~~Method for Permanent Bonding of Wafers~~

~~amended Claims~~

CLAIMS

1. A method for bonding of a first contact surface (3) of a first substrate (1) to a second contact surface (4) of a second substrate (2) with the following steps, especially the following sequence:

- forming a first reservoir (5) in a surface layer (6) on the first contact surface (3) and a second reservoir (5') in a surface layer (6') on the second contact surface (4), the surface layers (6, 6') consisting at least largely of a native oxide material,
- at least partial filling of the reservoirs (5, 5') with a first educt or a first group of educts,
- providing a second educt in a reaction layer (7) of the second substrate (2),
- providing a growth layer (8) at the second contact surface (4) of the second substrate (2),
- bringing the first contact surface (3) in contact with the second contact surface (4) for formation of a prebond connection,
- forming a permanent bond between the first and second contact surface (3, 4), at least partially strengthened by the reaction of the first educt with ~~a~~ the second educt ~~contained in a reaction layer (7) of the second substrate (2)~~, wherein the first educt and the second educt are capable to form and/or strengthen the permanent bond, and
- inhibiting growth of the growth layer (8) before the contact surfaces (3, 4) make contact.

2. The method as claimed in Claim 1, wherein the educts are taken from the group consisting of O_x^+, O_2, O_3, N_2, NH_3, H_2O, H_2O_2, and NH_4OH.

3. The method as claimed in Claim 1, wherein the substrates (1,2) are comprised of a material capable of reacting as an educt with one of the first educt and the second educt to form a growth layer (8) on the substrates (1, 2) to result in a product with a higher molar volume.

~~2~~4. The method as claimed in Claim 1, wherein formation and/or strengthening of the permanent bond takes place by diffusion of the first educt into the reaction layer (7).

~~3~~5. The method as claimed in one of the preceding claims, wherein the formation of the permanent bond takes place at a temperature between room temperature and 200°C, especially during a maximum 12 days, preferably a maximum 1 day, even more preferably a maximum 1 hour, best a maximum 15 minutes.

~~4~~6. The method as claimed in one of the preceding claims, wherein the irreversible bond has a bond strength of greater than 1.5 J/m^2, especially greater than 2 J/m^2, preferably greater than 2.5 J/m^2.

~~5~~7. The method as claimed in one of the preceding claims, wherein during the reaction a reaction product (10) with a greater molar volume than the molar volume of the second educt is formed in the reaction layer (7).

~~6~~8. The method as claimed in one of the preceding claims, wherein the reservoir (5) is formed by plasma activation.

~~7~~9. The method as claimed in one of the preceding claims, wherein the surface layer (6) consists essentially completely of an amorphous material, especially silicon oxide produced by thermal oxidation, and the reaction layer (7) consists of an oxidizable material, especially predominantly, preferably essentially completely, of Si, Ge, InP, GaP or GaN.

~~8~~10. The method as claimed in one of the preceding claims, wherein between the second contact surface (4) and the reaction layer (7) there is a growth layer (8), consisting especially at least largely of a native oxide material, preferably predominantly of native silicon dioxide.

~~9~~11. The method as claimed in Claim ~~8~~10, wherein before the formation of a permanent bond the growth layer (8) and/or the surface layer (6) has an average thickness A between 1 angstrom and 10 nm.

~~10~~12. The method as claimed in one of the preceding claims, wherein a reservoir is formed in a vacuum.

~~11~~13. The method as claimed in one of the preceding claims, wherein the reservoir is filled by one or more of the steps cited below:

- exposing the first contact surface (3) to the atmosphere, especially with a high oxygen and/or water content,
- exposing the first contact surface (3) to a fluid consisting especially predominantly, preferably almost completely, of especially deionized H_2O and/or H_2O_2,
- exposing the first contact surface (3) to N_2 gas and/or O_2 gas and/or Ar gas and/or forming gas, especially consisting of 95% Ar and 5% H_2, especially with an ion energy in the range from 0 to 200 eV.

~~12~~14. The method as claimed in one of the preceding claims, wherein the formation and the filling of a reservoir take place additionally on the second contact surface (4), especially in the growth layer (8), and the formation of the permanent bond is additionally strengthened by reaction of the first educt with a second educt contained in a reaction layer (7') of the first substrate (1).

~~13~~15. The method as claimed in one of the preceding claims, wherein the average distance (B) between the reservoir (5) and the reaction layer (7) immediately before formation of the permanent bond is between 0.1 nm and 15 nm, especially between 0.5 nm and 5 nm, preferably between 0.5 nm and 3 nm.

~~14~~16. The method as claimed in one of the preceding claims, wherein the irreversible bond has a bond strength which comprises twice, preferably 4 times, more preferably 10 times, most preferably 25 times the prebond strength.

~~15~~17. The method as claimed in one of the preceding claims, wherein the size of the reservoir (5) is configured to hold the first educt and to accomodate excess first educt remaining from the reaction of the first educt with the second educt.

~~16~~18. The method as claimed in one of the preceding claims, wherein O_2-gas is used for plasma discharge.