Method and apparatus for removing a carrier part from a carrier with a ~~single~~ operation, and a product removed from a carrier

The invention relates to a method for removing from a carrier a carrier part with a housing arranged thereon, wherein the carrier is engaged on two sides by cutting elements provided with at least one cutting edge, which cutting elements are subsequently moved toward each other such that the carrier part is separated from the remaining part of the carrier. The invention also relates to an apparatus for removing from a carrier a carrier part with a housing arranged thereon, which carrier part contains openings on the side of the carrier remote from the housing which are filled with encapsulating material, comprising cutting elements provided with at least one cutting edge for engaging the carrier on two sides, which cutting elements are displaceable relative to each other such that the carrier part can be separated from the remaining part of the carrier. The invention moreover provides a product removed from a carrier in accordance with the method.

In the production of electronic components, such as for instance semiconductor chips, the components are usually placed on a carrier, on which carrier the components are then encapsulated with for instance a synthetic resin or epoxy. The thus manufactured encapsulated components are subsequently released with a part of the carrier from the carrier. For this purpose a cutting plate engages the carrier on one side, in which plate are arranged recesses of the size of the carrier parts for separating. By means of one or more cutting members ("cutting punches"), likewise roughly the size of the carrier parts for separating, the carrier parts for separating are engaged on the side remote from the cutting plate and pressed by the cutting plate. Particularly in the separating of so-called "leadless packages", also referred to as BLP components (bottom lead packages), this existing method of separation results in problems. Since the underside of such carriers contains openings which are also filled with encapsulating material, the cutting plate supports the carrier , but there are also encapsulating material surfaces which adjoin the cutting plate. These surfaces formed by encapsulating material are to a limited extent generally more elevated than the underside of the carrier. As a result the surfaces formed by the encapsulating material are not properly supported by the cutting plate, whereby crack formation will occur in the encapsulating material when the separating operation

is performed. This is undesirable. Other drawbacks of the existing method is the forming of burrs on the underside of the separated carrier parts. This causes problems in the further processing of the separated components. While the problem of burr formation can be solved by reversing the separation process relative to the carrier, this causes problems in the placing of the cutting plate. There is generally only very little space available adjacently of the encapsulated components for engaging on the carrier, so that the cutting plate has to have a complex form with contact surfaces of very limited size. This reduces the tool life of such a cutting plate and can result in damage to the carrier material.

The object of the present invention is to improve the result of a separating operation while still performing a single operation, wherein particularly crack formation in a component for processing and burr formation will occur less or will be less of a problem.

The invention provides for this purpose a method of the type stated in the preamble, characterized in that before the separation takes place the cutting edge projecting relative to a base of the cutting element is urged into the carrier such that the carrier deforms permanently. For this purpose the carrier is preferably placed on one side on a first cutting element provided with a recess and a second cutting element having a cutting edge with dimensions which correspond with the dimensions of the recess in the first cutting element is moved to the first cutting element. In this method the projecting cutting edge of a cutting element is preferably urged into the contact side of the carrier with the cutting element. This single operation, wherein the deforming and the actual separation take place in a single stroke of the cutting elements, results in a controlled separation process. After applying the single-sided or double-sided deformation in the carrier the separation need be made over a thickness smaller than the thickness of the carrier. In the ideal case the separation will take place from the position where the carrier is most deformed (the deepest part of the imprint) to the other side of the carrier (the deepest part of the imprint on the opposite side or, if there is no second imprint, to the opposite side). Since this path which the separation has to cover is shorter than the

thickness of the carrier and because the separation tends to occur connecting onto a deformation (the source), the position of the separation can be more readily controlled if the carrier is already deformed prior to the start of the actual separation process. The danger of crack formation and the formation of "micro-gaps" in the encapsulating material is hereby also eliminated; during the actual separation a carrier part for separating lies against the cutting edge along the whole length of the cutting edge despite the often more elevated openings filled with encapsulating material. The standing cutting edge is urged so far into the carrier that at the position of a cutting line both the carrier itself and the encapsulating material in the openings arranged in the carrier lie against the cutting edge. Cracks in the encapsulating material are thus prevented. It is noted that the standing cutting edge preferably does not penetrate into the encapsulating material during deforming of the carrier but precisely that this edge comes to lie against the encapsulating material.

The single separating operation according to the invention has the additional advantage that possible burrs occurring during the separation do not protrude, or hardly so, relative to the flat sides of the carrier. The possible burrs will anyway develop at a distance from the flat sides of the carrier; in the most unfavourable case at the position where the deformation applied by the cutting edge ends. Because possible burrs occur at a distance from the flat sides of the carrier, in normal conditions they will not protrude outside the surfaces defined by the flat sides of the carrier. These possible burrs do not therefore form a problem in the further processing of the separated carrier parts.

Another advantage of the method according to the invention is that it is relatively clean. The first deformation of the carrier creates no fragments or other free material portions, or hardly so. The actual separation path, on which path free material portions will occur, is shortened owing to the at least one deformation, so that here also less contamination will occur than in conventional separation.

A further advantage of the method according to the invention is that it is a single operation which is comparatively not very labour-intensive. Repositioning of the carrier

after a first processing step is also unnecessary. These aspects make the present method reliable and little susceptible to malfunction.

After performing of the separating operation the cutting elements are preferably moved apart and the separated carrier part is released from the cutting elements, wherein one side of the carrier part connecting onto the separation edge is provided with a deformation. A carrier part (product) manufactured with the method according to the invention can thus be easily identified. The separated carrier part also forms an independent part of the present invention. Such a carrier part is preferably provided with a deformation on the side of the carrier remote from the housing connecting onto the separation edge.

The invention also provides an apparatus of the type stated in the preamble, characterized in that at least one of the cutting elements comprises a cutting edge projecting relative to a base of the cutting element for applying a permanent deformation in the carrier on at least one side.

An existing separating apparatus need only be modified in limited manner to make it suitable for performing the method according to the present invention; only at least one of the cutting elements need be provided with a standing cutting edge. In addition, it can be advantageous to also modify the control of the cutting elements. For optimal results the relative displacement speed of the cutting elements during the deformation will generally differ from the relative displacement speed of the cutting elements during the separation. The advantages as described above can thus be obtained with minimum investment.

Good results are achieved particularly when the projecting cutting edge has a form angled toward the base of the cutting element. Advantageous results are also achieved when the projecting cutting edge comprises an edge running substantially parallel to a carrier and a sloping part connecting thereto and having a form angled toward the base of the cutting element. For a further improvement in results, the apparatus will generally comprise means for positioning the carrier.

The present invention will be further elucidated with reference to the non-limitative embodiments shown in the following figures. Herein:

figure 1 shows a side view of a part of a carrier on which a separating operation is performed,

figures 2a and 2b show side views of cross-sections through a part of a carrier with housing arranged thereon prior to the performing of a separation operation according to the prior art,

figures 2c and 2d show side views of the cross-sections through the part of the carrier with housing arranged thereon as shown in figures 2a and 2b after performing of a separation operation according to the prior art,

figure 3a shows a side view of a cross-section through a part of a carrier with housing arranged thereon before the cutting elements engage on the carrier,

figures 3b and 3c show side views of cross-sections through the part of the carrier with housing arranged thereon as shown in figure 3a during the first part of the single stroke of the cutting elements, wherein the carrier is deformed by the standing cutting edges,

figures 3d and 3e show side views of the cross-sections through the part of the carrier with the housing arranged thereon as shown in figures 3b and 3c after performing of a separation operation according to the present invention,

figure 4a shows a cross-section through a cutting element provided with a standing cutting edge, and

figure 4b shows a cross-section through an alternative embodiment variant of a cutting element provided with a standing cutting edge.

Figure 1 shows a side view of a cross-section through a carrier 1 on which is arranged a housing 2. Carrier 1 is of a composite type and consists of metal tracks 3, intermediate spaces 4 of which are filled with epoxy (encapsulating material) during the manufacture of housing 2. The side of carrier 1 remote from housing 2 is not completely flat, and during feeding of the liquid epoxy is generally covered by a foil layer. A carrier 1 of the shown type is applied inter alia for the production of so-called leadless packages.

Figure 2a shows a cross-section through carrier 1 and housing 2 which is perpendicular to the cross-section as shown in figure 1. For the separation of a part of carrier 1 from

the remaining part of carrier 1 enclosing this part according to the prior art the carrier 1 is placed on a cutting plate 5. In the cross-section shown in this figure only one metal track 3 of carrier 1 is visible. Metal track 3 supports on cutting plate 5. A displaceable knife 6 is situated on the side of the carrier 1 remote from cutting plate 5. A narrow cutting gap 7 is situated between cutting plate 5 and knife 6. Figure 2b shows a cross-section through carrier 1 and housing 2 parallel to the cross-section shown in figure 2a, wherein an epoxy-filled intermediate space 4 of carrier 1 is visible. Clearly shown is that the epoxy-filled intermediate space 4 of carrier 1 does not support on cutting plate 5 but is situated at some distance therefrom. There is hereby still a limited view of a part of a metal track 3.

Figure 2c shows a view of carrier 1 and housing 2 as shown in figure 2a, this time however after performing of the prior art separating operation. A drawback of the existing method is that the underside of the separated metal track 3 can be provided with a burr 8 protruding below the track 3. Burr 8 makes further processing of the separated product more difficult. As shown in figure 2d, there is the danger that due to lack of support by cutting plate 5 the intermediate space 4 filled with epoxy may begin to display (hairline) cracks 9 during the separation. Such cracks 9 are undesirable since they can result in a reduced lifespan of a separated product, they can make the dimensions of the separated product unmanageable, and so on.

Figure 3a shows a side view of a cross-section through a part of a metal track 3 of a carrier with housing 2 arranged thereon before cutting elements 11,12 engage on metal track 3. The cutting elements are provided with projecting or standing cutting edges 13,14. After cutting elements 11,12 have been moved further toward each other, the standing cutting edges engage on metal track 3 such that it deforms permanently under the influence of the exerted pressure. It is noted with emphasis that the cutting elements do not deform the epoxy arranged in intermediate spaces 4 but are only brought into contact therewith. See respectively figures 3b and 3c above. Cutting element 12 (also referred to as the cutting plate) hereby also comes to lie along the whole length of cutting edge 14 against metal carrier 3 respectively the recess 4 filled with epoxy. The chance of the problems as illustrated in figures 2c and 2d is hereby minimized. A

possible burr 15 on metal track 3 will thus develop at a distance from a flat side of metal track 3, at which position it has no adverse effect (see figure 3d for illustration). The deformed edge side 16 of metal track 3 can be readily distinguished. Figure 3e shows a cross-section of the separated carrier part at the position of a recess filled with epoxy 4. Here also the deformed edge side 16 of metal track 3 can be distinguished; the recess 4 filled with epoxy is not deformed in angled manner by cutting edge 14.

Figures 4a and 4b show cutting elements 18,19, of which the respective standing cutting edges 20,21 have alternative forms. The projecting cutting edges 20 of cutting element 18 have a form angled toward the base of cutting element 18. The projecting cutting edges 21 of cutting element 19 comprise edges 22 which run substantially parallel to a carrier for processing and which have connecting thereto sloping parts 23 formed at an angle to the base of cutting element 19.

Claims

1. Method for removing from a carrier a carrier part with a housing arranged thereon, which carrier part contains openings on the side of the carrier remote from the housing which are filled with encapsulating material, wherein the carrier is engaged on two sides by cutting elements provided with at least one cutting edge, which cutting elements are subsequently moved toward each other such that the carrier part is separated from the remaining part of the carrier, **characterized in that** before the separation takes place the cutting edge projecting relative to a base of the cutting element is urged into the carrier such that the carrier deforms permanently.

2. Method as claimed in claim 1, **characterized in that** the carrier is placed on one side on a first cutting element provided with a recess and a second cutting element having a cutting edge with dimensions which correspond with the dimensions of the recess in the first cutting element is moved to the first cutting element.

3. Method as claimed in claim 1 or 2, **characterized in that** the projecting cutting edge of a cutting element is urged into the contact side of the carrier with the cutting element.

4. Method as claimed in any of the foregoing claims, **characterized in that** after performing of the separating operation the cutting elements are moved apart and the separated carrier part is released from the cutting elements, wherein one side of the carrier part connecting onto the separation edge is provided with a deformation.

5. Method as claimed in claim 4, **characterized in that** the carrier part on the side of the carrier remote from the housing connecting onto the separation edge is provided with a deformation.

6. Carrier part with a housing arranged thereon, which carrier part contains openings on the side of the carrier remote from the housing which are filled with

encapsulating material, manufactured with the method as claimed in any of the foregoing claims, **characterized in that** one side of the carrier part connecting onto the separation edge is provided with a deformation.

7. Apparatus for removing from a carrier a carrier part with a housing arranged thereon, which carrier part contains openings on the side of the carrier remote from the housing which are filled with encapsulating material, comprising cutting elements provided with at least one cutting edge for engaging the carrier on two sides, which cutting elements are displaceable relative to each other such that the carrier part can be separated from the remaining part of the carrier, **characterized in that** at least one of the cutting elements comprises a cutting edge projecting relative to a base of the cutting element for applying a permanent deformation in the carrier on at least one side.

8. Apparatus as claimed in claim 7, **characterized in that** the projecting cutting edge has a form angled toward the base of the cutting element.

9. Apparatus as claimed in claim 7 or 8, **characterized in that** the projecting cutting edge comprises an edge running substantially parallel to a carrier and a sloping part connecting thereto and having a form at an angle to the base of the cutting element.

10. Apparatus as claimed in any of the claims 7-9, **characterized in that** the apparatus also comprises means for positioning the carrier.

11. Apparatus as claimed in any of the claims 7-10, **characterized in that** the means for positioning the carrier are formed by the cutting plate.