Method and device for separating products with a controlled cut edge, and separated product

The invention relates to a method for separating products, in particular semiconductor circuits, from a shared carrier by means of laser cutting, wherein a cut is made by means of a first laser beam. The invention also relates to a device for separating products, in particular semiconductor circuits, from a shared carrier by means of laser cutting, comprising: a laser source and a product carrier displaceable relative to the laser source, wherein the laser source is adapted to generate a first laser beam for making a cut between the products. The invention further also relates to a product, in particular a semiconductor mounted on a carrier, separated by means of a laser beam using such a method.

The laser cutting of products is a technique with which smaller products, such as for instance electronic components, can be separated. An advantage of laser cutting over more traditional techniques for separating products, such as for instance sawing with a rotating saw blade, is that laser cutting requires no, or only very few, product-dependent machine parts and that the freedom in respect of the design of the products for separating is very great. By modifying the control of a device for laser cutting, which can be a software operation, it is already possible to change over the device in respect of the products for processing. A drawback of laser cutting is however that the edge created by laser cutting (the cut edge) has a determined surface roughness which is not acceptable under all circumstances. Furthermore, the cut usually tapers to a greater or lesser extent so that the cut edge is not normally perpendicular to a top and bottom surface of the product; this is not desirable either.

The present invention has for its object to increase the options for separating products, in particular semiconductor circuits, from a shared carrier by means of laser cutting, wherein the surface roughness of the cut edges resulting from the laser cutting is controllable.

The invention provides for this purpose a method of the type stated in the preamble, wherein the surface roughness of a cut edge is reduced by means of a second laser beam. For this purpose the second laser beam is moved substantially parallel to a cut

edge for smoothing. The irregularities resulting from the laser cutting process with the first laser beam can thus be at least partly removed using the second laser beam. The irregularities resulting from the laser cutting with the first laser beam are (partly) a consequence of the usually pulsating pattern of the first laser beam, as a result of which the laser cutting is accompanied by successive shock waves. Deeper openings ("craters") and less deeply cut-away portions hereby remain on the surface of the cut edge after laser cutting with the first laser beam, which results in a less smooth cut edge (with a roughness in the order of magnitude of 8 - 5 Ra, typically about 5.8 Ra). The second laser beam can be optimized to remove only a limited amount of material, in particular those portions which are less deeply cut-away by the first laser beam. After removing these higher portions (or protruding portions) from the surface of the cut edge with the second laser beam there thus remains a smoother cut edge (with a roughness in the order of magnitude of 2 - 4 Ra, typically about 3.0 Ra). The use of the second laser beam to smooth the cut edge is less obvious since it is precisely due to the application of a laser beam that the rough cut edge is created. It has nevertheless been found possible in practice to realize a much smoother cut edge in this unexpectedly simple manner, the product being after all already situated in the laser device. Another important advantage is that the angle which the cut edge encloses with the top and/or bottom side of the product can also be influenced. This angle can now be made perpendicular, even if the cut edge resulting after processing with only the first laser beam enclosed a different angle with the top and/or bottom side. It is noted that the cut can be made by the first laser beam by means of multiple process runs, i.e. the first laser beam is moved several times through a groove becoming increasingly deeper until the actual desired cut is realized.

The distance from the centre line of the first laser beam to the cut edge is preferably greater than the distance from the second laser beam to the cut edge. The second laser beam is thus moved slightly closer to the cut edge as seen from the position of the first laser beam. A sufficient contact of the second laser beam with at least the higher portions of the cut edge is thus obtained.

Since the second laser beam has to remove less material, it is possible for the first laser beam to pulsate at a lower frequency than the second laser beam. The reason for this is that a considerable amount of energy is required for the cutting, and that more energy

can be transferred with longer pulses. It is moreover desirable during the smoothing (polishing) to have the pulses follow each other as closely as possible, and in this way approximate a straight line as well as possible. As alternative it is also possible to envisage the second laser beam having a substantially constant signal strength; a straight line is thus actually obtained. For the same reason it is also possible for the relative speed of displacement of the first laser beam relative to the products to be greater than the relative speed of displacement of the second laser beam relative to the products.

In order to simultaneously smooth the opposing cut edges of a cut in a single operating run it is advantageous if the second laser beam takes a multiple form. The multiple second laser beams must herein have a mutual distance (this distance optionally being controllable) such that the second laser beams just make contact with the cut edges in the desired manner. It is also possible to envisage the first and second laser beams being joined together into a combined laser beam in a manner such that the second laser beam is placed behind the first laser beam in the direction of displacement of the combined laser beam. This means that the second laser beam "lags" behind the first laser beam. The process run of the first and second laser beams can thus even be combined.

For separating products it is usual for the first laser beam to be positioned substantially perpendicularly of a contact surface for processing of the products for separating. Power can thus be transferred in optimal manner. In respect of the second laser beam the necessity for transferring power optimally is less pressing. There is therefore a less strict requirement in respect of positioning of the second laser beam; it is generally sufficient in practice if the second laser beam is substantially parallel to the cut edge for smoothing.

The invention also provides a device for separating products, in particular semiconductor circuits, from a shared carrier by means of laser cutting, comprising: a laser source and a product carrier displaceable relative to the laser source, wherein the laser source is adapted to generate a first laser beam for making a cut between the products and a second laser beam for reducing the surface roughness of a cut edge. A possible option here is to give the laser source a single form for the purpose of successively generating the first and second laser beam. Conversely, it is also possible

that the laser source takes a multiple form for the purpose of generating the first and second laser beam successively or simultaneously as desired. A product carrier displaceable relative to the laser source is understood to mean a stationary laser source in combination with a displaceable product carrier, a combination of a stationary product carrier and a displaceable laser source (this can also be a laser source with a displaceable mirror), or it can be a combination of a displaceable laser source and a displaceable product carrier. For the advantages of such a device reference is made to the above described advantages in respect of the method according to the present invention.

The present invention also provides a product, in particular a semiconductor mounted on a carrier, separated by means of a laser beam using the method as described above. Depending on the product and the application thereof, an optimal surface roughness of the cut edges can be chosen and the angle which the cut edges enclose with the top and/or bottom side of the product can be precisely controlled. It thus becomes possible for instance to embody the cut edge such that it encloses a right angle with the top and/or bottom side of the separated product.

It also becomes possible in particular that a cut edge at least partly bounding the product has over only a part of the length a surface roughness reduced by means of a second laser beam. A specific embodiment variant hereof forms a product which is provided with two opposing cut edges of different surface roughness. When such a product is for instance a memory card such as a Transflash (a product of standardized dimensions developed especially for mobile telecommunication), placing of the product in a holder can be facilitated and clamping of the product can also be readily controlled.

The invention will be further elucidated on the basis of the non-limitative exemplary embodiments shown in the following figures. Herein:
figure 1A shows a perspective view of an assembled product to be divided into individual segments,
figure 1B shows a perspective view of the assembled product of figure 1A in a situation where it has been divided into two segments by a first laser beam,
figure 1C shows a perspective view of the assembled product of figures 1A and 1B in a situation where the cut edges have been smoothed by a second laser beam,

figure 2A shows a schematic representation of a cross-section through a cut edge and a first laser beam,
figure 2B shows a schematic representation of a cross-section through a cut edge and a second laser beam,
figure 3 is a top view of a product separated by means of laser cutting, and
figure 4 is a schematic perspective representation of a laser cutting device according to the present invention.

Figure 1A shows an assembled product 1 consisting of a carrier 2 on which are placed electronic components (not shown) which are encapsulated by a moulding 3. Figure 1B shows that a cut 4 has been arranged by a first laser beam (not shown), whereby two product parts 5, 6 result. The cut 4 is bounded by cut edges 7, 8 having a relatively rough surface. Once these cut edges 7, 8 have been processed by a second laser beam, smoothed cut edges 9, 10 result (see figure 1C) having a lesser surface roughness than the surface roughness of the original cut edges 7, 8 made using the first laser beam.

Figure 2A shows a cut edge 20 of an only partly shown product 21 with a surface which is provided with irregularities 22. During separation (and therefore during making of cut edge 20) a first laser beam 23 is situated at a distance d_1 from cut edge 20. As shown schematically in figure 2B, a second laser beam 24 is placed a shorter distance d_2 from product 21 during a subsequent process, as a result of which a smoothed cut edge 25 results.

Figure 3 shows a top view of a product in the form of a memory card 30 (referred to more specifically as a Transflash) separated by means of laser cutting. The periphery of memory card 30 is so complex that it is not suitable for separating with a traditional sawing process. Shown in exaggerated manner is that three sides 31, 32, 33 of the memory card are bounded by relatively rough cut edges, while a fourth side 34 is bounded by a smoother cut edge. This fourth side 34 has therefore been processed with the second laser beam.

Figure 4 shows a laser cutting device 40 with a C-frame 41. Frame 41 supports a product carrier 42 which is displaceable in an X and Y direction. A product 43 yet to be processed is placed on product carrier 42. Two laser sources 44 and 45, with which a

first and a second laser beam can be respectively generated, are placed above product carrier 42.

Claims

1. Method for separating products, in particular semiconductor circuits, from a shared carrier by means of laser cutting, wherein a cut is made by means of a first laser beam, and
the surface roughness of a cut edge is reduced by means of a second laser beam.

2. Method as claimed in claim 1, characterized in that the cut is made by the first laser beam by means of multiple process runs.

3. Method as claimed in claim 1 or 2, characterized in that the distance from the centre line of the first laser beam to the cut edge is greater than the distance from the second laser beam to the cut edge.

4. Method as claimed in any of the foregoing claims, characterized in that the first laser beam pulsates at a lower frequency than the second laser beam.

5. Method as claimed in any of the foregoing claims, characterized in that the second laser beam has a substantially constant signal strength.

6. Method as claimed in any of the foregoing claims, characterized in that the relative speed of displacement of the first laser beam relative to the products is greater than the relative speed of displacement of the second laser beam relative to the products.

7. Method as claimed in any of the foregoing claims, characterized in that the second laser beam takes a multiple form for simultaneously smoothing the opposing cut edges of a cut.

8. Method as claimed in any of the foregoing claims, characterized in that the first and second laser beams are joined together into a combined laser beam in a manner such that the second laser beam is placed behind the first laser beam in the direction of displacement of the combined laser beam.

9. Method as claimed in any of the foregoing claims, characterized in that the

first laser beam lies substantially perpendicularly of a contact surface for processing of the products for separating.

10. Method as claimed in any of the foregoing claims, characterized in that the second laser beam is substantially parallel to the cut edge for smoothing.

11. Device for separating products, in particular semiconductor circuits, from a shared carrier by means of laser cutting, comprising:
- a laser source, and
- a product carrier displaceable relative to the laser source,
wherein the laser source is adapted to generate a first laser beam for making a cut between the products and a second laser beam for reducing the surface roughness of a cut edge.

12. Device as claimed in claim 11, characterized in that the laser source takes a single form for the purpose of successively generating the first and second laser beam.

13. Device as claimed in claim 11, characterized in that the laser source takes a multiple form for the purpose of generating the first and second laser beam successively or simultaneously as desired.

14. Product, in particular a semiconductor mounted on a carrier, separated by means of a laser beam using the method as claimed in any of the claims 1-10.

15. Product as claimed in claim 14, characterized in that a cut edge at least partly bounding the product has over only a part of the length a surface roughness reduced by means of a second laser beam.

16. Product as claimed in claim 14 or 15, characterized in that the product is provided with two opposing cut edges of different surface roughness.

17. Product as claimed in any of the claims 14-16, characterized in that the product is a memory card, more particularly that the product is a Transflash.