Method for Determining the Position of an Axis of Rotation

Description

The invention relates to a method for determining an X-Y position in an X-Y coordinate system of an axis of rotation that is perpendicular to the X-Y coordinate system of a substrate holding means that can rotate around the axis of rotation for holding a substrate ~~according to Claim 1~~ as well as a method for determining a position of an axis of rotation R of the substrate in the substrate plane that is perpendicular to a substrate plane of a substrate ~~according to Claim 2~~, and a method for determining a position of an axis of rotation of the substrate holding means that is perpendicular to a substrate holding means plane of a substrate holding means for holding a substrate ~~according to Claim 3~~. The substrates in question in terms of this invention include in particular semiconductors, preferably wafers, glass, quartz, ceramic and metal, and the application of the method relates~~, as provided in Claim 7,~~ in particular to the determination of an orientation error of a large number of contact points oriented to one another and arranged on two opposite sides of a substrate.

Because of ever greater miniaturization of semiconductor components, the latter will increasingly be built in stacked form in the future, so that a need for an optimized method for production of such stacked semiconductor products exists. A method to stack semiconductor components vertically consists in, i.a., outfitting a wafer on both sides with semiconductor elements, in particular dices and/or chips on both sides. On both sides of the wafer, there is therefore a large number of semiconductor components, which

Embodiments of the invention disclose~~The object is therefore to develop~~ a method with which the above-mentioned technical problems can be solved so that a faster and accordingly more economical determination of the righting error of the contact points to be oriented to one another in each case can be enabled.

~~This object is achieved with the features of Claims 1,2 or 3. Advantageous further developments of the invention are indicated in the subclaims.~~

According to an aspect, there is provided a method for determining an alignment error of a X-Y position arranged in a X-Y coordinate system, wherein the X-Y position is related to an axis of rotation of a substrate holding means, which is rotatable around the axis of rotation, and for determining an alignment error of contact points, comprising the steps of:

- determining a first X-Y reference position RP of a reference labeling that is provided on the substrate holding means,
- rotating the substrate holding means by a defined angle of rotation R around the axis of rotation,
- determining a second X-Y reference position RP' of the reference labeling that is changed by the rotation,
- calculating the -position of the axis of rotation in the substrate plane, and
- determining of the alignment error of contact points,

wherein the substrate is fixed on the substrate holding means during the determination of the position of the axis of rotation and during the determination of the alignment error of contact points.

All combinations of at least two features indicated in the description, the claims and/or the figures also fall within the scope of the invention. In the case of indicated value ranges, values that are within the above-mentioned limits are also to be disclosed as boundary values and can be claimed in any combination.

Embodiments of the~~This~~ invention are~~is~~ based on the idea of selecting a new approach whereby, before

the orientation errors of the contact points of the substrate are determined, the substrate's axis of rotation or the axis of rotation of a substrate holding means for holding the substrate is determined in order to be able to deduce the opposite position of the contact point for the measurement in the second rotational position in each case by means of the unchanging exact position of the axis of rotation of the substrate or the substrate holding means holding the substrate.

Thus, the time-consuming pre-alignment at each contact point is eliminated according to the invention, by which the determination of the orientation error of the contact points oriented to one another in each case is accelerated many times. In this case, it is especially advantageous that the rotation of each substrate has to take place only once if the X-Y positions of the contact positions are first detected in a first rotational position of the substrate/the substrate holding means, and then, i.e., after one-

time rotation of the substrate by the substrate holding means, the corresponding X-Y positions of the contact points are detected in a second rotational position.

With the previously necessary pre-alignment, first the corresponding contact point to be measured had to be brought after rotation from one side again into the detection area of the optical detection means and centered there before the position of the corresponding contact point of the opposite side could be determined on the opposite side of the substrate.

According to embodiments of the invention, the pre-alignment is replaced by a calculation of the position of the contact point after the rotation based on the known position of the axis of rotation. As reference labeling for determining the position of the axis of rotation, an optically detectable labeling especially provided for this purpose on the substrate or on the substrate holding means can be provided, or a structure that is present on the substrate, in particular a contact point, can be used.

According to an advantageous embodiment of the invention, it is provided that the rotation of the substrate around the axis of rotation is carried out with a specified angle of rotation R by a substrate holding means, whereby the substrate holding means is designed to support the substrate, in particular on its periphery, preferably in the form of a ring, so that the contact points on the bottom of the substrate remain accessible from below through the ring opening. Especially advantageously, and for the most exact possible determination of the position of the axis of rotation, it is suitable if the reference labeling is arranged on or in the ring of the substrate holding means. This is especially just because the substrate is fixed to the substrate holding means during the determination of the X-Y position of the axis of rotation as well as during the determination of the

orientation error of a large number of opposite contact points. Thus, the X-Y position of the reference labeling in each new substrate is already known in advance, and only the X-Y position of the axis of rotation is to be determined, without having to search for the position of the reference labeling on the substrate.

According to another advantageous embodiment of the invention, it is provided that the determination of the first and second reference positions is carried out by optical positional detecting means, in particular comprising a lens, preferably with an optical axis parallel to the axis of rotation R. In particular in the case of a digital configuration of the optical positional detection means, the detection can be carried out digitally, so that the position of the axis of rotation R is calculated in electronic form by a corresponding data processing system.

If the substrate holding means can be moved relative to the optical positional detection means along the X-Y coordinate system, and the relative movement can be detected in the X-direction and Y-direction spanned into the X-Y coordinate system, the calculation of the positions of the reference labeling and corresponding to the axis of rotation, in particular when using a Cartesian coordinate system, is greatly simplified.

Thus, in the further development and use of the above-described method, a method for determining an orientation error of a large number of contact points, oriented to one another and arranged on two opposite sides of a substrate, can be implemented according to embodiments of the invention, since it comprises the following sequence:

- Applying the substrate on a substrate holding means that can move along an X-Y coordinate system and that can rotate around an axis of rotation that is perpendicular to the X-Y coordinate system,