

high pressure drop at the outlet of the substrate wiping space. Due to the fact that the process takes place within a fraction of a second, the energy cannot be dissipated quickly enough and the process can be regarded as isenthalpic. Consequently, the JTC of the gas or gas mixture decides whether cooling or heating of the gas or gas mixture takes place during the isenthalpic expansion. The cooling of the gas or gas mixture can be so strong that the dew point of the gas or gas mixture is undershot and the gas or gas mixture or individual components of the gas mixture condense. The substrate surface serves as a crystallization nucleus. It is therefore a heterogeneous nucleation which has an even lower nucleation energy than a homogeneous nucleation in the gas phase. This physical process of condensation must be avoided.

Embodiments of the present invention overcome the disadvantages of the prior art and in particular to achieve an improved bond result.

According to first aspect of the present invention, there is provided a device for bonding a first substrate surface of a first substrate to a second substrate surface of a second substrate, having a first substrate holder for accommodating the first substrate, a second substrate holder for accommodating the second substrate, wherein at least the first substrate holder has a first recess with a fixing device for fixing the first substrate in the first recess, as well as an elevation at least partly surrounding the first recess; and wherein at least one of the first substrate holder and the second substrate holder has at least one hole for evacuating and/or rinsing the first recess, the first recess is rinsed with a gas and/or a gas mixture with a negative Joule-Thompson coefficient (JTC) before and/or during and/or after the bonding of the first substrate and the second substrate); wherein the elevation has an expansion surface for expansion of the first substrate surface; and wherein the first recess and/or the elevation is/are adapted to the first substrate in such a manner that the substrate surface with the expansion surface forms a substantially continuous surface and/or merges into the elevation.

According to second aspect of the present invention, there is provided a system made up of the above device and the first substrate, wherein the first substrate surface merges into the elevation.

According to third aspect of the present invention, there is provided a method for bonding a first substrate surface of a first substrate to a second substrate surface of a second substrate by means of the above device, wherein a gas arranged between the substrate surfaces during the bonding process is displaced from a centre to the edge of the substrates, wherein at least the first substrate surface merges into the elevation in such a way that expansion of the gas only takes place outside the substrates; and wherein the first recess is rinsed with a gas and/or a gas mixture with a negative JTC before and/or during and/or after the bonding of the first substrate and the second substrate.

All combinations of at least two features specified in the description, the claims and/or the drawings also fall within the scope of the invention. In the case of value ranges, values lying within the limits mentioned should also be disclosed as limit values and be claimable in any desired combination.

The core idea as per embodiments of the invention is that the substrate surface or the substrate surfaces are widened in such a manner that the gas which is displaced from the centre outwards during the bonding process does not already expand at the edge between the substrates but rather the expansion of the gas only takes place outside of the two substrates. In other words: the gas is still forced out of the intermediate space between the substrates with increased pressure, and the pressure drop or expansion only takes place when the surrounding elevation or the expansion surface has been reached or the gas has run beyond or been pushed beyond the elevation or the expansion surface.

The substrates may have any desired shape, but are preferably circular. The diameter of the substrates is in particular industrially standardized. For wafers, the industry-standard

Claims:

1. A device (10, 10') for bonding a first substrate surface (2os) of a first substrate (2o) to a second substrate surface (2us) of a second substrate (2u), having:
 - a first substrate holder (6o, 6o') for accommodating the first substrate (2o),
 - a second substrate holder (6u, 6u ') for accommodating the second substrate (2u),

wherein at least the first substrate holder (6o, 6o') has a first recess (7o) with a fixing device (3) for fixing the first substrate (2o) in the first recess (7o), as well as an elevation (8o) at least partly surrounding the first recess (7o);

wherein at least one of the first substrate holder (6o, 6o') and the second substrate holder (6u, 6u ') has at least one hole (11) for evacuating and/or rinsing the first recess (7o), the first recess (7o) is rinsed with a gas and/or a gas mixture with a negative Joule-Thompson coefficient (JTC) before and/or during and/or after the bonding of the first substrate (2o) and the second substrate (2u);

wherein the elevation (8o) has an expansion surface (8os) for expansion of the first substrate surface (2os); and

wherein the first recess (7o) and/or the elevation (8o) is/are adapted to the first substrate (2o) in such a manner that the substrate surface (2os) with the expansion surface (8os) forms a substantially continuous surface and/or merges into the elevation (8o).
2. The device (10, 10') according to Claim 1, wherein the first recess (7o) is rinsed with the gas and/or the gas mixture with a negative JTC to at least partially remove a gas and/or a gas mixture with a positive JTC.
3. The device (10, 10') according to Claim 1, wherein the first recess (7o) is rinsed with the gas and/or the gas mixture with a negative JTC to entirely remove a gas and/or a gas mixture with a positive JTC.
4. The device (10, 10') according to any one of Claim 1 to 3, the gas and/or the gas mixture with a negative JTC includes helium, hydrogen or neon.

5. The device (10, 10') according to Claim 2 or 3, the gas and/or the gas mixture with a positive JTC includes nitrogen.
6. The device (10, 10') according to Claim 1, wherein the expansion surface (8os) is seamless.
7. The device (10, 10') according to Claim 1, wherein the first recess (7o) and/or the elevation (8o) is/are adapted to the shape of the first substrate (2o).
8. The device (10, 10') according to any one of Claim 1 to 3, wherein the first recess (7o) and/or the elevation (8o) can be adapted manually and/or semi-automatically and/or automatically such that the substrate surface (2os) forms a substantially continuous surface with the expansion surface (8os) and/or merges into the elevation (8o).
9. The device (10, 10') according to any one of Claim 1 to 3, wherein the first substrate holder (6o, 6o') has an outer component (1o') and an inner component (5o) movable in the outer component (1o'), wherein the outer and/or inner component (5o) is translationally and/or rotatably movable, wherein the components (1o', 5o) can be fixed to one another.
10. A device (10, 10') according to any one of Claim 1 to 3, wherein the vertical distance (v_o , v_u) between the first substrate surface (2os) and the expansion surface (8os) is adjustable.
11. The device (10, 10') according to any one of Claim 1 to 3, wherein the holes (11) are arranged in a symmetrically distributed manner.
12. The device (10, 10') according to Claim 11, wherein the holes (11) are arranged in the inner component.

13. The device (10, 10') according to any one of Claim 1 to 3, wherein the elevation (8o, 8', 8 ") has an inwardly and/or outwardly curved expansion surface (8o, 8s', 8s'').
14. The device (10, 10') according to any one of Claim 1 to 3, wherein the elevation (8o, 8''', 8IV) has an inwardly and/or outwardly bevelled extension surface (8o, 8s''', 8sIV) at an angle (a).
15. A system made up of the device (10, 10') according to any one of Claim 1 to 14 and the first substrate (2o), wherein the first substrate surface (2os) merges into the elevation (8o).
16. A method for bonding a first substrate surface (2os) of a first substrate (2o) to a second substrate surface (2us) of a second substrate (2u) by means of the device (10, 10') according to any one of Claims 1 to 14, wherein a gas arranged between the substrate surfaces (2os, 2us) during the bonding process is displaced from a centre to the edge (9, 9o, 9u) of the substrates (2o, 2u),
wherein at least the first substrate surface (2os) merges into the elevation (8o) in such a way that expansion of the gas only takes place outside the substrates (2o, 2u); and
wherein the first recess (7o) is rinsed with a gas and/or a gas mixture with a negative JTC before and/or during and/or after the bonding of the first substrate (2o) and the second substrate (2u).