

According to an aspect of the present invention, there is provided a device for bonding a first substrate with a second substrate at respective contact faces of the substrates, the device including: a holding device for holding the first substrate to a first sample holder surface of a first sample holder with a holding force FH1 and holding the second substrate to a second sample holder surface of a second sample holder with a holding force FH2, wherein respective contact faces of the substrates are contacted at a bond initiation point, a bonding means for bonding the first substrate with the second substrate along a bonding wave running from the bond initiation point to respective side edges of the substrates, wherein the holding device is configured to curve the second substrate, in a convex manner or a concave manner through an over-pressurizing or an under-pressurizing therein; and measuring means configured to detect a bonding wave propagating from a point at which the first and second substrates come into contact to enable control of the bonding wave, wherein the holding force FH1 can be reduced during the bonding, to an extent such that the first substrate can be released from the first sample holder.

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 the 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. If an individual or a plurality of method steps can be performed on different devices or modules, the latter are in each case disclosed separately as an independent method.

Embodiments of the present invention reduce a heating temperature T_H already during the bonding and to switch off heating during the bonding. Heating temperature T_H serves in particular to produce a temperature sufficient for the bonding at a bonding face of the substrates. An embodiment of the invention consists in removing the fixing of a substrate, in particular during the bonding, in order to permit free deformability of the substrate stack to the bonded. A further embodiment of the invention consists in the possibility of the substrate stack, in particular its interface, being ventilated or subjected to pressure during the bonding.

As a first and/or second substrate wafers are particularly qualified.

A characteristic process according to embodiments of the invention during the bonding, in particular permanent bonding, preferably fusion bonding, is the most concentric, punctiform possible contacting of the two substrates. In particular, the contacting of the two substrates can also take place in a non-concentric manner. The bonding wave being propagated from a non-concentric contact point would reach different sides of the substrate edge at different times. The complete mathematical-physical description of the

Claims:

1. A device for bonding a first substrate (2) with a second substrate (2') at respective contact faces of the substrates, the device comprising:

a holding device for holding the first substrate to a first sample holder surface of a first sample holder with a holding force FH1 and holding the second substrate to a second sample holder surface of a second sample holder with a holding force FH2,

wherein respective contact faces of the substrates are contacted at a bond initiation point,

a bonding means for bonding the first substrate with the second substrate along a bonding wave running from the bond initiation point to respective side edges of the substrates,

wherein the holding device is configured to curve the second substrate, in a convex manner or a concave manner through an over-pressurizing or an under-pressurizing therein; and

measuring means (9) configured to detect a bonding wave (8) propagating from a point at which the first and second substrates come into contact to enable control of the bonding wave,

wherein the holding force FH1 can be reduced during the bonding, to an extent such that the first substrate can be released from the first sample holder.

2. The device according to claim 1, wherein the bonding wave (8) comprises a bonding wave front (8).

3. The device according to claim 1 or 2, wherein the measuring means (9) is provided such that a back side (2i) of the first substrate (2) can be detected.

4. The device according to claim 1 or 2, wherein a bond interface between the substrates (2,2') can be detected.

5. The device according to at least one of claims 1 to 4, wherein the measuring means is configured to detect a bonding wave front.

6. The device according to at least one of the preceding claims, wherein at least one of the holding forces (FH1, FH2) can be reduced to 0 (zero) to control the bonding wave.
7. The device according to at least one of the preceding claims, wherein a state of the bonding wave can be detected.
8. The device according to at least one of claims 1 to 6, wherein a state of the bonding wave front can be detected.
9. The device according to at least one of claims 1 to 6, wherein an advance of the bonding wave can be detected.
10. The device according to at least one of claims 1 to 6, wherein an advance of the bonding wave front can be detected.
11. The device according to at least one of claims 1 to 6, wherein a position of the bonding wave and/or a size of a bonded area can be detected.
12. The device according to at least one of claims 1 to 6, wherein a position of the bonding wave front and/or a size of a bonded area can be detected.
13. The device according to at least one of the preceding claims, wherein the measuring means comprises optics and/or cameras.
14. The device according claim 13, wherein the cameras comprises visual cameras and/or infrared cameras.
15. The device according to at least one of the preceding claims, wherein the measuring means comprises conductivity measurement means, comprising contacting two electrodes at two opposite positions of a substrate.
16. The device according to claim 15, wherein the conductivity measurement means comprises contacting the two electrodes at an edge of the substrates (2, 2').

17. The device according claim 15 or 16, wherein the conductivity measurement means comprises surface conductivity measurement means.
18. The device according to at least one of the preceding claims, wherein the bonding wave can be controlled by controlled and step-by-step releasing of a fixing means.
19. The device according to claim 18, wherein the fixing means comprises vacuum fixing.
20. The device according to claim 18, wherein the releasing of the fixing means comprises targeted releasing.
21. The device according to claim 18, wherein the releasing of the fixing means comprises radial symmetric releasing.
22. The device according to claim 18, wherein the releasing of the fixing means comprises releasing from inside to outside.
23. The device according to at least one of the preceding claims, wherein the bonding wave is detected over a period more than 1s.
24. The device according to 22, wherein the period is more than 2s.
25. The device according to claim 22, wherein the period is more than 3s.
26. The device according to claim 22, wherein the period is more than 4s.
27. The device according to claim 22, wherein the period is more than 5s.
28. The device according to at least one of the preceding claims, wherein the detection of the bonding wave takes place via a radial, position of the bonding wave as long as the bonding wave is at the radial position corresponds to at least 0.1 times the diameter of the substrate.
29. The device according claim 28, wherein the radial position is 0.2 times the diameter of the substrate.

30. The device according claim 28, wherein the radial position is 0.3 times the diameter of the substrate.

31. The device according claim 28, wherein the radial position is 0.4 times the diameter of the substrate.

32. The device according claim 28, wherein the radial position is 0.5 times the diameter of the substrate.

33. The device according to at least one of the preceding claims, wherein the detection of the bonding wave takes place via a percentage amount of the bonded surface respective the non-bonded surface until more than 1 % of the area is bonded.

34. The device according to at least one of claims 1 to 32, wherein the detection of the bonding wave takes place via a percentage amount of the bonded surface respective the non-bonded surface until more than 4 % of the area is bonded.

35. The device according to at least one of claims 1 to 32, wherein the detection of the bonding wave takes place via a percentage amount of the bonded surface respective the non-bonded surface until more than 9 % of the area is bonded.

36. The device according to at least one of claims 1 to 32, wherein the detection of the bonding wave takes place via a percentage amount of the bonded surface respective the non-bonded surface until more than 16 % of the area is bonded.

37. The device according to at least one of claims 1 to 32, wherein the detection of the bonding wave takes place via a percentage amount of the bonded surface respective the non-bonded surface until more than 25 % of the area is bonded.

38. The device according to at least one of the preceding claims, wherein the controlling takes place on the basis of defined, set of settable values from the detection.

39. The device according to claim 18, wherein the controlling takes place by targeted removal of the fixing means by continuous removal of a vacuum.

40. The device according to claim 39, wherein the continuous removal of the vacuum is from the center to the peripheral edge of the substrate holders.