often determined by other boundary conditions, thermal stresses can only be avoided when the temperature differentials within the process steps are as small as possible.

It should be mentioned that the material combinations with which the bonding process should offer the greatest advantage (as an integration of materials with different lattice parameters and/or different thermal expansion coefficients should follow) are least compatible with a heat-treatment process because it is mostly here that the greatest differences with regard to thermal expansion occur.

Embodiments of the present invention disclose a device and a method for bonding with which the bonding process can be carried out more efficiently and qualitatively more valuably.

According to an aspect of the present invention, there is provided a method for producing a direct bond between a bonding side of a first substrate and a bonding side of a second substrate in a workspace, wherein the method includes: ~~a)~~ modifying at least one of the bonding sides of the first substrate or the second substrate in a reducing atmosphere of a plasma in a plasma chamber and/or a bonding chamber/plasma chamber, to create a damaged layer on the at least one bonding side, the modifying including: changing a stoichiometry of oxide layers respectively formed on the bonding sides of the first and second substrates; and ~~effected by a control device using~~controlling parameters to adjust the thickness of the damaged layer, the density of the damage, and the species or dose of implanted ions, wherein the implanted ions are hydrogen ions, ~~b)~~ subsequently bonding the bonding side of the first substrate with the bonding side of the second substrate in the bonding chamber or the bonding/plasma chamber~~, and c) treating at least one of the bonding sides of the first substrate or the second substrate in a reducing atmosphere of a plasma in the plasma chamber and/or the bonding chamber/plasma chamber to create a damaged layer on the at least one bonding side, wherein the implanted ions are hydrogen ions~~.

The scope of the invention includes all combinations of at least two features given in the description, the claims, and/or the figures. With the given value ranges, values that lie inside of the boundaries mentioned should also be revealed as limits and should be claimable in any combination.

Claims

1. A method for producing a direct bond between a bonding side of a first substrate and a bonding side of a second substrate in a workspace, wherein the method comprises:
   a) modifying at least one of the bonding sides of the first substrate or the second substrate in a reducing atmosphere of a plasma in a plasma chamber and/or a bonding chamber/plasma chamber, to create a damaged layer on the at least one bonding side, the modifying comprising:
   (i) changing a stoichiometry of oxide layers respectively formed on the bonding sides of the first and second substrates; and
   ~~effected by a control device using~~(ii) controlling parameters to adjust the thickness of the damaged layer, the density of the damage, and the species or dose of implanted ions, wherein the implanted ions are hydrogen ions,
   b) subsequently bonding the bonding side of the first substrate with the bonding side of the second substrate in the bonding chamber or the bonding/plasma chamber~~, and~~.
   ~~c) treating at least one of the bonding sides of the first substrate or the second substrate in a reducing atmosphere of a plasma in the plasma chamber and/or the bonding chamber/plasma chamber to create a damaged layer on the at least one bonding side, wherein the implanted ions are hydrogen ions.~~
2. The method according to Claim 1, in which the modification takes place by:
   a) altering an oxide layer (2) on at least one of the bonding sides, and/or
   b) at least partial, and particularly complete, removal of part of an oxide layer (2) from at least one of the bonding sides.

3. The method according to one of the Claims 1 or 2, in which the bonding layer is exposed to an ion energy of less than 1000eV, especially less than 500eV, preferably less than 250eV, that is applied between an upper electrode (10) and a lower electrode (9) of the plasma chamber (4) and/or the bonding/plasma chamber (20).
4. The method according to Claim 3, in which an AC voltage with a frequency greater than the frequency of the AC voltage applied to the lower electrode is supplied to the upper electrode (10).
5. The method according to Claim 1, wherein the density of the plasma and the ion energy with which the ions strike the substrate are individually adjustable.
6. The method according to Claim 5, wherein the ion energy with which the particles strike the surface of the substrate is controlled primarily via a lower electrode of the plasma chamber and/or a bonding/plasma chamber.