

A COMPACT AND RELIABLE PRESS FOR PACKAGING SEMICONDUCTOR DEVICES

FIELD OF THE INVENTION

- 5 The present invention relates to a press for molding electronic devices. In particular, the present invention pertains to a compact, reliable press for encapsulating semiconductor devices.

BACKGROUND OF THE INVENTION

- 10 Mechanical and electromechanical presses are well known in the packaging industry for encapsulating semiconductor devices. The trend in the semiconductor field to pack more devices onto a single integrated circuit chip means that new and more reliable methods for packaging ever larger footprint semiconductors are required to sustain the growth of the semiconductor
15 industry.

- Existing presses for encapsulating semiconductors are encountering problems such as flashes and related quality control issues as a result of the industry having to increase clamping tonnage to cater for multiple cavity moulds for large
20 footprint semiconductors. By flashes, the present invention refers to the leakage of resin from the cavities of the moulds. As a direct result, the yield of acceptable end products from the semiconductor packaging industry has dropped.

- 25 The industry has responded by increasing the thickness of the plates of the presses and moulds. Some attempted to control the clamping tonnage of the

presses. In general, presses that are capable addressing the quality control issues outlined above tend to be larger than those used previously.

OBJECT OF THE INVENTION

- 5 It is an object of the present invention to overcome the flash problem without the attendant disadvantages of existing solutions.

It is a further object of the present invention to package semiconductor devices with a compact and reliable press.

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It is yet another object of the present invention to package semiconductor devices with improve yield.

- 15 It is an additional object of the present invention to package semiconductor devices without flashes economically.

It is yet another further object of the present invention to direct the clamping force onto the critical areas of the mould sets while minimizing dissipation of energy to the press.

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SUMMARY OF THE INVENTION

- The present invention is an electromechanical press that features a separate clamping mechanism from the closing and opening mechanism for the mould. By incorporating a clamping assembly and a clamping plate in a transfer mould
- 25 press, the present invention directs the clamping force onto the cavities. In the process, the reaction force from the clamping operation is deflected to the top and bottom plates of the press instead of the supporting plates for the mould

halves. As such, the cavities of the mould are closed fittingly at the critical moment and leakage of resin from the transfer operation is greatly minimized. It follows that a thinner clamping plate can be used without compromising the yield of the overall packaging process. By employing a transfer ball screw for the clamping mechanism, the present invention directs the clamping force onto the leadframe of the mould and minimizes the dissipation of energy to the peripheral areas of the mould set.

BRIEF DESCRIPTION OF THE DRAWINGS

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Fig. 1 is top, left, perspective, elevational view of the present invention.

Fig. 2 is a front, plan, elevational view of the present invention without the top mould.

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Fig. 3 is top, right, partial cutaway, perspective, elevational view of the present invention.

Fig. 4 is a top, plan, partial cutaway view of the present invention.

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Fig. 5 is a front, plan, elevational and simplified view of a prior art press for encapsulating semiconductors.

Fig. 6 is a front, plan, elevational and simplified view of the present invention.

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DETAILED DESCRIPTION OF THE INVENTION

Fig. 1 is top, left, perspective, elevational view of the present invention. A press 10 comprises a bottom plate 15, an open/close plate 20, a top plate 25, a plurality of tie bars 30, 32, 34 and 36, a clamping plate 40, a support plate 42, a lifting assembly 44, a clamping assembly 50, and a pair of mould assembly 70 (only a bottom mould 74 is shown in the figures). The plates 15, 20, 25, 40, and 42 are substantially parallel with each other in a planar fashion, secured at their corners by the plurality of tie bars 30, 32, 34 and 36 respectively. The lifting assembly is coupled at one end on the top surface of the bottom plate 15 and the other end to the bottom surface of the open/close plate 20 for providing the moving force thereto. Likewise, the clamping assembly 50 is secured at one end on the bottom surface of the top plate 25 and the other end on the top surface of the clamping plate 40. The open/close plate 20 moves slidably along the tie bars with respect to the bottom plate 15. The clamping assembly 50 moves the top mould 72 relative to the top plate 25. The bottom mould 74 is coupled to the top surface of the open/close plate, and the top mould 72 (not shown but understood) to the bottom surface of the clamping plate 40. The lifting assembly 44 raises and lowers the open/close plate 20 in a cooperative manner with the clamping assembly 50 and the clamping plate 40.

One of the novel features of the present invention is the segregation of the opening and closing mechanism (hereinafter open/close mechanism) from the clamping mechanism. As described and elaborated in further details below, having a separate open/close mechanism and clamping mechanism permits

the present invention to achieve the same tonnage without relying on large movers and yet minimize the problem of flashes in encapsulated devices.

It should be understood by one skilled in the art that other subassemblies of a press for encapsulating semiconductor devices are not shown in the drawings and description in order not to detract from the description of the present invention. For instance, the resin feeding, transfer mechanism and plunger arrangements, as well as the control circuitry of a press are not illustrated in the drawing but are understood to be necessary for the normal operations of a moulding press. Similarly, accessories such as input devices and control displays are not shown in order not to interrupt the flow of the presentation of the present invention.

Fig. 2 is a front, plan, elevational view of the present invention without the top mould. The lifting assembly 44 and the clamping assembly 50 are shown in greater details. The lifting assembly 44 rises on the top surface of the bottom plate 15; it comprises at least one lifting cylinder 46, a plurality of support bars 31, 33, 35 and 37, at least one mould close support plate 42 and at least one shuttle cylinder 48. The lifting cylinder 46 is coupled on one end to bottom surface of the open/close plate 20 and the other end to the bottom mould 74 for moving the bottom mould 74 up and down relative to the bottom plate 15. The shuttle cylinder 48 is coupled to the mould close support plate 42 (shown partially in Fig. 2) for facilitating the mould closing operation of the present invention.

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Referring again to Fig. 2, the clamping assembly 50 is disposed on top of the clamping plate 25. The clamping assembly 50 comprises at least one

clamping servo motor or cylinder 52, an actuating ball screw 54, at least one transfer plate 56 and at least one transfer base 58. The clamping assembly 50 can be a ball screw transfer plate. The transfer plate 56 further comprises of a plurality of spherical roller thrust bearings (such as those that complies with ISO 104-1979 standards) 60 and 62 disposed concentrically on the perimeter edge of the transfer base 58 for exerting even force thereon. The transfer plate 56 is flashed with the top surface of the clamping plate 40 for delivering onto the top mould 72 (not shown in the figures except Fig. 5).

10 The clamping assembly 50 of the present invention is more compact than any other clamping mechanism of a comparable pressing tonnage. As will be explained below, the even distribution of clamping force onto the molding area delivered by the clamping assembly 50 also minimizes the problem of resin flashes.

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Fig. 3 is top, right, partial cutaway, perspective, elevational view of the present invention 10. The upper portions of the press 10 are shown in cutaway view to illustrate the clamping assembly 50 in greater details. The top plate 32 and the clamping plate 40 are cut in half and the tie bars 30 and 36 are removed.

20 The clamping assembly 50 comprising of the clamping cylinder 52, the actuating ball screw 54 and the clamping plate 56 are shown coupled to the transfer base 58. In this figure, only one spherical roller thrust bearing 60 is shown resting against the perimeter of the transfer base. The bottom mould 74 with multiple cavities 71 and a plurality of plunger openings 73 rest on the top surface of the open/close plate 20 which in turn is raised and lowered by the lifting assembly 44.

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Again in Fig. 3, the movement of the open/close plate 20 is guided by the tie bars 30, 32, 34 and 36 respectively. A mould close support plate 42 provides further support for the lifting assembly 42 on the top surface of the bottom plate 15. The mould close support plate 42 has a plurality of openings
5 that corresponds to the diameter of the support bars 31, 33, 35 and 37 respectively. Once the mould reaches a close position, the shuttle cylinder 48 moves the mould close support plate 42 laterally to close the openings (not shown in the figures) and allows the lower end of the support bars 31, 33, 35 and 37 to rest on top surface of the mould close support plate 42.

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Fig. 4 is a top, plan, partial cutaway view of the present invention. The bottom plate 15 is shown providing support for the mould close support plate 42. At the four corners of the bottom plate 15 are the tie bars 30, 32, 34 and 36 for supporting the open/close plate 20, the clamping plate 40 and the top plate
15 25 which are all removed in this figure. The outline of the lifting cylinders 46 are shown together with the support bars 31, 33, 35 and 37 respectively. The outline of mould 74 is shown against the outline of the transfer base 58 in the same figure. It is clear that the clamping force exerted on the mould is directed at the cavities region (also leadframe) of the mould 74 instead of the region
20 outside of the mould. It follows that the present invention utilizes the clamping force more efficiently than that of prior art presses because the clamping force from the segregated clamping assembly of the present invention is directed to the more effective area of the mould. Not only is the dissipation of energy reduced significantly but also the problem of flashes is minimized. As such,
25 compact clamping assembly can be deployed with the present invention resulting in cost and energy savings.

While efficient use of clamping force contributes to the reduction of leakage of moulding products in presses, other larger aspects of encapsulation system have to be taken into consideration before the problem of flashes can be totally eliminated. Fig. 5 is a prior art press where the lifting assembly and the clamping assembly are integrated. Typically, the lifting assembly (typically toggling arms) and the clamping assembly are disposed below the bottom mould between the bottom plate 115 and the open/close plate 120. The top mould 172 and the bottom mould 174 are positioned between the top plate 125 and the open/close plate 120. The clamping assembly comprises of a plurality of toggle arms 131, 133, 135, and 137 respectively. When the clamping assembly is actuated, the open/close plate 120 and the top plate 125 experience deflection 120' and 125'. Although the deflections are exaggerated, such deflection results in the incomplete closing of the mould halves 172 and 174 resulting in leakage of resin called flashes. Prior art presses relies on thicker top and open/close plates to minimize such deflection. However, as the semiconductors industry migrates to increasingly larger cavities, increasingly larger clamping assemblies are deployed. Yet the problem of flashes persists.

Fig. 6 is a simplified view of the present invention where thinner open/close plates 20 and clamping plate 40 are employed. As described and explained earlier above, the clamping assembly and the lifting assembly are segregated. The deflection of clamping force of the present invention is directed to the bottom plate 15 and top plate 25 – 15' and 25' respectively. Note, the open/close plate 20 and clamping plate 40 experience relatively deflection. As such, thinner plates can be used. More importantly, the mould halves 72 and 74 encounter minimal amount of displacement. It follows that the problem

of flashes can be avoided. In the process, the present invention makes do with smaller clamping assembly as well as lifting assembly because of the efficiency achieved in clamping and also because of the thinner and lighter open/close and clamping plates.

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The present invention may be embodied in other specific forms without departing from the spirit or essential characteristics thereof. The presently disclosed embodiments are, therefore, to be considered in all respects as illustrative and not restrictive, the scope of the invention being indicated by the
10 appended claims and all changes which come within the meaning and range of equivalency of the claims are, therefore, to be embraced therein. For example, the clamping assembly can be positioned at the bottom while the lifting assembly at the top.

**CLAIMS****I Claim:**

- 1 1. In a system for encapsulating semiconductor devices, said system
2 comprising a press having at least one bottom plate, at least one
3 open/close plate, at least one clamping plate, and at least one top
4 plate, said system comprising:
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6 at least one lifting assembly for raising and lowering said open/close
7 plate for opening and closing at least one mould half disposed on said
8 open/close plate;
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10 at least one clamping assembly disposed separately and opposite
11 from said lifting assembly and on said clamping plate for exerting force
12 on another mould half; and
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14 at least one transfer base coupled to said clamping assembly for
15 exerting force on said mould halves as close to said cavities as
16 possible,
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18 whereby said system experiences minimal extent of deflection at the
19 mould halves while achieving optimal clamping efficiency.
- 1 2. The system as in claim 1 wherein said clamping assembly comprises at
2 least one clamping means, at least one actuating means, and at least
3 one transfer means.
- 1 3. The system as in claim 1 wherein said clamping means comprises a
2 clamping cylinder.
- 1 4. The system as in claim 1 wherein said clamping means comprises a
2 clamping motor.
- 1 5. The system as in claim 1 wherein said actuating means comprises a ball
2 screw.
- 1 6. The system as in claim 1 wherein said transfer means comprises a
2 transfer plate.



- 1 7. The system as in claim 2 wherein said actuating means is coupled to
2 said transfer means with roller bearing for distributing evenly the
3 clamping force.
- 1 8. The system as in claim 7 wherein said roller bearing comprises spherical
2 roller thrust bearings.
- 1 9. The system as in claim 1 wherein said lifting assembly comprises a
2 transfer drive.
- 1 10. The system as in claim 1 wherein said open/close plate and said
2 clamping pate is a fraction of the thickness of said bottom and top plate.