

Method and device for encapsulating electronic components with a conditioning gas

5 The invention relates to a method for encapsulating electronic components in a mould as according to the preamble of claim 1. The invention also relates to a device for encapsulating an electronic component, in particular a semiconductor, with encapsulating material as according to the preamble of claim 12.

10 The encapsulating of electronic components, such as semiconductor circuits in particular, is applied on large scale. The electronic components are here usually mounted on a carrier ("leadframe", "board") and such a carrier is clamped between mould parts such that a mould cavity is defined around electronic components mounted on the carrier. An important consideration here is that the adhesion of the encapsulating material to the mould during curing of the encapsulating material must remain limited
15 so as to thus prevent damage to the encapsulated products and to prevent contamination of the mould. There are various solutions for limiting the degree of adhesion between encapsulating material and mould. Use can thus be made of a layer of foil material separating the encapsulating material and the mould. This solution is expensive and not possible for all mould embodiments. Another solution employed on a large scale
20 heretofore is to provide a mould part, optionally locally, with a specific coating (for instance a coating with an increased concentration of Cr and/or TiN) optionally in combination with the application of a temporary coating (such as a wax layer). At first use or after a period of standstill mould parts are in practice first conditioned by carrying out some dummy encapsulating runs such that conditioning material from the
25 encapsulating material leaves a (temporary) coating on a mould part during these dummy encapsulating runs. When there is an undesirable increase in the adhesion between the encapsulating material and a mould part during performing of successive encapsulating operations, the usual option is to take the mould part or parts out of production for a time and to clean the mould parts for a longer period with a specific
30 cleaning material (such as for instance melamine). The existing solutions for limiting the adhesion between encapsulating material and mould part, with methods and in devices as described in the preamble, are: that the adhesion can still develop undesirably high values, that the process of the increase of the adhesion during use is not wholly

predictable and understandable, that mould parts are unusable for part of the time and that production losses occur.

5 The Japanese patent JP 03 281210 describes a method for encapsulating an electronic component with resin, wherein the encapsulating process takes place in an inert gas environment. It is thus possible to prevent air inclusions occurring in the encapsulating material and the surface of an moulded housing being provided with recesses or fragmented parts. Use is made here particularly of a nitrogen atmosphere.

10 Japanese patent JP 02 156644 discloses a method to release an encapsulated semiconductor device from a metal mould cavity, wherein an ejector pin is used to eject a moulded part from the cavity. A gas, such as air, nitrogen or the like is additionally discharged directly into the cavity through a blow-off port, positioned immediately adjacent to the ejector pin.

15 Japanese patent 2000 263603 discloses a device and method to release a moulding from a mould without cracking. The disclosed device comprises a channel, which terminates directly into the mould cavity and through which resin can be sucked into the mould cavity. After moulding, the same channel is used to introduce compressed air into the
20 mould cavity to release the moulding from the mould.

The object of the present invention is to provide an improved method and device for encapsulating electronic components in a mould, with which the problems resulting from adhesion between mould and encapsulating material can be limited.

25 The invention provides for this purpose a method as according to claim 1. The unexpectedly advantageous result of applying a conditioning gas such that it also exerts a releasing gas pressure on the encapsulating material is that multiple effects are achieved with a single measure. First of all it is possible to significantly reduce the
30 adhesion between encapsulating material and mould part by bringing the mould cavity into contact with a conditioning gas. A conditioning gas with a decreased oxygen concentration relative to the atmosphere (or low-oxygen conditioning gas) is understood to mean a gas with less than 20.9% by volume, preferably less than 15% by volume or even more preferably less than 10% by volume of oxygen. Other examples of gases

which can be used are inert gases, such as more or less pure nitrogen gas. The supplying of a gas is a very simple operation which can be realized with simple means and which is also simple to mechanize or to automate. Conversely, the use of a reducing gas (with which oxygen is bonded) also brings very advantageous results. During tests with both
5 nitrogen and reducing gases (optionally in combination) in the use of the conditioning gas very favourable results were achieved in reducing the degree of adhesion of the encapsulating material to the mould surface (also expressed in release force per unit area). The reduction in the degree of adhesion during a test with a TiN coating of the mould and nitrogen as conditioning gas came to more than 95%. This advantageous
10 supply of conditioning gas is now performed according to the present invention such that a second advantageous effect is realized. With the specific method of supplying the conditioning gas is also achieved that a force is exerted on the encapsulated electronic components to be released. The conditioning gas can thus be introduced/pressed between the encapsulating material and the mould cavity. This simplifies release of the
15 encapsulating material from the mould cavity. An additional advantage here is that this release force can be applied over a large area.

The encapsulating process can also be performed in an environment filled with conditioning gas. It thus becomes possible to have a mould cavity, respectively mould
20 part or mould parts remain more or less constantly in a conditioned environment with only limited use of conditioning gas, which, depending on the conditions, will result in a further optimization of the desired effect of reduced adhesion.

In order to increase the efficiency of the contact between the conditioning gas and the
25 mould part it is also advantageous if a flow of conditioning gas is guided along at least a part of the mould surface defining the mould cavity.

The gas pressure can advantageously be combined with more traditional release means so that the encapsulating material is also mechanically engaged at least locally for the
30 purpose of exerting a release force. Here can be envisaged ejector pins, guide strips optionally provided with additional anchors, and so forth. It will be apparent that a combination of traditional release means and gas pressure will generate an even greater release capability.

The gas pressure is developed in advantageous manner between the side of the encapsulated electronic component directed toward a mould part and the shape-defining mould part. A side of the encapsulated electronic component directed toward a mould part can thus be released as a wave front from the shape-defining mould part.

5

The conditioning gas can also be preheated before it is brought into contact with the encapsulated electronic component and the mould cavity, this to prevent thermo-shock and/or to prevent undesirable cooling of the mould cavity/mould and/or the encapsulated electronic component. In order to further limit the gas consumption, it is desirable that the gas pressure is reduced after full release of a side of the encapsulated electronic component directed toward a mould part.

10

The present invention also provides a device for encapsulating an electronic component with encapsulating material as according to claim 12. Such a device with an outflow opening arranged in a contact side of a mould cavity/mould part can be applied in advantageous manner particularly in the encapsulation of electronic components mounted on a carrier. The mould cavity or the mould parts are then usually provided here with a space for receiving such a carrier. It is noted that use is normally made of at least two, although optionally also more than two, mutually displaceable mould parts.

20 The device will usually also be provided with drive means for mutually displacing the mould parts, generally an electric motor, and optionally with additional mechanical ejector means for exerting an additional release force on an encapsulated electronic component to be released. Save for specific supply means for the conditioning gas, such a device is commercially available, and modification of existing equipment can

25 therefore be envisaged. For the further advantages of the device according to the invention reference is made to the advantages in respect of the above described method also forming part of the invention.

30

In yet another embodiment variant, the mould parts are enclosed by a screen. With such a screen a chamber can be formed which is at least partially gas-tight for the purpose of generating a local gas environment which encloses the mould parts and which differs from normal atmospheric gas conditions.

In yet another embodiment variant, the mould parts consist of a single material. That is, a specific coating which was required in the prior art to prevent adhesion of encapsulating material becomes unnecessary. Such coatings, such as a coating on the basis of nickel (for instance NiCrN) were applied to the surface of a mould part, and the
5 applying of the coating results in a substantial increase in the cost price of the mould parts. According to the present invention such a coating is unnecessary.

According to the state of the art, the supply means for the conditioning gas usually connect onto a mould cavity in one of the mould parts. The conditioning gas is thus
10 brought directly to the position where it can bring about a desired conditioning effect.

In yet another embodiment of the invention, the supply means can for instance connect to a venting and/or to a contact surface adjacently of the mould cavity. In addition to the advantages already mentioned above, it is also the case that applying a gas pressure is
15 structurally a simple operation, this while the traditional release means acting in mechanical manner require very major structural measures in the mould parts. The ejector pins applied here must be integrated into the mould parts in a manner such that encapsulating material cannot penetrate between such pins and the remaining mould part. The outflow opening can be provided as desired with a displaceable closing
20 element to enable the gas flow to be regulated therewith and to prevent contamination of the gas supply.

In a preferred variant an outflow opening is located on the same side of a mould cavity as that from which the encapsulating material is fed to the mould cavity. The
25 encapsulation can thus be "peeled" away from the mould cavity from the feed side. The device can be additionally provided with at least one mechanical ejector.

It can also be advantageous to provide the gas supplying means with heating means so as to thus prevent undesired cooling of the mould parts as a consequence of the gas
30 supply.

The present invention will be further elucidated on the basis of the non-limitative exemplary embodiments shown in the following figures. Herein:

figure 1 shows a schematic cross-section through an encapsulating device according to the state of the art provided with supply means for a conditioning gas,

figure 2 shows a schematic cross-section through an alternative embodiment variant of an encapsulating device according to the invention, and

5 figure 3 shows a cross-section through a part of a second alternative embodiment variant, more particularly a so-called top edge variant, of an encapsulating device according to the invention.

Figure 1 shows an encapsulating device 1 with a lower mould part 2, relative to which
10 an upper mould part 3 is displaceable as according to arrow P1. A mould cavity 4 is left clear in upper mould part 3 for the purpose of forming a housing, not shown in this figure, to be manufactured with encapsulating material 5. Arranged in lower mould part 2 is a recess 6 in which a carrier with an electronic component 12 is placed.

Encapsulating material 5 can be forced to mould cavity 4 by a plunger 7 displaceable as
15 according to arrow P2. Recessed into upper mould part 3 is an optionally closable channel 14 which connects to mould cavity 4. The conditioning gas is carried directly into mould cavity 4 through channel 14 and a force is simultaneously exerted on the (at least partially cured) encapsulating material 5 in order to release it from the contact side 8 of mould cavity 4.

20 Figure 2 shows an encapsulating device 20 in which a carrier 21 is placed with a housing 22 of encapsulating material 5 arranged thereon. Also shown is a runner 23 which is formed by encapsulating material 5 cured in a feed channel. This runner 23 is usually separated in a subsequent processing of carrier 21. As an alternative to channel
25 14 (or additionally to channel 14) shown in figure 1, a supply channel 16 for conditioning gas can also connect at a position of the contact side 15 of upper mould part 3 such that the conditioning gas is blown against the runner 23. The space between mould parts 2, 3 is moreover bounded by a screen plate 24 and a second screen plate 25 displaceable as according to arrow P4. Owing to the screen means 24, 25 it is possible
30 to maintain a gas environment between mould parts 2, 3 which differs from the environment.

Figure 3 shows a part of an encapsulating device 30 with a lower mould part 32 assembled from a plurality of mutually displaceable components. A carrier 34 is

clamped between a support 32 and an edge part 33 which are mutually displaceable such that encapsulating material 35 can be supplied over the top side of edge part 33. One of the advantages of using edge part 33 is that an edge zone of carrier 34 can thus be kept free of encapsulating material 35. Once the encapsulating material 35 has at least partially cured, mould parts 31, 32 can be moved apart (through for instance a small distance d of a few tenths of a millimetre, more specifically for instance 0.5 mm). By moving apart mould parts 31, 32 a supply channel 36 for feed of a conditioning gas is also opened, with the result that conditioning gas is supplied as according to arrow P5. This conditioning gas herein penetrates between the housing made of encapsulating material 35 and a mould cavity 38 in the contact side 37 of upper mould part 32. The conditioning gas will here fulfil a dual function: the gas pressure will exert a release force (for instance as a wave front) on the encapsulating material, whereby release of the encapsulating material 35 from mould cavity 38 is simplified and the conditioning gas moreover comes into contact in very specific manner with the contact side 37 of upper mould part 32, whereby the gas can carry out its conditioning action in efficient manner. The release of the encapsulating material 35 from mould cavity 38 can be initiated by moving the support 32 and the edge part 33 over a limited distance.

Claims

1. Method for encapsulating electronic components (12) in a mould (2, 3) by the processing steps of:

5 A) placing the electronic component (12) for encapsulating in a mould cavity (4), and

B) feeding an encapsulating material (5) to the mould cavity (4), wherein at least a part of the mould surface defining the mould cavity is brought into contact with a conditioning gas containing a decreased oxygen concentration relative to the atmosphere,

10 **characterized in that** at least a part of the conditioning gas is introduced from the contact side (15) of the mould into the mould cavity (4) during release of the encapsulating material from the mould cavity (4) such that a releasing gas pressure is exerted on the encapsulating material by the conditioning gas.

15

2. Method as claimed in claim 1, **characterized in that** the conditioning gas is introduced between the encapsulating material and a mould surface (8) defining the mould cavity (4) after at least partial curing of the encapsulating material in the mould cavity (4).

20

3. Method as claimed in claim 1 or 2, **characterized in that** a flow of conditioning gas is guided along at least a part of the mould surface (8) defining the mould cavity.

4. Method as claimed in any of the foregoing claims, **characterized in that** the mould surface (8) defining the mould cavity (4) is brought into contact with an inert conditioning gas.

25

5. Method as claimed in claim 4, **characterized in that** the mould surface (8) defining the mould cavity (4) is brought into contact with nitrogen as conditioning gas.

30

6. Method as claimed in any of the foregoing claims, **characterized in that** the mould surface (8) defining the mould cavity (4) is brought into contact with a reducing gas.

7. Method as claimed in claim 1, **characterized in that** during release the encapsulating material is also engaged mechanically for the purpose of exerting a release force.

5 8. Method as claimed in any of the foregoing claims, **characterized in that** the release of the encapsulating material is initiated by moving apart over a limited distance a support (32) of the electronic component (22) and an edge part (33) that is also part of the mould.

10 9. Method as claimed in any of the foregoing claims, **characterized in that** the gas pressure is developed between a side of the encapsulated electronic component (22) directed toward a mould part and a shape-defining mould part (3).

15 10. Method as claimed in any of the foregoing claims, **characterized in that** a side of the encapsulated electronic component (22) directed toward a mould part (3) is released as a wave front from the shape-defining mould part (3).

20 11. Method as claimed in any of the foregoing claims, **characterized in that** the gas pressure is produced by a heated gas.

12. Method as claimed in any of the foregoing claims, **characterized in that** the gas pressure is reduced after full release of a side of the encapsulated electronic component (22) directed toward a mould part (3).

25 13. Device for encapsulating an electronic component (12), in particular a semiconductor, with encapsulating material (5), comprising:

- at least two co-acting mould parts (2, 3, 31, 32) which are mutually displaceable between a moulding position, in which the mould parts take up a position for defining at least one mould cavity (4) receiving the electronic component, and an opened position
- 30 in which the mould parts are situated at a greater distance from each other than in the encapsulating position,
- feed means for encapsulating material (5) connecting to the mould cavity (4),
- and

- supply means for a conditioning gas with a decreased oxygen concentration relative to the atmosphere,

characterized in that the supply means for conditioning gas connect (16, 36) to a contact side (15) of at least one of the mould parts.

5

14. Encapsulating device as claimed in claim 13, **characterized in that** the supply means for the conditioning gas connect (16, 36) to a venting of the mould cavity.

15. Encapsulating device as claimed in any of the claims 13-14, **characterized in that** the supply means for the conditioning gas connect (16, 36) to a contact surface (15) adjacently of the mould cavity.

10

16. Encapsulating device as claimed in any of the claims 13-15, **characterized in that** the connection (16, 36) of the supply means for conditioning gas to a mould part is provided with a displaceable closing element.

15

17. Encapsulating device as claimed in any of claims 13-16, **characterized in that** the connection (16, 36) of the supply means for conditioning gas to a mould part is located on the same side of a mould cavity as that from which the encapsulating material is fed to the mould cavity.

20

18. Encapsulating device as claimed in any of claims 13-17, **characterized in that** the device is also provided with at least one mechanical ejector.

25 19. Encapsulating device as claimed in any of claims 13-18, **characterized in that** the means supplying conditioning gas are provided with heating means.

1/2

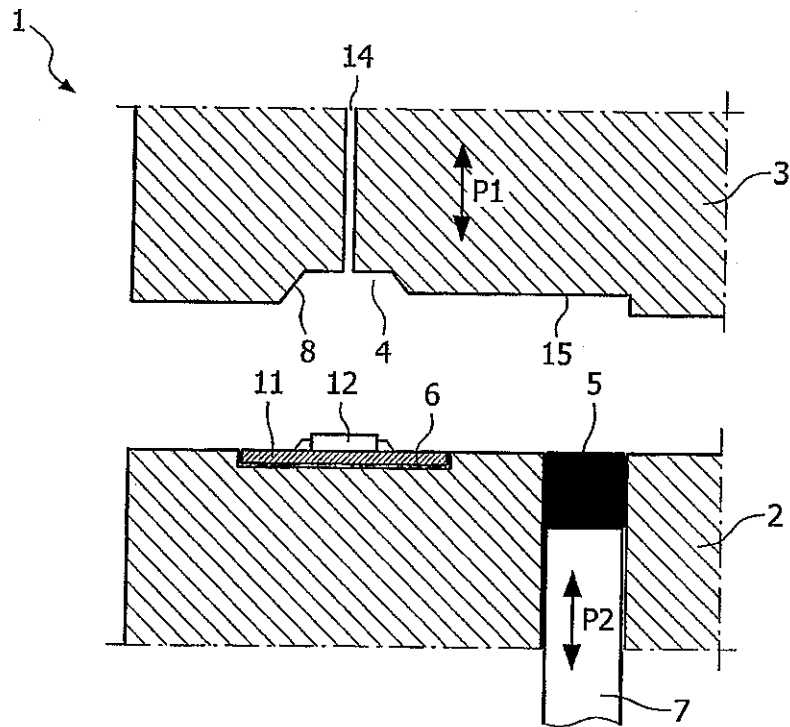


FIG. 1

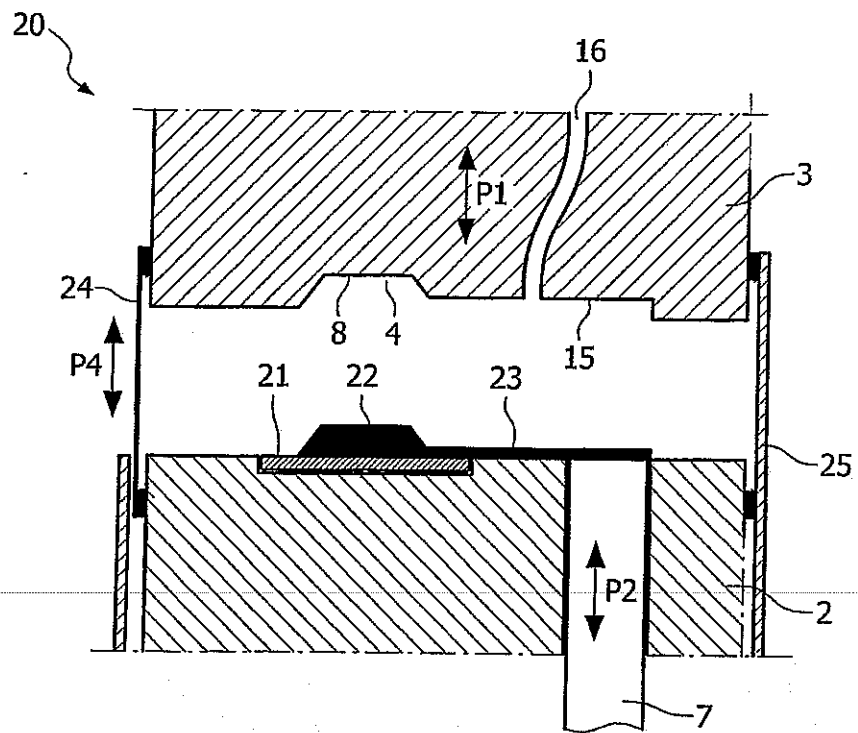


FIG. 2

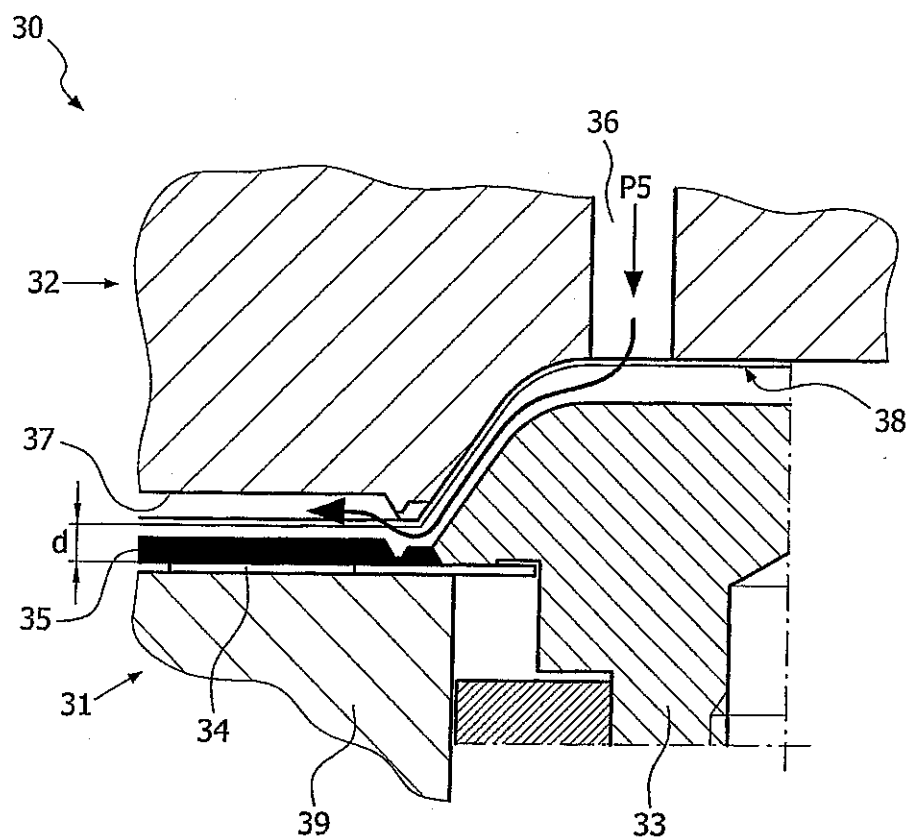


FIG. 3