Device and Method for Bonding Substrates

Specification

The present invention relates to a device for creating an electrically conductive direct bond between a bonding side of a first substrate and a bonding side of a second substrate and a method ~~according to Claim 1~~.

Especially when bonding metallic or metallized substrates, substrates with metallic surfaces, semiconductor substrates, or compound semiconductor substrates, the oxidation of the bonding sides of the substrates to be bonded plays a significant role, as it impedes the bonding process. The oxide prevents or reduces the formation of a mechanically and/or electrically valuable contact. Notably associated with this is, due to longer heating and cooling times, a deterioration in throughput; and, the higher the temperature is or must be during bonding, the larger the influences of expansion owing to temperature differentials are on the alignment or adjustment accuracy of the substrates relative to one another. Furthermore, certain MEMS- and/or semiconductor assemblies, for example, such as microchips or memory chips, do not allow high process temperatures.

In the state of the art, mainly wet etching processes are used for removing oxides that form on the above-mentioned substrates and consequently prevent, or at least impede, an optimum bonding of multiple substrates through a bond process. In the wet etching processes, hydrofluoric acid or hydrofluoric acid-containing mixtures are predominantly used. After reduction of the oxide, a surface – terminated by hydrogen

700 °C. At such high temperatures, the materials used are mechanically heavily stressed. In the presence of high temperature differentials, mechanical strain is determined by, above all, thermal stresses. The thermal stresses are dependent on the thermal expansion coefficient and temperature differential. If materials cannot expand freely together because they are welded together along a bond interface, a difference in the thermal expansion coefficients in the presence of a temperature differential results in correspondingly high thermal stress. Because the choice of material is quite 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.

~~The purpose~~ Embodiments of the present invention ~~is therefore to specify~~ disclose a device and a method for bonding with which the bonding process can be carried out more efficiently and qualitatively more valuably.

~~This task is accomplished with the features of Claim 1. Advantageous enhancements of the invention are given in the subclaims.~~

According to an aspect, 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, in which at least one of the bonding sides is modified in a plasma chamber and is subsequently bonded with the bonding side of the second substrate in a bonding chamber, and/or at least one of the bonding sides is modified in a bonding/plasma chamber and subsequently bonded with the bonding side of the second substrate in the bonding/plasma chamber, wherein modification of at least one of the bonding sides takes place through a change in the stoichiometry of an oxide layer on at least one of the bonding sides, and wherein one or more or the following specified reducing gases is introduced into the plasma chamber for modification: Hydrogen, Nitrogen oxides, Carbon monoxide, Methane, and wherein the reducing gas is mixed with one or more of the following inert gases: Xenon, Argon, Helium, Nitrogen, Carbon dioxide.

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.