Method and device for encapsulating electronic components while exerting fluid pressure

The invention relates to a method for encapsulating electronic components, in particular semiconductors, by receiving a component for encapsulating fixed on a carrier between two mould halves displaceable relative to each other and feeding a liquid encapsulating material under overpressure by means of a transfer mechanism to at least one mould cavity arranged for this purpose. The invention also relates to a device for encapsulating electronic components, in particular semiconductors, comprising: two mould halves displaceable relative to each other for receiving a component for encapsulating, which mould halves are provided with at least one mould cavity, and a transfer mechanism for feeding a liquid encapsulating material under overpressure to the mould cavity.

The encapsulating of electronic components, in particular semiconductors placed on carriers (leadframes), usually takes place by means of a so-called transfer press. Use is made herein of mould cavities defined by at least two mould parts displaceable relative to each other. In the opened position one or more carriers with components for encapsulating can be placed between the mould parts. After placing the carrier and closing the mould parts the encapsulating process can begin. Encapsulating material is herein pressed through runners to mould cavities by means of plungers. The liquid encapsulating material flows into a mould cavity and herein displaces the gas present which escapes by means of ventings arranged for the purpose. In order to prevent undesired air enclosures in the encapsulating material, experiments have been done with applying an underpressure in a mould cavity at the time the encapsulating material is fed. After curing of the encapsulating material in the mould cavity the mould parts are moved apart and the encapsulated component can be taken out.

The present invention has for its object to improve the quality of encapsulation of electronic component while retaining the advantages of the prior art.

The invention provides for this purpose a method of the type stated in the preamble, characterized in that during feeding of liquid encapsulating material to the mould cavity the part of the mould cavity not yet filled with encapsulating material is filled with a fluid under overpressure. In a preferred application of the method the fluid pressure is realized by a gas, but it is also possible to employ a liquid for this purpose. The fluid pressure can be applied such that it exerts only unilateral pressure on a carrier to which the electronic component for encapsulating is fixed. A pressure difference will thus be created over the carrier whereby the carrier is urged against a part of the cavity. This contributes toward an improved positioning of the electronic component in the cavity. An improved positioning will result in an improved encapsulating result, owing to inter alia a smaller chance of damage to wires (wire jump), less chance of leakage of

encapsulating material along the edges of the mould cavity (bleed and flash), an improved ability to control the size of the encapsulated component, and so on. In normal conditions the overpressure will be lower than the pressure on the encapsulating material and higher than the ambient pressure.

In a preferred application of the method a foil layer is placed between the mould cavity and the component for encapsulating. The chance of encapsulating material (or a fraction of the encapsulating material, also known as "flash" or "bleed") passing between the mould halves can thus be reduced further. The fluid under overpressure can be situated between the cavity and the foil layer so that the fluid does not come into contact with the encapsulating material. In addition to preventing interaction between the fluid and the encapsulating material, this also has the advantage that the flow of the encapsulating material can be influenced by the foil which is present. An example hereof is the encapsulation of so-called flip-chips, wherein the encapsulating material must be carried between two stacked parts (the carrier and the chip placed thereon with contact points). Due to the presence of the foil material the flow of the encapsulating material can be guided specifically between the carrier and the chip.

The fluid pressure (gas pressure) in the mould cavity is preferably maintained until the cavity is completely filled with encapsulating material. The above described advantages are thus obtained throughout the encapsulating process. Favourable results are obtained when, subject to other process-influencing factors, the fluid pressure (gas pressure) amounts to at least $1.5X10^5$ Pa, preferably at least $5X10^5$Pa. Other factors which influence the process are for instance the composition of the encapsulating material, the temperature of the encapsulating material, the thickness of the carrier, the carrier material, the size of the mould cavity and the component for encapsulating.

The fluid pressure can be applied by means of compressed air. This is a simple and thus inexpensive manner of creating the desired pressure. Another possibility is for the fluid pressure to be applied by means of an inert gas, such as for instance nitrogen. This gas can for instance be drawn off via a valve from a gas buffer such as a gas bottle. The advantage of using an inert gas is that the gas will not have any adverse effect on the component for encapsulating.

The fluid pressure can be applied by at least one venting opening for excess gas connecting onto the mould cavity. Such a venting is already present in most existing moulds, so that these require little or no modification to apply the method according to the invention.

In addition to applying overpressure in the mould cavity, it is also possible to simultaneously create an underpressure locally on a side of the carrier remote from the

component for encapsulating where the overpressure is created. The applying of underpressure is already employed. Due to a local underpressure a carrier can be "sucked" against a side of the mould cavity and thus be positioned more accurately. With a combination of a local underpressure and an overpressure applied at another position in the cavity, the pressure difference over the carrier can increase further, further enhancing the already recited advantages. Depending on a pressure difference required for a desired level of process control, it is possible to vary both the level of overpressure and the level of underpressure; the difference in the two pressures must have a determined value. It is noted here that the adjustment range of the overpressure (above 1 bar) is much greater than the adjustment range of the underpressure (0 bar-1 bar).

The invention also provides a device of the type stated in the preamble, with the feature that a fluid feed connects onto the mould cavity for receiving liquid encapsulating material. The existing transfer presses for encapsulating electronic components require only a limited modification to make them suitable for use of the present method. It is of course desirable here that the fluid feed connects onto the cavity on the side remote from a gate for encapsulating material. An overpressure can thus be maintained in the cavity throughout filling of the cavity. The fluid feed can herein be used simultaneously to allow excess fluid (gas) to escape as the degree of filling of the cavity with encapsulating material increases. It is also possible for the mould cavity to be provided for this purpose at a distance from the fluid feed with at least one venting opening for fluid. The fluid feed and the fluid venting can thus be controlled separately. The chance of contamination of the fluid feed in particular is hereby also reduced.

In order to generate the gas pressure the fluid feed connects onto means for generating an overpressure, such as a pump or pressurized gas container. When the fluid feed is also employed to allow fluid to escape from the cavity, it is recommended that the fluid feed also connects onto means for generating an underpressure. For a good positioning of a carrier in a cavity, this latter will be provided with a receiving space for a carrier. Use of the method according to the invention is found to be particularly advantageous when recesses for the purpose of forming encapsulating parts are located on either side of the receiving space for the carrier. Such a carrier with an encapsulation to be formed on two sides is very difficult to position in a cavity, even when it is positioned on one side with an underpressure (over a part of the surface in respect of the creating of encapsulating parts on two sides). Such components in particular can advantageously be positioned more accurately by the unilaterally applied overpressure of a fluid. To maintain the generated fluid pressure it may be desirable for the mould cavity to be provided with a medium-tight sealing edge.

The present invention also comprises a method for encapsulating electronic components, in particular semiconductors, by receiving a component for encapsulating fixed on a carrier between two mould halves displaceable relative to each other and feeding a liquid encapsulating material under overpressure by means of a transfer mechanism to at least one mould cavity arranged for this purpose, with the feature that during feeding of liquid encapsulating material to the mould cavity a fluid pressure is exerted on the carrier on the side of the carrier remote from the cavity. Instead of creating an overpressure in the mould cavity, it is also possible, conversely, to opt for applying an overpressure with a fluid on a side remote from the cavity. The carrier can hereby also be urged into a desired position. A more precise positioning of the carrier means a better controlled encapsulating process, and therefore a better controlled final result. The fluid under overpressure is preferably a gas. The fluid pressure can very advantageously be adjusted in relation to the pressure on the liquid encapsulating material. When the pressure of the encapsulating material is limited, the pressure of the fluid is also kept limited, this to avoid deformation of the carrier. When the pressure of the encapsulating material increases, the pressure of the fluid preferably also increases at the same time. For this purpose the adjustment range of the fluid pressure is preferably at least as large as the maximum pressure on the encapsulating material (the process pressure). A significant advantage, in addition to the accurate positioning, is that this enables the processing of carriers of varying thickness. Differences in the thickness of for instance a Ball Grid Array (BGA) will thus not result, or much less quickly, in damage to the carrier (board) as a consequence of local loads on the carrier rising to a high level. It will always be possible to connect the carrier, irrespective of the thickness, onto the mould cavity with a controllable pressure (the fluid pressure). The tolerance in dimensional variations in the carriers for processing is much greater as a result of this method than in the case of a rigid mechanical clamping of the carriers for processing.

Linked to the latter described method, the invention also provides a device for encapsulating electronic components, in particular semiconductors, comprising: two mould halves displaceable relative to each other for receiving a component for encapsulating, which mould halves are provided with at least one mould cavity, and a transfer mechanism for feeding a liquid encapsulating material under overpressure to the mould cavity by means of a feed for encapsulating material, with the feature that at a distance from the feed for encapsulating material at least one fluid feed connects onto the displaceable mould halves for positioning the component for encapsulating by means of fluid pressure. The mould cavity is preferably arranged at least substantially in one of the mould halves, and the fluid feed connects onto the mould half connecting to the mould half in which the cavity is arranged. For a good operation the fluid feed connects onto means for generating an overpressure, or the fluid feed connects onto means for generating an underpressure. The mould cavity can be provided with a

receiving space for a carrier and recesses for the purpose of forming encapsulating parts located on either side of the receiving space for the carrier. The advantages already described above can be realized with such a device.

The present invention will be further elucidated with reference to the non-limitative embodiments shown in the following figures. Herein:
figure 1 shows a cross-section through a part of a mould cavity with a carrier provided with a component for encapsulating according to the prior art, and
figure 2 shows a cross-section through a part of a mould cavity with a carrier on which an encapsulating part is arranged on two sides as according to the present invention.

Figure 1 shows a mould part 1 with a mould cavity 2. A carrier 3 is placed against cavity 2 such that an electronic component 4 supported by carrier 3 is situated in cavity 2. A drawback of prior art encapsulation is shown in this figure. Carrier 3 can be positioned such that a contact wire 5 with which the electronic component 4 is connected conductively to carrier 3 comes into contact with mould part 1. Proper functioning of electronic component 4 can thus be disturbed after arranging of an encapsulation.

Figure 2 shows two mould parts 6,7 between which is placed a carrier 8 with an electronic component 9. Carrier 8 is provided with a central recess through which contact wires 10 of component 9 are fed to the opposite side of carrier 8. Encapsulating parts 11,12 are produced on two sides of carrier 8. Liquid encapsulating material is supplied for this purpose through a runner 13 and a gate 14. The encapsulating part 11 located on the upper side in figure 2 is not yet fully formed; an upper cavity 15 is still partially gas-filled. The gas-filled part of upper cavity 15 is connected by means of a venting 16 to a gas feed 17. The gas feed for creating an overpressure in the gas-filled part of upper cavity 15 is indicated symbolically by means of an arrow P1. The overpressure in the gas-filled part of upper cavity 15 is indicated symbolically by arrows P2. It is noted that during feed of encapsulating material the gas feed 17 can also be used to discharge gas so that the arrow P1 can be in a direction opposed to the flow direction of the gas in the gas feed at the moment of encapsulation shown in the figure. The overpressure in the gas-filled part of upper cavity 15 ensures inter alia that carrier 8 is urged against the lower mould part 7, thereby increasing the reliability of the encapsulating process.

For further accurate positioning of carrier 8, the lower mould part 7 is also provided with an underpressure system 16 with suction lines 17, whereby an underpressure is created as according to arrows P3. Particularly the carrier 8 with a central opening enables positioning of carrier 8 in the desired manner using only the underpressure system 16. Particularly in the case of carriers 8 of the type as shown in this figure it is

advantageous to apply an overpressure as according to the present invention in the gas-filled part of upper cavity 15.

Claims

1. Method for encapsulating electronic components (4, 9), in particular semiconductors, by receiving a component for encapsulating (4, 9) fixed on a carrier (3, 8) between two mould halves (1, 6, 7) displaceable relative to each other and feeding a liquid encapsulating material under overpressure by means of a transfer mechanism to at least one mould cavity (2, 15) arranged for this purpose,
characterized in that during feeding of liquid encapsulating material to the mould cavity (2, 15) the part of the mould cavity (2, 15) not yet filled with encapsulating material is filled with a fluid under overpressure.

2. Method as claimed in claim 1, characterized in that the fluid under overpressure is a gas.

3. Method as claimed in claim 1 or 2, characterized in that a foil layer is placed between the mould cavity (2, 15) and the component for encapsulating (4, 9).

4. Method as claimed in claim 3, characterized in that the fluid under overpressure is situated between the cavity (2, 15) and the foil layer.

5. Method as claimed in any of the foregoing claims, characterized in that the fluid pressure in the mould cavity (2, 15) is maintained until the cavity (2, 15) is completely filled with encapsulating material.

6. Method as claimed in any of the foregoing claims, characterized in that the fluid pressure amounts to at least $1.5X10^5$ Pa, preferably at least $5X10^5$Pa.

7. Method as claimed in any of the foregoing claims, characterized in that the fluid pressure is applied by means of compressed air.

8. Method as claimed in any of the claims 1-6, characterized in that the fluid pressure is applied by means of an inert gas.

9. Method as claimed in any of the foregoing claims, characterized in that the fluid pressure is applied by at least one venting opening (16) for excess gas connecting onto the mould cavity (2, 15).

10. Method as claimed in any of the foregoing claims, characterized in that an underpressure is also created locally in the mould cavity (2, 15) on a side remote from the component for encapsulating (4, 9) where the overpressure is created.

11. Device for encapsulating electronic components (4, 9), in particular semiconductors, comprising:
- two mould halves (1, 6, 7) displaceable relative to each other for receiving a component for encapsulating (4, 9), which mould halves are provided with at least one mould cavity (2, 15), and
- a transfer mechanism for feeding a liquid encapsulating material under overpressure to the mould cavity (2, 15),
characterized in that a fluid feed (16) connects onto the mould cavity (2, 15) for receiving liquid encapsulating material.

12. Device as claimed in claim 11, characterized in that the fluid feed (16) connects onto the cavity (2, 15) on the side remote from a gate (14) for encapsulating material.

13. Device as claimed in claim 11 or 12, characterized in that the mould cavity (2, 15) is also provided at a distance from the fluid feed (16) with at least one venting opening for fluid.

14. Device as claimed in any of the claims 11-13, characterized in that the fluid feed (16) connects onto means for generating an overpressure.

15. Device as claimed in any of the claims 11-14, characterized in that the fluid feed (16) connects onto means for generating an underpressure.

16. Device as claimed in any of the claims 11-15, characterized in that the cavity (2, 15) is provided with a receiving space for a carrier (3, 8) and recesses (2, 15) for the purpose of forming encapsulating parts (11) located on either side of the receiving space for the carrier (3, 8).

17. Device as claimed in any of the claims 11-16, characterized in that the mould cavity (2, 15) is provided with a medium-tight sealing edge.

18. Method for encapsulating electronic components (4, 9), in particular semiconductors, by receiving a component for encapsulating (4, 9) fixed on a carrier (3, 8) between two mould halves (1, 6, 7) displaceable relative to each other and feeding a liquid encapsulating material under overpressure by means of a transfer mechanism to at least one mould cavity (2, 15) arranged for this purpose,
characterized in that during feeding of liquid encapsulating material to the mould cavity (2, 15) a fluid pressure is exerted on the carrier (3, 8) on the side of the carrier (3, 8) remote from the cavity (2, 15).

19. Method as claimed in claim 18, characterized in that the fluid under overpressure is a gas.

20. Method as claimed in claim 18 or 19, characterized in that the fluid pressure is adjusted in relation to the pressure on the liquid encapsulating material.

21. Device for encapsulating electronic components (4, 9), in particular semiconductors, comprising:
- two mould halves (1, 6, 7) displaceable relative to each other for receiving a component for encapsulating (4, 9), which mould halves are provided with at least one mould cavity (2, 15), and
- a transfer mechanism for feeding a liquid encapsulating material under overpressure to the mould cavity (2, 15) by means of a feed (14) for encapsulating material, characterized in that at a distance from the feed (14) for encapsulating material at least one fluid feed (16) connects onto the displaceable mould halves (1, 6, 7) for positioning the component for encapsulating (4, 9) by means of fluid pressure.

22. Device as claimed in claim 20 or 21, characterized in that the mould cavity (2, 15) is arranged at least substantially in one of the mould halves (1, 6, 7), and the fluid feed (16) connects onto the mould half (1, 6, 7) connecting to the mould half (1, 6, 7) in which the cavity (2, 15) is arranged.

23. Device as claimed in any of the claims 20-22, characterized in that the fluid feed (16) connects onto means for generating an overpressure.

24. Device as claimed in any of the claims 20-23, characterized in that the fluid feed (16) connects onto means for generating an underpressure.

25. Device as claimed in any of the claims 20-24, characterized in that the mould cavity (2, 15) is provided with a receiving space for a carrier (3, 8) and recesses (2, 15) for the purpose of forming encapsulating parts (11) located on either side of the receiving space for the carrier (3, 8).