

Method and Device for Aligning Two Optical Partial Systems

In the semiconductor industry, aligners are used to align substrates, in particular wafers, relative to one another, so that they are connected to one another in a further process step. The connection process is called bonding. The alignment of the substrates relative to one another occurs by means of alignment marks, which are located on the surfaces of the substrates. The alignment marks on opposite sides of the opposite substrates are in particular complementary to one another.

The alignment processes, in the case of which the alignment marks are located at the substrate surfaces, which are to be bonded, are identified as face-to-face alignments. If the substrates are not transparent for the electromagnetic radiation, which is to be measured, methods need to be developed to measure the marks, before the substrate approach one another.

A method, which has been practiced for a very long time, was to insert a camera, which was removed prior to the approach, between the substrates. This was associated with a plurality of disadvantages. First of all, the camera resulted in a particle contamination on at least the lower substrate and, secondly, the distance between the substrates had to be chosen to be relatively large, in order to place the camera between both substrates. The large distance had the disadvantage that the travelling distance in response to the approach of the two substrates, after the camera had been removed, was very large and that the substrates shifted laterally in response to the mutual approach, and thus differed from their previous, optimal alignment relative to one another.

The aligner of publication US6214692B1 represents an improvement of the face-to-face alignment. In the disclosed aligner, the use of a camera, which is to be inserted between the substrates, was completely forgone. Instead, two lens groups, each comprising two lenses, which are located opposite to one another, were used, to create a system comprising two reference points, in relation to which the substrates are mutually positioned. The reference points were the points of intersection of the optical axes of two lenses, which are located opposite to one another. The corresponding process for the calibration of such lenses has been disclosed and described extensively in Figures 2c and 2e of publication WO2014202106A1 or in Figures 5a and 5b of publication WO2015082020A1.

The problem with the prior art, in particular the calibration method according to Figures 2c and 2e of publication WO2014202106A1 or according to Figures 5a and 5b of publication WO2015082020A1 is that a calibration substrate is required, in relation to which a calibration of the optical axes of the lenses is performed. The upper and the lower lenses are calibrated to an alignment mark in the, in particular transparent, substrate. The left optical axes are thus adjusted to a left focal point, and the right optical axes are adjusted to a right focal point. It is thus the object of the invention at hand to specify a method and a system, which do not have the disadvantages of the prior art and by means of which in particular two lenses can

be alignment or calibrated, respectively, relative to one another in a simplified manner.

According to a first aspect of the present invention, there is provided a method for aligning two optical partial systems of an optical system, which are arranged so as to be located opposite to one another, in particular on top of one another, including the following steps: projecting alignment marks into an image plane of the first, in particular lower, optical partial system, projecting the alignment marks from the first image plane onto a sensitive surface of the second, in particular upper, optical partial system, aligning the optical partial systems relative to one another, so that projections of the alignment marks in a depth of field of the sensitive surface are imaged at ideal positions.

According to a second aspect of the present invention, there is provided a system for aligning two optical partial systems of the optical system, which are located opposite to one another, in particular on top of one another, in particular by means of the above method, having: a first camera including a first camera chip for projecting alignment marks in an image plane of the first, in particular lower, optical partial system, means for projecting the alignment marks from the first image plane onto a sensitive surface of the second, in particular upper, optical partial system, means for aligning the optical partial systems relative to one another, so that projections of the alignment marks can be imaged at ideal positions in a depth of field of the sensitive surface.

According to a third aspect of the present invention, there is provided a camera chip including alignment marks in the vicinity and/or on its sensitive surface, in particular for the above system and/or method.

All combinations from at least two features specified in the description, the claims and/or the figures, also fall within the scope of the invention. In the case of specified value ranges, values within the mentioned boundaries shall also be considered as being disclosed as threshold values and shall be capable of being claimed in any combination.

Embodiments of the invention describe in particular, how the two image planes of the two lenses, which are located opposite to one another, and/or the optical axes of the two lenses can be alignment relative to one another.

Advantageously, the use of a calibration substrate according to publication WO2014202106A1 can be forgone.

According to embodiments of the invention, provision is made for a method for the alignment of two optical partial systems of an optical system, which are arranged so as to be