Receiving Means for Mounting of Wafers

Specification

The invention relates to a receiving means for receiving and mounting of wafers, a device and a method for aligning a first wafer with a second wafer using the receiving means.

These receiving means or sample holders or chucks are available in diverse versions and a flat receiving surface or mounting surface is decisive for the receiving means, so that the structures which are becoming smaller and smaller can be correctly aligned and bonded on wafer surfaces which are larger and larger over the entire wafer surface. This is especially important when a so-called prebonding step which joins the wafers to one another by means of a separable interconnection is carried out before the actual bond process. High alignment accuracy of the wafers to one another is especially important as soon as an alignment accuracy or especially distortion values of < 2 µm are to be achieved for all structures located on one or both wafers. In the vicinity of the alignment marks this succeeds especially well in the indicated receiving means and devices for alignment, so-called aligners, especially bond aligners. With increasing distance from the alignment marks, controlled and perfect alignment with alignment accuracies or especially distortion values better than 2 µm, especially better than 1 µm and even more preferably better than 0.25 µm cannot be achieved.

Embodiments of this invention improve generic receiving means such that more accurate alignment can be achieved with them.

According to a first aspect of the present invention, there is provided a receiving means for receiving and mounting of wafers with the following features: a mounting surface, mounting means for mounting of the wafer on the mounting surface and compensation means for active, at least partial compensation of global distortions of the wafer, wherein the compensation is controllable by temperature.

According to a second aspect of the present invention, there is provided a device for alignment of a first wafer with a second wafer with the following features: a means for determining local alignment errors which have occurred due to strain and/or distortion of the first wafer relative

to a second wafer when the first wafer is joined to the second wafer, at least one receiving means as claimed in one of the preceding claims for receiving at least one of the wafers and alignment means for alignment of the wafers with compensation by the compensation means.

According to a third aspect of the present invention, there is provided a method for alignment of a first wafer with a second wafer with the following steps, especially the following sequence: determining local alignment errors which have occurred due to strain and/or distortion of the first wafer relative to a second wafer when the first wafer is joined to the second wafer, receiving at least one of the wafers on the above receiving means and aligning the wafers with compensation by the compensation means.

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combinations of at least two of the features given in the specification, the claims and/or the figures also fall within the framework of the invention. At the given value ranges, values within the indicated limits will also be disclosed as boundary values and will be claimed in any combination.

Embodiments of the invention are based on the finding of the applicant according to European patent applications EP 09012023 and EP 10 015 569, with the former a detection of the entire surface, especially the positions of the structures on the surface of each wafer as a position map of the wafer being possible. The latter invention relates to a device for determining local alignment errors which have occurred due to strain and/or distortion of the first wafer relative to a second wafer when the first wafer is joined to the second wafer, with the following:

- a first strain map of strain values along a first contact surface of the first wafer and/or
- a second strain map of strain values along a second contact surface and
- evaluation means for evaluating the first and/or second strain maps by which the local alignment errors can be determined.

The basic idea of embodiments of this invention is to provide a receiving means consisting of several active control elements which are independent of one another and with which the mounting surface of the receiving means can be influenced, especially in shape and/or temperature. Here the active control elements are used by the corresponding activation such that the local alignment errors or local distortions which are known by means of the position maps and/or strain maps are compensated or for the most part minimized or reduced. Here not only are local distortions eliminated, but a macroscopic distortion or stretching of the wafer which arises from the local distortions altogether in its outside dimensions is at the same time minimized or corrected.

Thus, as per embodiments of the invention, especially in combination with the above described

embodiments relating to the position maps, strain maps and/or stress maps and the in-situ correction of alignment faults disclosed there during contact-making and bonding of the wafers, it is possible to achieve a still better alignment result by active, especially local action on distortions of the wafer.

According to one advantageous embodiment of the invention it is provided that the temperature of the mounting surface can be locally influenced by the compensation means. A local temperature increase of the mounting surface leads to local expansion of the wafer which is held on the mounting surface at this position. The higher the temperature gradient, the more the wafer expands at this position. Based on the data of the position maps and/or strain maps, especially the vector evaluation of the alignment error, especially for each position of the position maps and/or strain maps, it is possible to act on local wafer distortions or to counteract them in a controlled manner.

In this connection vector evaluation is defined as a vector field with distortion vectors, which field has been determined especially by means of one of two versions of embodiments of the invention described below.

The first version relates to applications in which only one of the two wafers is structured. In this case, it is provided as per embodiments of the invention that the deviation of the structures is detected, especially the deviation of the geometrical shape from the desired shape. In this case the deviation of the shape of exposure fields, especially exposure fields of a step & repeat exposure device, from the nominally expected shape which is conventionally rectangular is of special interest. These deviations, especially the vector field which describes these deviations, can take place based on the detection of a position map of the individual alignment marks which correspond to the exposure fields according to EP 09012023. Alternatively this vector field can also be determined based on

stress maps and/or strain maps which are acquired by means of EP 10 015 569.6. Advantageously this vector field can however as per embodiments of the invention also be determined by any other suitable measurement means and can be read in. In particular, step & repeat lithography systems which are operated for acquisition of these data with a special test mask and/or a special test routine are suitable for this measurement.

The second version relates to applications in which two wafers are structured. In this case it is provided as per embodiments of the invention that the vector field of the alignment deviation be computed for all positions of the position maps, especially of the first and second position maps according to EP 09012023. This vector field is to be determined especially for the alignment position which is considered ideal according to technological and/or economical criteria according to the material in EP 10 015 569.6.

In another advantageous embodiment of the invention it is provided that the strain of the mounting surface can be locally influenced by the compensation means, especially by arrangement of piezoelements which can preferably be individually activated on one back of the mounting surface. By stretching or shrinkage, therefore negative stretching, the mounting surface, also the wafer, is deformed accordingly, especially stretched or shrunk, especially by the mounting force acting from the mounting surface on the wafer so that in this way the wafer can be influenced in a controlled manner by a corresponding control means based on the values of the strain map which has been determined for this wafer. To the extent the shape of the mounting surface can be locally influenced by the compensation means, especially by preferably mechanical action in one Z direction, there is another possibility for counteracting distortions of the wafer on the mounting surface. Here it also applies that the control of the compensation means takes place by a control

means which undertakes a correspondingly dedicated local control of the compensation means based on the values of the position maps and/or strain maps.

The control means encompasses especially software for executing/computing corresponding routines.

According to another advantageous embodiment of the invention, it is provided that the mounting surface can be locally exposed to pressure from the back of the mounting surface, by the compensation means, especially hydraulically and/or pneumatically. In this way the shape of the mounting surface can likewise be influenced so that the aforementioned effects arise. Control likewise takes place again by the above described control means.

Advantageously the compensation means are provided as a plurality of active control elements in the receiving means, especially integrated, preferably embedded into the mounting surface. Thus a receiver of the receiving means can be made monolithic, as is likewise the case in the known receiving means.

Here it is especially advantageous if each control element or groups of control elements can be activated separately. Accordingly local activation means that a small extract, especially an extract smaller than half the wafer, preferably smaller than 1/4 of the wafer, preferably smaller than 1/8 of the wafer, even more preferably smaller than 1/16 of the wafer, can be locally activated by the compensation means. It is especially advantageous if the compensation means can act on each region of the wafer occupied by its own structure with at least one control element.

The device as per embodiments of the invention comprises the above described control means advantageously in a central control unit which is responsible for all control processes. But as per embodiments of the invention it is conceivable to provide the control means in the receiving means,

especially as a module of an overall device.

The method as per embodiments of the invention can be still further improved by there being one, especially repeated, acquisition of position maps and/or strain maps of the first and/or second wafer after the alignment. Thus as per embodiments of the invention after completed alignment there can be checking of the alignment success. Accordingly it is conceivable to eliminate a wafer pair with overly large alignment errors in order for example to align them again as per embodiments of the invention or to dispose of them. At the same time the acquired data can be used for self-calibration of the device, especially by the control means.

The inventions disclosed in European patent application EP 09012023.9 and/or the European patent application EP 10 015 569.6 will be considered as concomitantly disclosed at the same time as embodiments for this invention.

Other advantages, features and details of the invention will become apparent from the following description of preferred exemplary embodiments and using the drawings.

Figure 1a shows a plan view of a receiving means as claimed in the invention in a first embodiment,

Figure 1b shows a cross sectional view of the receiving means according to cutting line A-A from Figure 1a,

Figure 2a shows a plan view of a receiving means as claimed in the invention in a second embodiment,

Figure 2b shows a cross sectional view of the receiving means according to cutting line B-B from Figure 2a,

Figure 3a shows a plan view of a receiving means as claimed in the invention in a third