Device and method for bonding substrates

The invention relates to a method for bonding a first substrate with a second substrate and a corresponding device.

Substrates have been joined together by so-called bonding processes for many years in the semiconductor industry. Before the joining, these substrates must be aligned with one another as accurately as possible, wherein divergences in the nanometre range occurring in the meantime play a part. The alignment of the substrates usually takes place by means of alignment marks. Apart from the alignment marks, other, in particular functional elements are also present on the substrates, which also have to be aligned with one another during the bonding process. This alignment accuracy between the individual functional elements is required for the entire substrate surface. Thus, for example, it is not sufficient for the alignment accuracy to be very good in the centre of the substrates, but to diminish towards the edge.

In the prior art, there are a number of methods and systems, with the aid of which an attempt can be made to exert an influence on the bonding process, such as for example publications EP2656378B1or WO2014191033A1.

One of the greatest challenges in bonding is in the bonding process itself, i.e. during the bond initiation up to the complete contacting of the contact faces of the substrates. The alignment of the two substrates with respect to one another can still change decisively here compared to the previous alignment. If the two substrate surfaces are first joined together, a separation is theoretically again possible, but is associated with high costs, low throughput and susceptibility to errors.

Embodiments of the present invention provide a device and a method for bonding two substrates, with which the bonding accuracy, in particular at the edge of the substrates, is increased.

According to an aspect of the present invention, there is provided a method for bonding a first substrate with a second substrate at mutually facing contact faces of the substrates with the following steps, in particular the following sequence: holding of the first substrate to a first holding surface of a first holding device and holding of the second substrate to a second holding surface of a second holding device, curvature of the contact faces before contacting of the contact faces, characterised in that a change in curvature of the contact face of the first substrate and/or a change in curvature of the contact face of the second substrate are controlled during the bonding.

Disclosed herein is a device for bonding a first substrate with a second substrate at mutually facing contact faces of the substrates with: a first holding device for holding the first substrate to a first holding surface and a second holding device for holding the second substrate to a second holding surface, curvature means for the curvature of the contact faces before contacting of the contact faces, characterised in that curvature changing means for changing the curvature of the first substrate and/or for changing the curvature of the second substrate can be controlled during the bonding.

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

The idea underlying embodiments of the invention is that both substrates are curved before the contacting or bonding and the curvature of at least one of the two substrates is changed by controlling the curvature during the bonding, in particular during the course of a bonding wave, preferably in fusion bonding. The curvature of the other (preferably upper) substrate is preferably also changed in a controlled manner.

The curvature also changes through automatic contacting of the substrates. The automatic contacting takes place in particular through the force of gravity acting on the substrate and/or other forces of attraction

CLAIMS

1. A method for bonding a first substrate (4o) with a second substrate (4u) at mutually facing contact faces (4k) of the substrates (4o, 4u) with the following steps, in particular the following sequence:
   - holding of the first substrate (4o) to a first holding surface (1s, 1s', 1s", 1s''') of a first holding device (1, 1‘ 1", 1''', 1^{IV}, 1^{V}, 1^{VI}) and holding of the second substrate (4u) to a second holding surface (1s, 1s', 1s", 1s''') of a second holding device (1, 1‘ 1", 1''', 1^{IV}, 1^{V}, 1^{VI}),
   - curvature of the contact faces (4k) before contacting of the contact faces (4k),

   characterised in that

   a change in curvature of the contact face (4k) of the first substrate (4o) and/or a change in curvature of the contact face (4k) of the second substrate (4u) are controlled during the bonding.

2. The method according to claim 1, wherein the curvatures and/or changes in curvature are adjusted and/or controlled mirror-symmetrically and/or concentrically with respect to the contact faces (4k) before contacting of the contact faces (4k).

3. The method according to any one of the preceding claims, wherein at least one of the curvatures and/or changes in curvature takes place by means of an, in particular mechanical, curvature means (5'), in particular a pin.

4. The method according to any one of the preceding claims, wherein at least one of the curvatures and/or changes in curvature is adjusted and/or controlled by fluid pressurisation by means of a fluid, in particular acting directly on the substrate.

5. The method according to any one of the preceding claims, wherein the first substrate (4o) and/or the second substrate (4u) are fixed by fixing means arranged, in particular in a ring-shaped, preferably a circular ring-shaped manner, at the periphery of the holding surfaces (1s, 1s', 1s", 1s'''), in particular solely in the region of side edges (4os, 4us) of the substrates (4o, 4u).

6. The method according to claim 5, wherein the fixing means comprise, in particular separately controllable, fixing elements (2) divided up into zones, arranged preferably concentrically, in particular distributed uniformly at the holding surfaces (1s, 1s', 1s", 1s''').

7. The method according to any one of the preceding claims, wherein the first holding surface (1s, 1s', 1s", 1s''') and/or the second holding surface (1s, 1s', 1s", 1s''') are formed from elevations (7, 7', 7", 7''', 7'''') forming in particular a first holding plane of the first holding surface (1s, 1s', 1s", 1s''') and a second holding plane of the second holding surface (1s, 1s', 1s", 1s''').

8. The method according to any one of the preceding claims, wherein the curvature and/or change in curvature is detected by means of curvature measure means, in particular sensors (3), preferably distance sensors, arranged in particular along the first and/or second holding surfaces (1s, 1s', 1s", 1s''').