carry-out portion |
| 13 | Inspection portion |
| 14 | Arm mechanism |
| 14a | Adsorption hand portion |
| 14b | Arm portion |

| | |
|---|---|
| 14c | Drive portion |
| 20 | Substrate deliver module |
| 21 | Loader |
| 22 | Unloader |
| 30 | Molding module |
| 40 | Resin supply module |
| 41 | Small tray |
| 42 | Small tray conveying mechanism |
| 43 | Large tray |
| 44 | Large tray conveying mechanism |
| 50 | Control portion |
| 100 | Resin material housing device |
| 300 | Resin molding portion |
| 305 | Molding die |
| 310 | Fixed platen |
| 320 | Upper die |
| 330 | Lower die |
| 331 | Bottom member |
| 332 | Side member |
| 333 | Spring |
| 334 | Base plate |
| 340 | Moving platen |
| 350 | Clamping mechanism |
| 352, 354, 356, 358 | Optical sensor |
| 360 | Base |
| 362 | Light emitter |
| 364 | Light receiver |
| 370 | Mirror |

382, 384 Cover

C1 Electronic component

F1 Release film

L1 Rail

LP1 Light path

O1 Object to be molded

P1 Substrate

R1 Resin material

S1, S2 Slit

SD1, SD2, SD3, SD4 Side

# CLAIMS

[Claim 1] A resin molding apparatus configured to perform compression molding, comprising:

a molding die including an upper die and a lower die facing the upper die; and

a clamping mechanism configured to clamp the molding die,

wherein the clamping is performed in a state in which an object to be molded is placed on a lower surface of the upper die and a resin is placed on an upper surface of the lower die,

the object to be molded includes a substrate and a plurality of electronic components placed on the substrate,

the plurality of electronic components are located under the substrate in a state in which the object to be molded is placed on the lower surface, and

the resin molding apparatus further comprises a sensor configured to detect that at least one of the plurality of electronic components has fallen downward from the substrate in a state in which the object to be molded is placed on the lower surface.

[Claim 2] The resin molding apparatus according to claim 1, further comprising

a control portion configured to execute processing for stopping the compression molding when the sensor detects that at least one of the plurality of electronic components has fallen downward from the substrate.

[Claim 3] The resin molding apparatus according to claim 1 or 2,

wherein the sensor includes:

a light-emitting portion configured to emit light to a space between the upper die and the lower die in a state in which the clamping is not performed; and

a light-receiving portion configured to receive light emitted by the light-emitting portion, and

the sensor detects that at least one of the plurality of electronic components has fallen downward from the substrate based on a result of light reception by the light-receiving portion.

[Claim 4] The resin molding apparatus according to claim 3,

wherein at least a portion of a light path between the light-emitting portion and the light-receiving portion is inclined with respect to the lower surface and the upper surface.

[Claim 5] The resin molding apparatus according to claim 3 or 4,

wherein the light-emitting portion includes a first light-emitting portion and a second light-emitting portion,

the light-receiving portion includes a first light-receiving portion and a second light-receiving portion,

in a plan view, a shape of the molding die is a rectangular shape,

the rectangular shape includes a first side and a second side that face each other, and a third side and a fourth side that face each other,

the first light-emitting portion is formed along the first side,

the first light-receiving portion is formed along the second side,

the second light-emitting portion is formed along the third side, and

the second light-receiving portion is formed along the fourth side.

[Claim 6] The resin molding apparatus according to claim 3 or 4,

wherein the light-emitting portion includes a first light-emitting portion and a second light-emitting portion,

each of the first light-emitting portion and the second light-emitting portion

includes a plurality of light emitters,

the light-receiving portion includes a first light-receiving portion and a second light-receiving portion,

each of the first light-receiving portion and the second light-receiving portion includes a plurality of light receivers,

in a plan view, a shape of the molding die is a rectangular shape,

the rectangular shape includes a first side and a second side that face each other,

the plurality of light emitters included in the first light-emitting portion are arranged in a line along the first side,

the plurality of light receivers included in the first light-receiving portion are arranged in a line along the first side,

the plurality of light emitters included in the first light-emitting portion are located above the plurality of light receivers included in the first light-receiving portion,

the plurality of light emitters included in the first light-emitting portion and the plurality of light receivers included in the first light-receiving portion are arranged in a staggered pattern,

the plurality of light emitters included in the second light-emitting portion are arranged in a line along the second side,

the plurality of light receivers included in the second light-receiving portion are arranged in a line along the second side,

the plurality of light emitters included in the second light-emitting portion are located below the plurality of light receivers included in the second light-receiving portion, and

the plurality of light emitters included in the second light-emitting portion and the plurality of light receivers included in the second light-receiving portion are arranged in a staggered pattern.

[Claim 7] The resin molding apparatus according to claim 6,

wherein at least a portion of each of the plurality of light emitters is covered by a first cover having a first slit, and

each of the plurality of light emitters emits light into the space through the first slit.

[Claim 8] The resin molding apparatus according to claim 6 or 7,

wherein at least a portion of each of the plurality of light receivers is covered by a second cover having a second slit, and

each of the plurality of light receivers receives light emitted by the light-emitting portion through the second slit.

[Claim 9] A method for manufacturing a resin molded product using the resin molding apparatus according to any one of claims 1 to 8, the method comprising:

placing the object to be molded on the lower surface;

placing a resin on the upper surface; and

clamping the molding die.