

A further problem in the prior art consists in the fact that minimal deviations from the setpoint position of the alignment marks can arise. Although the positions of the alignment marks are defined with the greatest possible accuracy in the computer, the production of the alignment marks is however limited by the accuracy of the processes and equipment which generate the alignment marks on the substrate surface. Even if the alignment marks were to have no deviation from their ideal geometry, their real position can diverge minimally from the ideal position. The alignment mark deviation lies approximately between 1-100 nm, i.e. in the nanometre range.

Embodiments of the present invention disclose a method with which the accuracy of the alignment of two substrates with respect to one another can be improved.

According to a first aspect of the present invention, there is provided a method for the alignment of two substrates to be bonded, wherein the first substrate includes a first substrate surface with a first substrate surface side and a second substrate surface side which lies opposite the first substrate surface side, wherein the second substrate includes a second substrate surface to be bonded with the first substrate surface, wherein the second substrate surface includes a third substrate surface side and a fourth substrate surface side which lies opposite the third substrate surface side, wherein the method includes at least the steps of: detection and storage of first positions of a first alignment mark pair on the first substrate surface of the first substrate, wherein a first alignment mark of the first alignment mark pair is arranged on the first substrate surface side and a second alignment mark of the first alignment mark pair is arranged on the second substrate surface side, detection and storage of second positions of a second alignment mark pair on the second substrate surface of the second substrate, wherein a third alignment mark of the second alignment mark pair is arranged on the third substrate surface side and a fourth alignment mark of the second alignment mark pair is arranged on the fourth substrate surface side, detection and storage of third positions of a third alignment mark

pair on the second substrate surface of the second substrate, wherein a fifth alignment mark of the third alignment mark pair is arranged on the third substrate surface side and a sixth alignment mark of the third alignment mark pair is arranged on the fourth substrate surface side, detection and storage of fourth positions of a fourth alignment mark pair on the first substrate, wherein a seventh alignment mark of the fourth alignment mark pair is arranged on the first substrate surface side and an eighth alignment mark of the fourth alignment mark pair is arranged on the second substrate surface side, alignment of the two substrates with respect to one another based on statistically averaged positions of each of the detected first positions, second positions, third positions and fourth positions.

According to a second aspect of the present invention, there is provided a device for the alignment of two substrates to be bonded with the above method, including: substrate holders for holding and fixing the substrates, movement devices for moving the substrate holders, lens systems for detecting positions of alignment marks on the substrates, a storage device for storing the positions of the alignment marks.

According to a third aspect of the present invention, there is provided a product with two substrates to be bonded with the above method, including at least two alignment marks on each side.

All combinations of at least two features given in the description, the claims and/or the drawings also fall within the scope of the invention. In value ranges, values lying inside the stated limits are also deemed to be disclosed as limiting values and can be claimed in any combination.

Embodiments of the invention describe the alignment of two substrates to be bonded, wherein the first substrate comprises a first substrate surface with a first substrate surface side (also referred to hereinafter as the left-hand substrate surface side) and a second substrate surface side (also referred to hereinafter as the right-hand substrate surface side) which lies

Claims

1. A method for the alignment of two substrates (2u, 2o) to be bonded, wherein the first substrate (2u) comprises a first substrate surface (2us) with a first substrate surface side and a second substrate surface side which lies opposite the first substrate surface side, wherein the second substrate (2o) comprises a second substrate surface (2os) to be bonded with the first substrate surface (2us), wherein the second substrate surface (2os) comprises a third substrate surface side and a fourth substrate surface side which lies opposite the third substrate surface side, wherein the method comprises at least the following steps:
 - detection and storage of first positions of a first alignment mark pair (6ul, 6ur) on the first substrate surface (2us) of the first substrate (2u), wherein a first alignment mark (6ul) of the first alignment mark pair (6ul, 6ur) is arranged on the first substrate surface side and a second alignment mark (6ur) of the first alignment mark pair (6ul, 6ur) is arranged on the second substrate surface side,
 - detection and storage of second positions of a second alignment mark pair (6ol, 6or) on the second substrate surface (2os) of the second substrate (2o), wherein a third alignment mark (6ol) of the second alignment mark pair (6ol, 6or) is arranged on the third substrate surface side and a fourth alignment mark (6or) of the second alignment mark pair (6ol, 6or) is arranged on the fourth substrate surface side,
 - detection and storage of third positions of a third alignment mark pair (6ol', 6or') on the second substrate surface (2os) of the second substrate (2o), wherein a fifth alignment mark (6ol') of the third alignment mark pair (6ol', 6or') is arranged on the third substrate surface side and a sixth alignment mark (6or') of the third alignment mark pair (6ol', 6or') is arranged on the fourth substrate surface side,

- detection and storage of fourth positions of a fourth alignment mark pair (6ul', 6ur') on the first substrate (2u), wherein a seventh alignment mark (6ul') of the fourth alignment mark pair (6ul', 6ur') is arranged on the first substrate surface side and an eighth alignment mark (6ur') of the fourth alignment mark pair (6ul', 6ur') is arranged on the second substrate surface side,
 - alignment of the two substrates (2u, 2o) with respect to one another based on statistically averaged positions of each of the detected first positions, second positions, third positions and fourth positions.
2. The method according to claim 1, with the following steps, in particular the following sequence:
- arrangement and fixing of the substrates (2u, 2o) on substrate holders (12u, 12o),
 - movement of the first substrate holder (12u) with the first substrate (2u) into a first detection position before detection and storage of the first positions of the first alignment mark pair (6ul, 6ur) on the first substrate surface (2us) of the first substrate (2u) in the first detection position,
 - movement of the second substrate holder (12o) with the second substrate (2o) into a second detection position and movement of the first substrate holder (12u) with the first substrate (2u) into a first waiting position after detection and storage of the first positions of the first alignment mark pair (6ul, 6ur) and before detection and storage of second positions of the second alignment mark pair (6ol, 6or) on the second substrate surface (2os) of the second substrate (2o) in the second detection position,
 - movement of the first substrate holder (12u) with the first substrate (2u) into the first detection position and movement of the second substrate holder (12o) with the second substrate (2o) into a second

waiting position after detection and storage of the third positions of the third alignment mark pair (6ol', 6or') on the second substrate surface (2os) of the second substrate (2o) in the second detection position of the second substrate holder (12o) and before detection and storage of the fourth positions of the fourth alignment mark pair (6ul', 6ur') on the first substrate (2u) in the first detection position,

3. The method according to claim 1 or 2, wherein detection and storage of each of the first pair of alignment marks (6ul, 6ul'), second pair of alignment marks (6ur, 6ur'), third pair of alignment marks (6ol, 6ol') and fourth pair of alignment marks (6or, 6or') comprises detection of each pair of alignment marks simultaneously in a field of view of a lens system.

4. The method according to any one of the preceding claims, wherein the positions of at least two alignment marks (6ul, 6ul', 6ur, 6ur', 6ol, 6ol', 6or, 6or') are detected per substrate surface side on the substrates (2u, 2o), preferably of at least three alignment marks (6ul, 6ul', 6ur, 6ur', 6ol, 6ol', 6or, 6or'), still more preferably of at least four alignment marks (6ul, 6ul', 6ur, 6ur', 6ol, 6ol', 6or, 6or'), most preferably of at least five alignment marks (6ul, 6ul', 6ur, 6ur', 6ol, 6ol', 6or, 6or'), with utmost preference of at least six alignment marks (6ul, 6ul', 6ur, 6ur', 6ol, 6ol', 6or, 6or').

5. The method according to any one of the preceding claims, wherein the alignment marks (6ul, 6ul', 6ur, 6ur', 6ol, 6ol', 6or, 6or') of a substrate surface side are arranged inside a circle K with a radius less than 100 mm, preferably less than 50 mm, still more preferably less than 25 mm, most preferably less than 10 mm, with utmost preference less than 1 mm.

6. The method according to any one of the preceding claims, wherein the positions of the alignment marks (6ul, 6ul', 6ur, 6ur', 6ol, 6ol', 6or, 6or') are detected optically.
7. The method according to any one of the preceding claims, wherein the positions of the substrate holders (12u, 12o) are detected by interferometers and/or lens systems, which in particular are independent of the detection devices for detecting the positions of the alignment marks (6ul, 6ul', 6ur, 6ur', 6ol, 6ol', 6or, 6or').
8. The method according to any one of the preceding claims, wherein the substrate holders (12o, 12u) are fixed in the detection positions.
9. A device for the alignment of two substrates (2u, 2o) to be bonded with a method according to claim 1 or 2, comprising:
 - substrate holders (12u, 12o) for holding and fixing the substrates (2u, 2o),
 - movement devices for moving the substrate holders (12u, 12o),
 - lens systems for detecting positions of alignment marks (6ul, 6ul', 6ur, 6ur', 6ol, 6ol', 6or, 6or') on the substrates (2u, 2o),
 - a storage device for storing the positions of the alignment marks (6ul, 6ul', 6ur, 6ur', 6ol, 6ol', 6or, 6or').
10. A product with two substrates (2u, 2o) to be bonded with a method according to claim 1 or 2, comprising at least two alignment marks (6ul, 6ul', 6ur, 6ur', 6ol, 6ol', 6or, 6or') on each side.