Device and Method for Stripping a Product Substrate Off a Carrier Substrate

Specification

Embodiments of the invention relate to a device and a method for stripping a product substrate off a carrier.

The back-grinding of product substrates is often necessary in the semiconductor industry and can take place mechanically and/or chemically. For purposes of back-grinding in general the product substrates are temporarily fixed on a carrier, there being various methods for the fixing. The carrier material can be for example films, glass substrates or silicon wafers.

US 2009/305617 A1 shows a carrier device for holding wafers with a supply chamber for solvent to reduce bonding strength. Further devices are shown in US 2007/255458 A1 and DE 197 34 635 A1.

Depending on the carrier materials used and the bonding layer used between the carrier and the product substrate, different methods for dissolving or destroying the bonding layer are known, such as for example the use of UV light, laser beams, the action of temperature, or solvents.

Stripping increasingly constitutes one of the most critical process steps since thin substrates with substrate thicknesses of a few microns easily break during stripping/peeling or are damaged by the forces which are necessary for the stripping process.

Moreover thin substrates have hardly any stability of shape or none at all and typically curl without support material. During handling of back-ground wafers therefore fixing and support of the wafers are essentially indispensable.

Embodiments of the invention disclose a device and a method to detach a product substrate from a carrier as nondestructively and easily as possible.

According to a first aspect, there is provided a device for stripping a product substrate off a carrier substrate connected to the product substrate by a bonding layer with the following features: a film frame, a flexible film which is connected to the film frame and which has an adhesive layer for holding the product substrate in a contacting surface section of the film, the film being connected to the film frame in an attachment section of the film which surrounds the contacting surface section, a solvent reservoir formed by the film frame and the film for holding the solvent for detaching the bonding layer, and wherein the product substrate and the bonding layer can be accommodated in the solvent reservoir, delivery means for delivering the solvent into the solvent reservoir and stripping means for stripping the product substrate off the carrier substrate.

According to a second aspect, there is provided a method for stripping a product substrate off a carrier substrate connected to the product substrate by a bonding layer with the following steps: forming a solvent reservoir for holding solvent for detaching the bonding layer which is formed by a film frame and a flexible film connected to the film frame, holding the product substrate and the bonding layer in the solvent reservoir, delivering solvent into the solvent reservoir and detaching the product substrate from the carrier substrate.

The framework of embodiments of the invention also

encompasses all combinations of at least two of the features given in the specification, the claims, and/or the figures. In the specified value ranges, values which lie within the indicated limits will also be disclosed as boundary values and they are to be claimed in any combination.

Embodiments of the invention are based on the idea of developing a generic device and a generic method by solvent being delivered to a solvent reservoir which is formed by the film frame and the film attached to it. Due to the elasticity or flexibility of the film which is mounted on the film frame it is at the same time possible to make the solvent tank of variable volume and the elasticity or flexibility of a film is moreover used to carefully strip the product substrate starting from the edge of the product substrate. In this way the product substrate is immediately available for other process steps directly after separation and is protected by the film and the film frame. Many process steps can be carried out directly on the product substrate mounted on the film frame.

A product substrate is defined as a product substrate, for example a semiconductor wafer, which is conventionally thinned to a thickness between 0.5 μm and 250 μm, the trend being toward thinner and thinner product substrates. Embodiments of the invention work especially effectively with product substrates which themselves have a flexibility similar to the film mounted on the film frame. The product substrate in embodiments of the device and the method of the invention is peeled off the carrier substrate, especially proceeding concentrically from the periphery of the product substrate.

The carrier is for example a carrier substrate with a thickness between 50 μm and 5000 μm, especially between 500 μm and 1000 μm.

The bonding layer can be an adhesive, for example a soluble adhesive, especially a thermoplastic, which is applied for example selectively in the edge region of the carrier-product

substrate combination, especially in an edge zone from 0.1 to 20 mm. Alternatively the adhesive can be applied over the entire surface, and the adhesive force can be reduced in the center by an adhesion-reducing layer, for example a fluoropolymer, preferably teflon.

A chuck is especially well suited as the holding means, especially a spinner chuck for holding the carrier substrate, especially by means of negative pressure, for example on suction paths, holes or suction cups. Alternatively, mechanical holding, for example by lateral clamps, is conceivable. Holding takes place electrostatically in another alternative configuration.

The stripping means encompass the film mounted on the film frame and a film frame holder which applies a force and which holds the film frame.

In one advantageous embodiment of the invention it is provided that the solvent is made to work essentially without heating. The solvent is preferably used at ambient temperature. In this way it is possible to omit any heating means.

By the solvent being intended for at least partially detaching the connection between the carrier substrate and the product substrate caused by the bonding layer, stripping by the stripping means is advantageously clearly facilitated.

Because the solvent comprises especially a fluid agent which selectively dissolves the bonding layer for at least partial detachment of the bonding layer, for bonding layers encompassing different adhesives it becomes possible to dissolve a certain bonding layer in a controlled manner or in defined regions. Chemical dissolution of the bonding layer is especially protective of the product substrate and with the corresponding material choice, dissolution can also take place very quickly, especially when only edge regions of the product substrate are provided with an bonding layer, so that the solvent can act very quickly from the side. In this way perforations in the carrier substrate

and/or product substrate can be omitted.

To the extent the solvent reservoir is made such that the solvent acts at least at the start of detachment of the bonding layer, especially solely in the region of the periphery of the product substrate, action on the product substrate and/or carrier substrate from the top and/or bottom, especially the inner region of the product substrate which lies within the side edge, can be omitted.

In another configuration of the invention it is provided that the stripping means are made to cause a force F_s which acts on the carrier substrate and a force F_f which acts on the film frame and which is directed against the force F_s. In this way stripping is effected in a manner which is simple and especially protective by the film. The force F_F acts on the periphery of the film frame, especially at at least two locations on the film frame which are distributed over the periphery, and the forces F_{f1} and F_{f2} can be controlled differently in one advantageous embodiment in order to strip the product substrate from the side with the greater force F_f.

Here it is especially advantageous if the film can be clamped, especially by the force Fs and force Ff in a stripping section which lies between the contacting surface section and the attachment section. In this way stripping is carefully effected on the periphery of the product substrate. Detachment by the solvent and stripping by the forces F_s and F_f mutually support one another.

According to one advantageous embodiment of the invention it is provided that there is a vibration generator which acts on the solvent and/or the bonding layer, which adjoins especially the film, and/or which can be placed in the solvent in the solvent reservoir. "Can be placed" comprises both surface contact and also at least partial immersion. This supports detachment by the solvent and accelerates the detachment process at least by a factor of 2, with an optimized configuration by a factor of 5, even more preferably by a factor of 10 to 50. Preferably the vibration generator acts by

ultrasonic waves, especially in the region of the contacting surface section.

In another advantageous embodiment the solvent reservoir is made trough-shaped, by which stripping of the product substrate can be achieved with a minimum solvent consumption.

Other advantages, features and details of the invention will become apparent from the following description of preferred exemplary embodiments and using the drawings.

Figure 1a shows a schematic top view of a substrate combination consisting of the product substrate, the carrier substrate and the bonding layer on a film frame,

Figure 1b shows a schematic side view to Figure 1a with a detailed view,

Figure 2 shows a schematic according to Figure 2 when the solvent is being delivered,

Figure 3 shows a schematic of the method step of detaching the bonding layer,

Figure 4 shows a schematic of the method step of stripping of the product substrate off the carrier substrate as claimed in the invention,

Figure 5 shows a schematic of one alternative method step of stripping the product substrate off the carrier substrate as claimed in the invention.

In the figures the same components and components with the same function are identified with the same reference number.

Figure 1a shows a film frame 1 which is round in this embodiment at least on the inner periphery 1i, on whose bottom according to the sectional view shown in Figure 1b a film 3 is cemented with its adhesive layer 3s concentrically to the film frame 1. With a radial distance A to the inner periphery 1i of the film frame 1, within the film frame 1 the product substrate-carrier substrate combination is cemented on a adhesive layer 3s of the film 3 concentrically to the film frame 1. The product substrate-carrier substrate combination consists of a product substrate 4 which

adheres to the film 3, a carrier substrate 2 and a bonding layer 6 which connects the product substrate 4 and the carrier substrate 2. The diameters of the product substrate 4 and of the carrier substrate 2 are essentially identical, while the thickness of the product substrate 4 is less than the thickness of the carrier substrate 2.

The film 3 consists of an attachment section 3b which has the shape of a circular ring in this case and in which the film 3 is fixed to the film frame 1. Furthermore, the film 3 consists of a contacting surface section 3k in which the product substrate 4 can be fixed on the adhesive layer 3s of the film 3. Between the attachment section 3b and the contacting surface section 3k there is a stripping section 3a which is located especially concentrically to the attachment section 3b and the contacting surface section 3k, and which need not have a cementing function, to which however a function which is critical as claimed in the invention is attached. The stripping section 3a thus extends from the periphery 4u of the product substrate 4 to the inner periphery 1i of the film frame 1, here labeled the radial distance A. The ratio between the thickness D of the film frame 1 and the distance A is advantageously at least 1:2 to 1:50, especially 1:5 to 1:25.

In the initial position shown in Figure 1b, the side of the product substrate 4 which makes contact with the film 3 and the side of the film frame 1 which makes contact with the film 3 are arranged flush and in one plane E. The parts shown in Figures 1a and 1b are assembled on a known film frame mounter.

The film 3 and the inner periphery 1i of the film frame 1 form a trough-shaped solvent reservoir 20 in which the product substrate-carrier substrate can be arranged as described above.

According to the method step shown in Figure 2 the solvent 22 can be delivered into the solvent reservoir 20 by delivery means 23. The delivery means 23 here consists of a line 24 and a

solvent storage 25 which can be triggered from a central unit in order to deliver the solvent 22 into the solvent reservoir 20.

As Figure 2 shows, the solvent reservoir 20 is of variable volume due to the film 3 which is elastic at least in the stripping section 3a by a force F_s acting on the carrier substrate 2 downwardly and a force F_f acting on the film frame 1 upwardly. Application of the force is likewise controlled by a central unit.

Increasing the volume of the storage means reservoir prevents the solvent 22 running over the edge of the film frame 1 and at the same time prompt distribution or delivery of the solvent 22 is enabled.

The force F_s as shown in Figure 3 is transferred by way of the carrier substrate holder 7 for holding the carrier substrate 2, fixing of the carrier substrate 2 on the carrier substrate holder 7 taking place by vacuum paths 8 which have been machined into the surface of the carrier substrate holder 7 and via a vacuum means which is connected to them and which is not shown.

On the opposite side of the film 3 to the product substrate 4 there can be an acoustic wave generator 10, especially for producing ultrasonic waves, by which ultrasonic waves can be transmitted onto the product substrate 4, but especially onto the bonding layer 6 and the solvent 22, since in this way the process of detachment is greatly accelerated, especially by a factor of 2, preferably by a factor of 5, even more preferably by a factor of 10 to 50.

According to one alternative embodiment shown in Figure 5, the acoustic wave generator 10' is in contact at least with the surface of the fluid solvent 22, but preferably is at least partially immersed in it. In this way the acoustic waves can be transmitted directly onto the solvent 22 and from the solvent 22 onto the bonding layer 6.

The force F_f acting on the film frame 1, as shown in Figure 3, can act uniformly distributed as a superficial force on the film frame 1 so that a change in the volume of the solvent reservoir 20 can be caused by way of deformation of the film 3 in the stripping section 3a.

As shown in Figure 4, stripping of the product substrate 2 from the carrier substrate 4 takes place in reverse, by the forces F_s and F_f or F_{s1} and F_{s2} being pointed in the opposite direction, the force F_{f1} in the embodiment shown here being set to be greater than the force F_{f2} in order to have the stripping of the product substrate 4 start carefully first from the edge side according to the enlargement shown in Figure 4.

The force F_{f1} or several forces F_{f1}, F_{f2} to F_{fn} can be delivered in spots distributed on the periphery of the film frame 1 or can be delivered distributed by a film frame holder.

To the extent the forces F_{f1}, F_{f2} and/or F_{fn} are made differently, the holding means for applying the force to the film frame 1 must be made to allow tilting of the film frame 1.

Between the process step of detachment by the solvent 22 shown in Figure 3 and the method step of stripping by opposing forces F_s, F_{f1}, F_{f2}, F_{fn} shown in Figure 4 there can be one method step by which the solvent 22 is removed from the solvent reservoir 20, especially by suction.

Reference Number List

1	film frame
2	carrier substrate
3	film
3a	stripping section
3b	attachment section
3k	contacting surface section
3s	adhesive layer
4	product substrate
4u	periphery
6	bonding layer
7	carrier substrate holder
8	vacuum paths
10, 10'	acoustic wave generator
20	solvent reservoir
22	solvent
23	delivery means
24	line
25	solvent storage
F_s, F_{f1}, F_{f2} ... F_{fn}	force
Fs	force

Claims

1. Device for stripping a product substrate (4) off a carrier substrate (2) connected to the product substrate (4) by a bonding layer (6) with the following features:

- a film frame (1),
- a flexible film (3) which is connected to the film frame (1) and which has an adhesive layer (3s) for holding the product substrate (4) in a contacting surface section (3k) of the film (3), the film (3) being connected to the film frame (1) in an attachment section (3b) of the film (3) which surrounds the contacting surface section (3k),
- a solvent reservoir (20) formed by the film frame (1) and the film (3) for holding the solvent (22) for detaching the bonding layer (6), and wherein the product substrate (4) and the bonding layer (6) can be accommodated in the solvent reservoir (20),
- delivery means (23) for delivering the solvent (22) into the solvent reservoir (20) and
- stripping means for stripping the product substrate (4) off the carrier substrate (2).

2. Device as claimed in Claim 1, wherein there is a solvent (22) for at least partial detachment of the connection between the carrier substrate (2) and the product substrate (4) caused by the bonding layer (6).

3. Device as claimed in one of the preceding claims, wherein the solvent (22) comprises a fluid means which selectively dissolves the bonding layer (6), for at least partial detachment of the bonding layer (6).

4. Device as claimed in one of the preceding claims, wherein the solvent reservoir (20) is

made such that the solvent (22) at least at the start of detachment of the bonding layer (6) acts especially exclusively in the region of the periphery (4u) of the product substrate (4).

5. Device as claimed in one of the preceding claims, wherein the stripping means is made to cause a force Fs which acts on the carrier substrate (2) and a force Ff which acts on the film frame (1) and which is directed against the force Fs.

6. Device as claimed in one of the preceding claims, wherein the film (3) can be clamped, especially by the force Fs and force Ff, in a stripping section (3a) which lies between the contacting surface section (3k) and the attachment section (3b).

7. Device as claimed in one of the preceding claims, wherein there is a vibration generator (10, 10') which acts on the solvent (22) and/or the bonding layer (6), which adjoins especially the film (3), and/or which can be placed in the solvent (22).

8. Device as claimed in one of the preceding claims, wherein the stripping means are made to act concentrically from the periphery (4u) of the product substrate (4) to the center (4z) of the product substrate (4).

9. Device as claimed in one of the preceding claims, wherein the solvent reservoir (20) is made trough-shaped.

10. Method for stripping a product substrate (4) off a carrier substrate (2) connected to the product substrate (4) by a bonding layer (6) with the following steps:

- forming a solvent reservoir (20) for holding solvent (22) for detaching the bonding layer (6) which is formed by a film frame (1) and a flexible film (3) connected to the film frame,
- holding the product substrate (4) and the bonding layer (6) in the solvent reservoir (20),
- delivering solvent (22) into the solvent reservoir (20) and

- detaching the product substrate (4) from the carrier substrate (2).

11. Method as claimed in Claim 10, wherein the solvent (22) is used for at least partial detachment of the connection between the carrier substrate (2) and the product substrate (4) caused by the bonding layer (6).

12. Method as claimed in Claim 10 or 11, wherein the solvent (22) acts at least at the start of detachment of the bonding layer (6), especially solely in the region of the periphery (4u) of the product substrate (4).

13. Method as claimed in one of Claims 10 to 12, wherein detachment is caused by a force Fs acting on the carrier substrate (2) and a force Ff which is acting on the film frame (1) and which is directed against the force Fs.

14. Method as claimed in one of Claims 10 to 13, wherein detachment of the product substrate (4) takes place concentrically from the periphery (4u) of the product substrate (4) to the center (4z) of the product substrate (4).