Apparatus and method for removing at least one chip-type semiconductor component from a film

Description

The invention describes an apparatus and a method for simultaneously removing at least one chip-type semiconductor component, in particular a semiconductor component having a thickness of less than 130 µm, or preferably of less than 100 µm, from a film. Such semiconductor components are present for example after the division of wafers arranged on an adhesive film. Advantageously, the semiconductor components are power semiconductor components such as IGBTs or power diodes.

The thinner the semiconductor component, the greater the risk of damage, in particular fracture, during removal thereof from the film.

The apparatuses and methods mentioned are preferably employed in so-called pick and place installations for populating substrates with semiconductor components.

The invention is based on the object of presenting an apparatus and a method for removing at least one chip-type semiconductor component from a film, wherein the risk of damage is significantly reduced.

The object is achieved according to the invention by means of an apparatus comprising the features of Claim 1, and also by means of a method in accordance with Claim 7. Preferred embodiments are described in the respective dependent claims.

The invention describes an apparatus for simultaneously removing at least one chip-type semiconductor component from an adhesive film, wherein the respective semiconductor component is arranged on the first main surface of the film. The apparatus has a removal device for at least one semiconductor component, and a lifting device that can be arranged at the second main surface of the film, wherein said lifting device has a contact region for arrangement with respect to the film, which has, for its part, a plurality of suction cutouts and cutouts for pin-type lifting means. In this case, all the suction cutouts are connected jointly to one or at least two suction cutouts; alternatively, groups of suction cutouts are connected to separate and separately regulable vacuum regulating devices.

The area of the contact region of the lifting device is preferably larger than that of the semiconductor component(s) that is (are) arranged on the first main surface of the film and is (are) to be removed in one step, and in this case projects beyond said semiconductor component(s) on all sides.

The pin-type lifting means have a pointed or convex end, which can pass through the respectively assigned cutouts and project beyond the plane of the contact region and deform the film in this case. In this case, the suction cutouts remain connected to the film and the semiconductor component(s) is (are) partially or completely lifted off from the film, as a result of which the adhesion forces between semiconductor component and film decrease and the semiconductor component(s) can be removed by the removal device without being damaged. In this case, pointed ends of the lifting means can penetrate through the film, while convex ends generally can only deform the film.

The suction cutouts can be embodied as concentrically arranged trenches and/or as holes distributed on the contact region partially uniformly or irregularly.

Furthermore, it is advantageous if the the lifting device has a thermal device for changing the temperature of the adhesive film. Depending on the purpose of use, for example depending on the film used, in this case it can be expedient to decrease or increase the temperature. A reduction of the temperature is appropriate, for example, in order to reduce the adhesive force between the film and the semiconductor component to be removed. An increase in the temperature is appropriate, for example, in order to increase the elasticity of the film.

It is often necessary that temperature changes of this type by at least 20°C can be performed. A thermal device of this type can be embodied, for example, as a Peltier element.

The method according to the invention for operating an apparatus of this type has the following steps:

- Arranging (I) the lifting device with respect to the film, wherein the contact region of the lifting device bears against the second main surface of the film. In this case, the chip-type semiconductor component to be lifted off is arranged on the first main surface opposite the contact region.

- Applying to a plurality of suction cutouts of the lifting device, by means of assigned vacuum regulating devices, a constant value of a vacuum for all the suction cutouts or different values of the vacuum for different suction cutouts or groups of

suction cutouts. The at least one vacuum regulating device required for this purpose applies a defined vacuum to the film, which vacuum can be kept constant over time, that is to say regulated.

The term "vacuum" designates the difference relative to atmospheric pressure (approximately 100 kPa), wherein larger values describe a larger difference and the suction effect is thus greater.

However, it is preferred if the vacuum is varied in a controlled manner, that is to say adapted, during the method. Consequently, the vacuum can be adapted to the differing extent of the contact area of the film with the contact region of the lifting device. In this case, a preferred limit of this regulation or adaptation is 10% of the value of the vacuum.

Alternatively or additionally, it can equally be preferred to apply different values of the vacuum to different suction cutouts. In this case, it is usually advantageous to apply a lower vacuum to those suction cutouts which are arranged further centrally with respect to the semiconductor component than those which are arranged further towards the edge region of the semiconductor component.

It can also be advantageous if the vacuum of one suction cutout or one group of suction cutouts is kept constant during the deformation, while the vacuum at another or a group of other suction cutouts is varied.

- Partially deforming the film above the contact region by lifting the film by means of lifting means arranged in assigned cutouts 42 of the lifting device.

- Removing (II) the at least one semiconductor component from the film by means of the removal device.

Furthermore, it is advantageous to influence the temperature of the film during the lift-off process by means of a thermal device. In this case, the thermal element can increase the temperature of the film; alternatively or additionally, it can decrease the temperature.

This temperature variation can be operated either continuously in continuous operation or advantageously in a pulsed fashion. During pulsed operation, it is furthermore preferred if the thermal regulation is activated only after the lifting device has been arranged with respect to the film, that is to say if the contact region bears against the film.

The inventive solution will be explained in greater detail on the basis of the exemplary embodiments in accordance with Figures 1 to 4.

Figure 1 shows a first configuration of an apparatus according to the invention in lateral section.

Figure 2 shows a second configuration of an apparatus according to the invention likewise in lateral section.

Figure 3 shows the arrangement in accordance with Figure 2 in plan view.

Figure 4 shows a third configuration of an apparatus according to the invention in plan view.

Figure 1 shows a side view of a first apparatus

according to the invention in section. The illustration shows an excerpt from a sawn wafer arranged on an adhesive film 12, said wafer thereby forming a plurality of semiconductor components 10 present in a manner spaced apart from one another.

The apparatus according to the invention comprises as essential components a removal device 20, a lifting device 22 and at least one vacuum regulating device 60, 62.

The lifting device 22 is embodied as a metal shaped body having cutouts 42 for pin-type lifting means 40 and having a plurality of suction cutouts 50, 52, here first and second suction cutouts, which are connected to assigned first and second vacuum regulating devices 60, 62. The illustration shows a situation at the process beginning of the method according to the invention, wherein the lifting means 40 are arranged completely in the assigned cutouts 42. Furthermore, the lifting device 22 is still spaced apart from the film 12 with semiconductor components 10 arranged on the first main surface 120 thereof. In a first process step, not relevant to the invention, the contact region 30 of the lifting device 22 is brought into contact with the second main surface 122 of the film 12. What is essential, however, is that the lifting device 22 is arranged in alignment with the semiconductor component 10 to be removed.

Vacuum is thereupon applied, in a manner regulated by means of the vacuum regulating devices 60, 62, as a result of which the film 12 is sucked onto the suction cutouts 50, 52. The vacuum regulating devices 60, 62 generate, for example, a constant vacuum at 40 kPa at all the suction cutouts, which rises to 42 kPa during the deformation of the film.

These are only advantageous values for a specific combination of semiconductor component 10 and film 12; other semiconductor components, in particular depending on their thickness, and other films, in particular depending on their adhesion force and elasticity, can require a different vacuum and also a different change. A vacuum of between 5 kPa and 60 kPa and a change of less than 10% of this value were successfully used experimentally.

In the simplest embodiment of the method, a constant vacuum is applied to all the suction cutouts 50, 52.

It is more advantageous to apply a different vacuum to individual suction cutouts or groups of suction cutouts. In this case, it is in turn advantageous to apply a lower vacuum to the suction cutouts or groups of suction cutouts arranged centrally with respect to the semiconductor component than those suction cutouts or groups of suction cutouts that are arranged further towards the edge region of the semiconductor component.

In both embodiments of the method it is furthermore advantageous for the pressure during the phase of deformation of the film not to be kept constant, but rather to be varied, in particular increased, in a defined manner by not more than 10% from the original vacuum.

This variation can be effected uniformly for all the suction cutouts or just for individual suction cutouts or individual groups of suction cutouts.

Given the presence of a constant vacuum, the semiconductor component 10 to be removed is lifted from the plane of the remaining semiconductor components by

means of the lifting means 40. In this case, the film 12 is partially deformed.

After the semiconductor component 10 has been lifted, cf. Figure 2, from the film 12, it can be lifted by means of the removal device 20 and thus completely removed from the film 12.

Figure 2 shows the plan view of a second apparatus according to the invention. The method step illustrated corresponds to that already described with respect to Figure 1, wherein the film 12 has already been deformed and the semiconductor component 10 to be removed has already been lifted.

This configuration of the apparatus essentially differs from that in accordance with Figure 1 by virtue of an additionally provided Peltier element 70, which here simultaneously, but not necessarily, forms the contact region 30 of the lifting device 22. In addition, the area of the contact region 30 is made larger here and extends to below the adjacent semiconductor components 10.

The second vacuum regulating device 62 generates a constant vacuum of 35 kPa at the centrally arranged second suction cutouts 52, while the first vacuum regulating device 60 applies a constant vacuum of 40 kPa to the outer, first suction devices 50. For the rest, the description given with respect to Figure 1 applies to the choice and regulation of the vacuum.

Figure 3 schematically shows the arrangement in accordance with Figure 2 in plan view. The semiconductor components 10 arranged in a matrix-like manner on the film 12 and the lifting device 22 arranged below one of said semiconductor components 10

are illustrated. Said lifting device has here four first suction cutouts 50 in the corner regions of the semiconductor component 10 and a second suction cutout 52 provided centrally with respect to the semiconductor component 10. The first cutouts 50 form a group to which vacuum is applied by means of a common first vacuum regulating device 60 (not illustrated), while the second cutout 52 is connected to a dedicated second vacuum regulating device 62 and the latter applies vacuum to said second cutout; also cf. Figure 2 with regard to the position and connection of the respective vacuum regulating devices.

Four lifting means 40 are furthermore illustrated, wherein these are provided in each case preferably near, but not directly alongside an assigned suction device 50.

Figure 4 schematically shows a third configuration of an apparatus according to the invention in plan view. In contrast to the configuration in accordance with Figure 3, here only one first 50 and one second suction device 52 are provided, which are respectively connected to an assigned first and second vacuum regulating device (not illustrated).

In this case, both suction devices 50, 52 are embodied as trenches and not as circular holes, as illustrated in Figure 3. The description given above is applicable with regard to the regulation of the vacuum.

Claims

1. Apparatus for removing at least one chip-type semiconductor component 10 from an adhesive film 12, wherein the semiconductor component 10 is arranged on a first main surface 120 of the film 12, comprising a removal device 20 for the semiconductor component 10 and comprising a lifting device 22 that can be arranged at a second main surface 122 of the film, wherein said lifting device 22 has a contact region 30 for arrangement with respect to the film 12, said contact region having, for its part, a plurality of suction cutouts 50, 52 and cutouts 42 for pin-type lifting means 40, wherein all the suction cutouts 50, 52 are jointly connected to a vacuum regulating device 60, 62, or at least two suction cutouts 50, 52 or groups of suction cutouts 50, 52 are connected to separate vacuum regulating devices 60, 62.

2. Apparatus according to Claim 1, wherein
the pin-type lifting means 40 have a pointed or convex end and these can pass through the contact region 30 of the lifting device 22.

3. Apparatus according to Claim 1, wherein
the suction cutouts 50, 52 are embodied as concentrically arranged trenches and alternatively or additionally as holes distributed on the contact region 30 partially uniformly or irregularly.

4. Apparatus according to Claim 1, wherein
the lifting device 22 has a thermal device 70 for changing the temperature of the adhesive film 10, wherein the temperature of the film 12 can be

decreased and/or increased by means of said thermal device 70.

5. Apparatus according to Claim 4, wherein
the temperature are varied by at least 20°C.

6. Apparatus according to Claim 4, wherein
the thermal device 70 is a Peltier element.

7. Method for operating an apparatus for removing at least one chip-type semiconductor component 10 from an adhesive film 12, comprising the following steps:
   - arranging the lifting device 22 with respect to the film 12, wherein a contact region 30 of the lifting device 22 bears against a second main surface 122 of the film 12, opposite a chip-type semiconductor component 10 that is arranged on a first main surface 120 and is to be lifted off;
   - applying to suction cutouts 50, 52 of the lifting device 22, by means of an assigned vacuum regulating device 60, 62, a constant value of a vacuum for all the suction cutouts 50, 52 or different values of the vacuum for different suction cutouts 50, 52 or groups of suction cutouts 50, 52;
   - partially deforming the film 12 in the contact region 30 by lifting the film 12 by means of lifting means 40, arranged in assigned cutouts 42 of the lifting device 22;
   - removing the at least one semiconductor component 10 from the film by means of a removal device 20.

8. Method for operating an apparatus according to Claim 7, wherein
the vacuum is kept constant, or is adapted, during

the partial deformation of the film 12.

9. Method for operating an apparatus according to Claim 8, wherein
the vacuum is varied by not more than 10% during the partial deformation.

10. Method for operating an apparatus according to Claim 7, wherein
the vacuum of centrally arranged suction cutouts 52 is chosen to be less than that of outer suction cutouts 50.

11. Method for operating an apparatus according to Claim 7, wherein
the temperature of the film is partially varied via the contact region 30 by means of a thermal device 70.

12. Method for operating an apparatus according to Claim 11, wherein
the thermal device 70 is operated permanently or in pulsed fashion.

13. Method for operating an apparatus according to Claim 12, wherein
during pulsed operation of the thermal device 70, the latter is activated only after the lifting device 22 has been arranged with respect to the film 12.