Flexible Carrier Mount, Device and Method
for Detaching a Carrier Substrate

Specification

The invention relates to a flexible carrier mount ~~as claimed in Claim 1~~, a device for detaching a carrier substrate from a product substrate in one detachment direction L ~~as claimed in Claim 2~~, a corresponding method ~~as claimed in Claim 9~~ and a use of a flexible carrier mount for mounting a carrier substrate in the debonding of a carrier substrate from a product substrate ~~as claimed in Claim 10~~.

In the semiconductor industry structure wafers or product wafers are often temporarily bonded to carrier wafers or carrier substrates in order to be able to handle them. After processing of the product substrates, they should be removed from the carrier substrate as easily, promptly, economically and cleanly as possible. The most frequently used method for bonding of product wafers on a carrier wafer is the application of an adhesion layer to one of the two substrates (or both substrates) and making contact under pressure. During debonding, the carrier wafer is debonded from the product wafer after reducing the adhesion force of the cement (temperature, UV radiation, etc.), for example by parallel shifting of the wafers against one another. The wafers are held by so-called chucks by negative pressure.

During debonding, a plurality of critical factors must be considered and the top priority is to expose the brittle product wafer which is very expensive due to preprocessing to as little stress as possible and to not damage it. The carrier substrate should be debonded on the other hand economically and promptly with as little energy consumption as possible. In a plurality of known debonding processes it is necessary, especially for breaking up the adhesion properties of the adhesion layer between the wafers, to heat the stack of carrier wafers and structure wafers/product

wafers to a temperature which is specific to the cement.

Embodiments of the present invention~~The object of this invention is therefore to~~ develop the generic devices and methods for debonding of carrier substrates such that careful debonding which is at the same time much quicker is enabled. At the same time the energy consumption will be reduced.

~~This object is achieved with the features of Claims 1, 2, 9 and 10. Advantageous developments of the invention are given in the dependent claims.~~In a first aspect, there is provided a flexible carrier mount for mounting of a carrier substrate when the carrier substrate is detached from a product substrate, detachment means being provided for debonding of the product substrate with bending of the carrier substrate, wherein the carrier mount is designed to allow bending of the carrier substrate and made as an open ring with an adjustable diameter (D_k).

In a second aspect, there is provided device for detaching a carrier substrate from a product substrate in one detachment direction (L) with the following features: a carrier mount which is flexible in the detachment direction (L) for mounting of the carrier substrate, a substrate mount for mounting of the product substrate and detachment means for debonding of the carrier substrate from the product substrate with bending of the carrier substrate, wherein the carrier mount is designed to allow bending of the carrier substrate and made as an open ring with an adjustable diameter (D_k).

In a third aspect, there is provided a method for detaching a carrier substrate from a product substrate in one detachment direction (L) with the following steps, especially the following sequence: mounting of the product substrate with a substrate mount and mounting of the carrier substrate with a carrier mount which is flexible in the detachment direction (L) and which is

designed to allow bending of the carrier substrate and made as an open ring with an adjustable diameter (D_k), and debonding of the carrier substrate form the product substrate with bending of the carrier substrate.

In a fourth aspect, there is provided the use of a flexible carrier mount for mounting of a carrier substrate when the carrier substrate is debonded from a product substrate, wherein the carrier mount is designed to allow bending of the carrier substrate and made as an open ring with an adjustable diameter (D_k).

All combinations of at least two of the features given in the specification, the claims and/or the figures also fall within the framework of the embodiments of the invention. At the given value ranges, values within the indicated limits will also be disclosed as boundary values and will be claimed in any combination.

The basic idea as per embodiments of this invention is to engineer a carrier mount for mounting of the carrier substrate in the detachment of the carrier substrate from the product substrate such that the carrier mount is made to allow bending of the carrier substrate. The carrier mount as per embodiments of~~claimed in~~ the invention has a bending stiffness which is sufficient to cause a detachment force for debonding of the carrier substrate from the product substrate, especially by lifting from the edge of the carrier substrate.

As per embodiments of~~claimed in~~ the invention only a slight bowing should occur, especially < 45° bending angle, preferably < 40°, more preferably < 30°, especially preferably < 20°, even more preferably < 10°, most preferably < 5°. In this way the carrier substrate which also has a certain bending stiffness which is similar to the carrier mount, and above all the product substrate are protected against damage. Bending causes most of the detachment force on the migrating detachment front which migrates especially from the edge of the carrier substrate in the direction of the center.

The heart of the embodiments of the invention is therefore a flexible carrier mount for mounting of a carrier

substrate in the detachment of the carrier substrate from a product substrate, detachment means being provided for debonding of the product substrate with bending of the carrier substrate on the carrier mount.

As per embodiments ofclaimed in the invention therefore blanket, non-annular versions of the carrier mount, especially of a polymer with a certain elasticity or bending strength, are also conceivable. To fix and hold the carrier substrate they would have vacuum passages. In this connection, especially in addition to increasing the holding force, there can be electrostatic fixing of the carrier substrate on the carrier mount.

The carrier mount can also consist at least partially of metal, ceramic or a composite material. The materials used need allow only the functionality as per embodiments ofclaimed in the invention.

An embodiment of theindependent invention is moreover a device for detaching a carrier substrate from a product substrate in one detachment direction L with the following features:

- a carrier mount which is flexible in the detachment direction L for mounting of the carrier substrate,
- a substrate mount for mounting of the product substrate,
- detachment means for debonding of the carrier substrate from the product substrate with bending of the carrier substrate.

The detachment direction L as per embodiments ofclaimed in the invention is essentially, in particular exactly, normal to the surface of the carrier substrate and/or product substrate. One bending axis of the bending of the carrier mount and/or of the carrier substrate held by the carrier mount is normal to the detachment direction L. The bending axis is especially parallel to the surface of the product substrate and/or of the carrier substrate.

In one advantageous version the device as per embodiments of~~claimed in~~ the invention can advantageously comprise a pressure chamber which can be exposed to overpressure in order to fix a carrier substrate which has been fixed with negative pressure on the carrier mount more strongly to it. The pressure in the chamber can be > 1 bar, preferably > 2 bar, even more preferably > 5 bar, still more preferably > 10 bar, especially less than 100 bar.

According to one advantageous embodiment of the invention it is provided that the carrier mount is elastically deformable in the detachment direction L. As per embodiments of~~claimed in~~ the invention the elasticity of the carrier mount makes it possible to concentrate the detachment force on the migrating detachment front, although a tensile force is applied only on the periphery of the carrier substrate.

In another advantageous embodiment~~version~~ of the invention it is provided that at least one tensile force acting on the periphery of the substrate mount and at least one opposing force acting against the tensile force on the periphery of the carrier mount can be applied by the detachment means to produce detachment moments along one detachment front. In this way the total load, especially at the start of debonding, can be reduced. In this way greater protection of the carrier substrate and of the product substrate is afforded. It is provided in particular that the tensile forces add up, especially by uniform application of tensile forces on the periphery of the substrate mount, to a resulting tensile force in the center of the substrate mount, while the opposing force or the opposing forces add up to a resulting opposing force on one edge of the carrier mount and corresponding detachment moments on the migrating detachment front. The carrier mount is accordingly tilted relative to the substrate mount.

For better protection of the product substrate, especially for very sensitive or very expensive

product substrates, as per embodiments of~~claimed in~~ the invention it is provided that the substrate mount be made as a rigid receiver which holds the product substrate over the entire surface.

According to another advantageous embodiment of the invention, it is provided that the carrier mount be made as an especially open ring with an adjustable inside diameter D_i. The bending stiffness can be optimally adjusted to the carrier substrate due to the ring shape also by the ring geometry, especially the ring width B to the ring diameter D_a, and/or to the height H of the ring. The ring shape furthermore results in that in the region of the ring opening greater freedom of motion of the carrier substrate is allowed so that an interaction of the bending stiffness of the carrier mount and the bending stiffness of the carrier substrate is achieved. Here the bending stiffness of the carrier mount is especially at least equal to or greater than the bending stiffness of the carrier substrate.

The bending stiffness of the carrier mount is advantageously chosen as per embodiments of~~claimed in~~ the invention such that it lies in a range between 1/20 to 20 times, especially between 1/10 to 10 times, preferably between 1/5 to 5 times, even more preferably between 1/2 to 2 times, the bending stiffness of the carrier substrate. The carrier substrate is especially a wafer of silicon with a thickness d between 500 μm and 750 μm, preferably of 600 μm. It can have a diameter D_t of 200 mm or 300 mm.

Here it is especially advantageous to provide holding means which run especially over the entire ring periphery, especially in the form of a rebounding peripheral shoulder. Thus, with a simple geometrical shape which can be economically produced, both the detachment force can be applied to the carrier substrate, especially on the entire periphery of the carrier substrate, and the especially critical initiation of the detachment front at the start of debonding can be concentrated at

one or more sites on the periphery of the carrier substrate.

In one development it is provided as per embodiments of~~claimed in~~ the invention that the carrier mount is made to laterally surround the carrier substrate essentially completely, especially at least to 98% of the periphery, preferably at least to 99%, even more preferably to at least 99.5%. In this way the carrier substrate is supported more or less over the entire periphery. The carrier mount is made especially as a ring which is peripherally closed preferably at least up to 98% of the periphery, even more preferably at least to 99%, still more preferably at least to 99.5%. The ring can also be composed of individual sections.

According to one advantageous embodiment, the detachment means have translational drive means for causing a translation movement of at least one peripheral section of the carrier mount in the detachment direction L.

An embodiment of the~~independent~~ invention is a method for detaching a carrier substrate from a product substrate in one detachment direction L with the following steps, especially the following sequence:

- mounting of the product substrate with a substrate mount and mounting of the carrier substrate with a carrier mount which is flexible in the detachment direction L and
- debonding of the carrier substrate from the product substrate with bending of the carrier substrate.

Furthermore, in an embodiment~~as claimed in~~ the invention there is a use of a flexible carrier mount for mounting of a carrier substrate when the carrier substrate is debonded from a product substrate.

In one advantageous embodiment of the invention it is provided that the debonding takes place at a temperature < 200°C, preferably < 100°C, even more preferably < 50°C, ideally at ambient temperature, especially without blanket heating means.

As per embodiments of~~claimed in~~ the invention it is conceivable to accelerate the debonding, especially on the detachment front, by action of the detachment means, especially by separating means, locally on the detachment front. The separating means can comprise mechanical separation and/or local heating, preferably a directed hot air flow. Specifically a separating wedge, a separating blade, a separating wire or a preferably hot compressed air jet directed at the detachment front can be provided individually or in combination.

A separating wedge is defined as a tool with a preferably v-shaped profile. A separating blade is defined as a tool with an extremely sharp edge. The separating wire is a very thin, preferably high strength wire which is moved by a corresponding apparatus in the tensioned state in the plane of the intermediate layer toward it. The separating wire is made especially as a heated wire, therefore able to be heated.

~~As claimed in the invention o~~One embodiment is also conceivable in which the detachment front runs more or less in a spiral during the detachment along the periphery of the product substrate to the inside toward the center. This is achieved by the detachment forces which are acting on the periphery being increased running around the periphery.

The described features apply analogously to the device as claimed in above aspect of the invention and the method as claimed in the above aspect of the invention as well as the use as claimed in the above aspect of the invention.

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

Figure 1 shows a plan view of one carrier mount as claimed in the invention with a cutting line A-A,

Figure 2 shows a cross sectional view of the carrier mount according to cutting line A-A