Device and method for separating a temporarily bonded substrate stack

The present invention relates to a method for separating a temporarily bonded substrate stack as well as a corresponding device.

There are countless methods in the prior art for joining substrates to one another. The purpose and aim of the joining is either permanent or temporary substrate stacks. If the substrates are joined temporarily, in particular by means of a bonding layer, they are again separated from one another at another point in the process chain. The separation process is known as debonding. One of the latest and most important methods for separating substrate stacks is laser debonding. In the case of laser debonding, a focused laser beam with high power and defined wavelength scans the substrate stack interface region of two substrates and leads to a separation of the two substrates from one another as a result of the high energy input into the bonding layer.

An evaluation of the debonding process takes place in the prior art after the separation of the substrates from one another, for example by an optical assessment. The surface roughness and the surface quality, for example, are examined.

A problem in the prior art consists in the fact that, as a result of the bombardment with laser beams, destruction of the substrates, in particular of expensive functional components of the substrates, can take place.

Embodiments of the present invention overcome the drawbacks of the prior art and in particular to ensure a separation of the substrate stack in as destruction-free manner as possible, but at the same time in an effective manner.

According to a first aspect of the present invention, there is provided a device for separating a temporarily bonded substrate stack including: bombarding means for bombardment of a joining layer of a substrate stack by means of laser beams emitted by a laser, and detection means for detecting laser beams of the laser reflected and/or transmitted at the temporarily bonded substrate stack and/or a reference substrate stack, wherein the bombardment means including: the laser beams illuminating a plurality of positions of the joining layer, measurement means for measuring the reflected and/or transmitted laser beams, and

determination means for determining an intensity profile of the laser beams for bombarding the joining layer based on the result of the measuring as to prevent damage to the substrate stack, wherein monitoring and/or adaptation of parameters of the laser can take place during bombardment of the joining layer, and wherein to align depth of focus range at each x-y position exactly on joining layer, the z-position of depth of focus range is adjustable by means of at least one of telescopes, which are located in the beam path of laser beam.

According to a second aspect of the present invention, there is provided a method for separating a temporarily bonded substrate stack, the method including: bombarding a joining layer of the substrate stack by means of laser beams emitted by a laser, and detecting the laser beams of the laser reflected and/or transmitted at the temporarily bonded substrate stack during the bombarding step, wherein the bombarding step including: illuminating a plurality of positions of the joining layer with the laser beams, measuring the laser beams reflected and/or transmitted during-the illuminating, and determining an intensity profile of the laser beams for bombarding the joining layer based on the result of the measuring as to prevent damage to the substrate stack, wherein monitoring and/or adaptation of parameters of the laser takes place during bombarding of the joining layer, and wherein to align depth of focus range at each x-y position exactly on joining layer, the z-position of depth of focus range is adjustable by means of at least one of telescopes, which are located in the beam path of laser beam.

All combinations of at least two features stated in the description, the claims and/or the drawings also fall within the scope of the invention. In the case of the value ranges, values lying within the stated limits are also deemed to be disclosed as limiting values and can be claimed in any combination.

Claims

1. A device for separating a temporarily bonded substrate stack (23) comprising:

bombarding means for bombardment of a joining layer (25) of a substrate stack (23) by means of laser beams (16, 16') emitted by a laser (5), and

detection means for detecting laser beams (16, 16', 16r) of the laser (5) reflected and/or transmitted at the temporarily bonded substrate stack (23) and/or a reference substrate stack,

wherein the bombardment means comprising:

the laser beams (16, 16') illuminating a plurality of positions of the joining layer (25),

measurement means for measuring the reflected and/or transmitted laser beams (16,16',16r), and

determination means for determiningan intensity profile of the laser beams (16, 16') for bombarding the joining layer (25) based on the result of the measuring as to prevent damage to the substrate stack (23),

wherein monitoring and/or adaptation of parameters of the laser (5) can take place during bombardment of the joining layer (25), and

wherein to align depth of focus range (28) at each x-y position exactly on joining layer (25), the z-position of depth of focus range (28) is adjustable by means of at least one of telescopes (9), which are located in the beam path of laser beam (16).

2. The device according to claim 1, wherein the detection means for detecting the laser beams (16, 16', 16r) of the laser (5) reflected and/or transmitted at the temporarily bonded substrate stack (23) or a reference substrate stack detects the laser beams (16, 16') before the bombardment of the joining layer (25) with the laser beams (16, 16').

3. The device according to any one of claims 1 or 2, which comprises a control device for controlling the beam shape and/or an intensity profile of the laser beams (16, 16') by means of the detected laser beams (16, 16', 16r).

4. The device according to any one of claims 1 to 3, comprising:

- a base (2),
- a stand 3,
- an optical system (26) for influencing the beam shape and/or beam direction of the laser beams (16, 16', 16r) and
- a substrate holder (22) for accommodating and fixing the substrate stack (23), wherein the substrate stack is movable relative to the laser beams (16, 16').

5. A method for separating a temporarily bonded substrate stack (23), the method comprising:

bombarding a joining layer (25) of the substrate stack (23) by means of laser beams (16, 16') emitted by a laser (5), and

detecting the laser beams (16, 16', 16r) of the laser (5) reflected and/or transmitted at the temporarily bonded substrate stack (23) during the bombarding step,

wherein the bombarding step comprising:

illuminating a plurality of positions of the joining layer (25) with the laser beams (16, 16'),

measuring the laser beams (16,16',16r) reflected and/or transmitted during-the illuminating, and

determining an intensity profile of the laser beams (16, 16') for bombarding the joining layer (25) based on the result of the measuring as to prevent damage to the substrate stack (23),

wherein monitoring and/or adaptation of parameters of the laser (5) takes place during bombarding of the joining layer (25), and

wherein to align depth of focus range (28) at each x-y position exactly on joining layer (25), the z-position of depth of focus range (28) is adjustable by means of at least one of telescopes (9), which are located in the beam path of laser beam (16).

6. The method according to claim 5, wherein the reflected and/or transmitted laser beams (16, 16', 16r) of the laser (5) are detected before the bombarding of the joining layer (25) with the laser beams (16, 16') at the temporarily bonded substrate stack (23) or a reference substrate stack.

7. The method according to any one of claims 5 or 6, wherein a beam shape and/or an intensity profile of the laser beams (16, 16') are controlled by means of the detected laser beams (16, 16', 16r).

8. The method according to any one of claims 5 to 7, wherein the bombarding of the joining layer (25) takes place in a scanned manner with the laser beams (16, 16').

9. The method according to any one of claims 5 to 8, wherein the detected laser beams (16, 16', 16r) are evaluated and used to control the process.