Device and Method for Coating of a Carrier Wafer

Specification

This invention relates to a device and a method for coating of an inner circular surface of a coating surface of a carrier wafer with a coating material as claimed in Claim 1 and 9.

In semiconductor technology, methods for temporary bonding are playing a more and more important part to be able to optimally handle structure wafers which are becoming thinner and larger in area. The handling of structure wafers in the prior art has been especially improved by only one part of the structure wafer being temporarily bonded to the carrier wafer, preferably a peripheral edge. In this way contact of adhesive with the structured side of the structure wafer is avoided as much as possible. This is achieved in the prior art by only one edge zone of the coating surface of the carrier wafer being made adhesive, in particular by an inner circular surface of the wafer being coated with a coating material which reduces the adhesive force. A nonadhesive coating material is preferably, but not restrictively, an Anti Sticking Layer Material (ASL) such as for example EasyClean Coat 1000 from 3M.

The prior art has instantaneously following steps for production. First the edge zone B of a carrier wafer is coated with a resist, for example a photoresist. The photoresist is cured in a furnace or on a heating plate. Afterwards an ASL is applied over the entire surface. The ASL material cannot reach the surface of the carrier wafer which has been covered by the photoresist. After a certain action time in which a molecular layer has formed on the central region of the carrier wafer which is not covered with the photoresist, the remaining ASL material is spun off. Afterwards the

photoresist is removed, for example with acetone. At this time the carrier wafer consists of two zones, one edge zone without ASL coating and a core zone with ASL coating. Afterwards an adhesive is applied on the entire carrier wafer. The adhesive adheres very well to the edge zone which has not been covered with ASL material. The adhesive strength of the adhesive in the core zone which has been coated with ASL material is very low. The cement is used in this core zone mainly to support structures of the structure wafer which is to be bonded later to the carrier wafer. It is clearly apparent from the prior art that several steps are required for producing the two zones. First, the application of the photoresist, second the curing of the photoresist, third the application of the ASL material, fourth the removal of the photoresist, and fifth the application of the adhesive.

The application of the coating and of the adhesive to the carrier wafer will take place as economically and quickly as possible, but at the same time in high quality, therefore especially a layer thickness as uniform as possible.

The object of this invention is therefore to optimize a device and a method for coating of a carrier wafer such that application can take place quickly and economically, but at the same time with high quality.

This object is achieved with the features of Claims 1 and 9. Advantageous developments of the invention are given in the dependent claims. All 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 considered to be disclosed as boundary values and will be claimed in any combination.

The basic idea of this invention is to provide the coating of the carrier wafer with a coating material in different zones of the coating surface of the carrier wafer at least largely at the same

time with inhibition, preferably prevention of the coating with the coating material in the zones (especially consisting of an inner circular surface and a preferably surrounding outer circular ring surface which encompasses the inner circular surface) of the coating surface in which coating is not to take place (outer circular ring surface). The coating material can be especially an antiadhesion material which as much as possible prevents the adhesion of the structure wafer or an applied adhesive on the carrier wafer in the region in which the coating material has been applied on the coating surface of the carrier wafer. The coating surface of the carrier wafer is generally one flat side of the carrier wafer on which the structure wafer is accommodated with its structure side, especially over the entire surface, preferably with a largely identical surface and surface contour. Structure wafers can also be wafers with two structure sides. Since the application of the coating material advantageously takes place concentrically to the carrier wafer, the coating material is advantageously applied during rotation of the carrier wafer and by rotation of the carrier wafer is uniformly and homogeneously distributed on it. By predominantly at the same time a solvent which dissolves the coating material being applied in regions of the structure wafer which are not to be coated, especially the adhesion zone, a coating of the coating surface with coating material in this region is at least largely, especially completely avoided. The coating of the edge zone (especially the outer circular ring surface) can also be prevented by the coating agent moving away over the solvent on the edge. In another embodiment it can be any liquid which need not necessarily be a solvent, over which the coating material can move away. These aforementioned agents inhibit or prevent, especially completely, the coating in the region where they are applied (outer circular ring surface). They are therefore called coating inhibitors here.

After curing of the coating material in the region of the coating surface to be coated and

removal of the coating inhibitor, especially by rotation of the carrier wafer, or by evaporation, there is a carrier wafer with an only partially coated coating surface which can be produced in a continuous and single-stage process as claimed in the invention. In the uncoated region subsequently, especially by means of the second application means for applying the solvent, adhesive can be applied in the uncoated region of the coating surface and distributed. The adhesive can, as already known in the prior art, also be applied in a blanket manner, over the entire substrate, its covering the regions with low adhesive strength and high adhesive strength equally. Thus as claimed in the invention a carrier wafer can be produced with a coating surface which has several zones for accommodating a structure wafer in a two-stage production method as claimed in the invention. Coating inhibitors and coating material are preferably applied at the same time. The activation sequence calls for the solvent to be applied preferably at latest until the coating material is reached, more preferably at the same time with the coating material, most preferably prior to the coating material. The deactivation sequence calls for the coating with the coating material to end before coating with the solvent.

Preferably no significant intermixing of the solvent with the coating material takes place. In the boundary layer the coating material is evaporated at most more rapidly by the solvent. The intermixing of the coating material with the coating inhibitor, especially solvent, is to be so small as claimed in the invention that the zone which is not to be coated is not coated with the coating material. After a successful coating of the central region (especially inner circular ring surface) the condition can be tested afterwards by a measurement method, preferably by a contact angle measurement device. Advantageously the contact angle in the area not to be coated according to the process as claimed in the invention has been changed at most by 15°, more preferably at most by

10°, still more preferably at most by 5°, most preferably by 0°.

The separate process step of removal of the material, which step was used in the past, on the wafer edge as claimed in the invention is converted into a process of flushing of the edge which proceeds especially at the same time with the coating in order to inhibit the coating by a coating material or preferably to completely prevent it. The especially blanket application of the adhesive is not a critical component of the method or device as claimed in the invention, but can be implemented in them.

According to one advantageous embodiment it is provided that the first application means is arranged or can be arranged such that the application of the coating material takes place in the region of the rotation axis R of rotation, especially concentrically to the carrier wafer. In this way a homogenous distribution of the coating material on the entire coating surface is enabled since the distribution of the coating material takes place extremely uniformly especially at a constant rotational speed along the coating surface. The carrier wafer is rotated by accommodating and fixing of the carrier wafer on a rotatable receiver, especially a chuck, the accommodating and fixing of the carrier wafer taking place in an alignment as exactly concentric as possible to the axis of rotation of the receiving apparatus.

Because the second application means is arranged or can be arranged such that the application of the coating inhibitor takes place especially on one peripheral section of the outer circular ring surface 1a in the region of a radially inner edge of the outer circular ring surface, the principle of distribution of the coating inhibitor by rotation of the carrier wafer can also be used here so that an at least largely simultaneous application of the coating inhibitor with the coating material is conceivable as claimed in the invention. Only the application site on the coating surface

differs, the application of the solvent to the carrier wafer taking place farther away from the axis R of rotation than the application of the coating material.

Here it is advantageous if there are control means as claimed in the invention for controlling an application amount and/or an application pressure and/or an application instant and/or an application speed and/or an application angle and/or an application point and/or an application position of the first and/or second application means. If these parameters are made to be adjustable, the device as claimed in the invention and the method as claimed in the invention can be set to different combinations of coating materials and corresponding coating inhibitors. With greater application of the amount of coating inhibitors on the one hand the coating material is more effectively detached or dissolved, or that the coating material is more strongly hindered by the coating inhibitor from coating or covering the outer edge zone, on the other hand more coating inhibitor is consumed. By increasing the application pressure or the application speed or by choosing a skillful application angle the discharge of the coating inhibitor and coating agent can be optimized especially without increasing the application amount.

To the extent there are curing agents for curing of the coating material, the single-stage or two-stage process as claimed in the invention is further optimized since the curing of the coating material can take place especially at the same time with the distribution of the coating material on the coating surface. In conjunction with the ASL materials the monomolecular or multimolecular layer is understood during curing. In one embodiment as claimed in the invention these layers are formed by segregation effects on the surface. "Curing" below means the formation of a nonadhesive layer.

According to another advantageous embodiment of the invention, it is provided that the

second application means have at least one line which can be arranged pointing with one outlet end toward the outer circular ring surface. Thus a directed jet and controlled application of the coating inhibitor in regions of the coating surface are possible, where the coating material in the distribution of the coating material is to be specially dissolved, or in general is to be kept away so that it does not cure there ("Curing" - see above).

Here it is especially advantageous if the second application means, especially on each outlet end, have an especially controllable nozzle. The inner nozzle typically has an opening diameter of 0.125 inch, the outer nozzle typically an opening diameter of 0.25 inch. Nozzles with smaller or larger opening diameters are also conceivable. The opening diameters are greater than 0.001 inch, preferably greater than 0.01 inch, more preferably greater than 0.1 inch, especially smaller than 1 inch. By this measure the device as claimed in the invention can be set not only to different coating material and solvent combinations, but also can be set to different sizes of the carrier wafer or the desired ratio of the size of the adhesion zone to the antiadhesion zone.

To the extent features which are disclosed according to the device also imply method features, they should also be considered as disclosed according to the method and vice versa.

Other advantages, features and embodiments of the invention are disclosed below.

Figure 1 shows a perspective view of one embodiment of the device as claimed in the invention before application of the coating material and

Figure 2 shows one embodiment according to Figure 1 after implementing the two-step process as claimed in the invention.

The same or equivalent components in the figures are labeled with the same reference numbers.

The illustrated embodiment of the device as claimed in the invention for coating of an inner circular surface 7i of a coating surface 3b of a carrier wafer 3 with a coating material 9 is shown only schematically in the figures and is reduced to the components important for the description of the invention. Thus the figures lack a rack for holding the illustrated components as well as a control apparatus as claimed in the invention for controlling the components as claimed in the invention which are described below.

The carrier wafer 3 is received and fixed on a receiver 2 (for example a chuck) on its bottom 3u facing away from the coating surface 3b after the carrier wafer 3 has been aligned relative to one axis R of rotation. The axis R of rotation is located as claimed in the invention at the center (center of rotational symmetry) of the carrier wafer 3. The rotation takes place by a rotating shaft 6 which is driven by driving means which are not shown (controlled by the control apparatus). The receiver 2 and the rotating shaft 6 as well as the control apparatus jointly form the rotation means as claimed in the invention.

Above the coating surface 3b there are or can be first application means 5 in the form of a line 5l, the first application means 5 being arranged fixed or fixable to the axis R of rotation. In the illustrated embodiment the line 5l on its outlet end 5e is provided with a nozzle 5d and points in the direction of the center of the carrier wafer 3 (intersection of the axis R of rotation and the coating surface 3b).

The line 5l is connected to a storage vessel which is not shown for the coating material 9 and the delivery of the coating material 9 from the storage vessel to the nozzle 5d and the application to the coating surface 3b take place via a pump (not shown) which is triggered by the control apparatus. The aforementioned features form the first application means 5. The coating

material 9 need not be applied by a pump, but can be applied by an elevated tank, simply by the action of gravity. Furthermore an application of the liquid with increased pressure or increased speed is conceivable. It is clear to one skilled in the art in the field that application of the coating material is all that matters.

The first application means 5 applies the coating material 9 to the inner circular surface 7i, especially at the intersection of the inner circular surface 7i with the axis R of rotation (center of the carrier wafer 3), especially accelerated by the rotation of the rotation means around the axis R of rotation, distributed on the inner circular surface 7i.

It can be easily imagined that by the rotation and the centrifugal force generated thereby on the coating surface 3b of the coating material 9 delivery takes place from the center of the carrier wafer 3 radially and concentrically to the outside until it leaves the inner circular surface 7i and enters an outer circular ring surface 7a. The friction of the coating surface 3b with the coating material 9 also accelerates the coating material in the direction of rotation of the rotating means so that the coating material is accelerated on an arc-shaped path from the center of the carrier wafer 3b to the peripheral edge 7e. Continued rotation conveys the coating material 9 furthermore essentially radially to the outside to one peripheral edge 7e where the coating material leaves the carrier wafer 3 and is captured by a capture apparatus which is not shown.

During the movement of the coating material 9 along the coating surface 5b the coating material 9 is cured by curing agents (curing - see above) so that a homogenous layer of the coating material 9 would form on the entire coating surface 3b without further measures.

Second application means 4 for applying a solvent as coating inhibitor which can dissolve the coating material 9 to an outer circular ring surface 7a which surrounds the inner circular surface

7i are located or can be located in the illustrated exemplary embodiment above the carrier wafer 3. Advantageously the application means or the application site of the coating surface 3b of the second application means 4 can be set by alignment means, especially by adjusting the application means 4 parallel to the coating surface 3b.

The application by the second application means 4 takes place relative to the application by the first application means 5 farther away from the center of the carrier wafer 3.

The structure of the second application means 4 can be analogous to the first application means 5, especially with a line 41, one outlet end 4e and one nozzle 4d as well as a storage vessel which is not shown for the solvent, and a pump (controlled by the control apparatus).

The solvent is applied by the second application means 4 in the region of the peripheral section 7u so that the solvent is applied in the illustrated exemplary embodiment only at one site on the periphery. Only by rotation of the carrier wafer 3 by the rotating means is solvent fully applied to the outer circular ring surface 7a after one rotation of the carrier wafer.

The second application means 4 are arranged such that the solvent is applied on an inner edge 7r of the outer circular ring surface 7a, therefore toward the center of the carrier wafer 3. From there it is accelerated radially to the outside and in the direction of rotation analogously to the coating agent 9 so that the entire outer circular ring surface 7a is continuously supplied with solvent which dissolves the coating material 9 and/or prevents curing of the coating material 9 on the outer circular ring surface 7a, and/or separates the coating material 9 from the coating surface 3b by its providing for the coating material 9 being spun off beyond the coating inhibitor.

Thus, after application of a defined application amount of the coating agent 9 by the first application means 5 a cured part of the coating agent 9 remains on the inner circular surface 7i as a

homogeneous antiadhesion layer, while the curing of the coating agent 9 in the outer circular surface 7a is prevented or at least inhibited by the solvent.

Consequently, by simultaneous application of coating material 9 and coating inhibitor a carrier wafer 3 which is coated only in the inner circular surface 7i with coating material 9 (antiadhesion layer) is formed in a single-stage process.

In a second step, especially in the device as claimed in the invention, an adhesive layer can be applied to the outer circular ring surface 7a, especially the entire coating surface 3b (therefore also to the coating material 9 in the inner circular surface 7i). For this purpose either the first and/or the second application means 4, 5 or separate third application means (not shown) can be used.

Furthermore, as claimed in the invention there can be fourth application means for cleaning the carrier wafer 3 after coating.

A radius X of the inner circular surface 7i is defined by the distance of the application site of the coating inhibitor from the axis R of rotation on the coating surface 3b. The ring width B of the outer circular ring surface 7a is also defined automatically by this. The ring width B is smaller than 10 mm, preferably smaller than 5 mm, more preferably smaller than 2 mm, most preferably smaller than 1 mm. The application of the solvent as a directed jet, especially flat jet, can take place due to the shape of the nozzle 4d so that the inner edge 7r is delineated as clearly as possible and runs concentrically to the carrier wafer 3.

In one advantageous embodiment of the invention, distributed on the periphery there can be several lines 41 for applying solvents on several peripheral sections 7u. In one advantageous embodiment the application angle (in the illustrated exemplary embodiment parallel to the axis of rotation) can be angled such that the nozzle 4d is located tilted obliquely to the outside. This

measure prevents the coating inhibitors from striking the inner circular surface 7i.

Reference number list

2	receiver
3	carrier wafer
3b	coating surface
3u	bottom
4l	line
4d	nozzle
4e	outlet end
5	first application means
5l	line
5d	nozzle
5e	outlet end
6	rotating shaft
7a	outer circular ring surface
7i	inner circular surface
7e	peripheral edge
7r	inner edge
7u	peripheral section
8	adhesive
9	coating agent
R	axis of rotation
X	radius/distance
B	ring width

Claims

1. A device for coating of an inner circular surface (7i) of a coating surface (3b) of a carrier wafer (3) with a coating material (9) with the following features:

- an application means (5) for applying the coating material (9) intended for coating of the inner circular surface (7i) to the inner circular surface (7i), and
- a rotating means (2, 6) for accommodating and rotating the carrier wafer (3) around an axis (R) of rotation and for distribution of the coating material on the coating surface (3b),

characterized in that there are the second application means (4) for applying a coating inhibitor which at least inhibits the coating of the outer circular ring surface (7a) during the distribution of the coating material (9) to an outer circular ring surface (7a) which surrounds the inner circular surface (7i).

2. The device as claimed in Claim 1, wherein the coating inhibitor is a solvent which can dissolve the coating material (9).

3. The device as claimed in one of the preceding claims, wherein the first application means (5) is arranged or can be arranged such that the application of the coating material (9) takes place in the region of the rotation axis (R) of rotation, especially concentrically to the carrier wafer (1).

4. The device as claimed in one of the preceding claims, wherein the second application means is arranged or can be arranged such that the application of the coating inhibitor takes place at least in one peripheral section (7u) of the outer circular ring surface (7a) in the region of a radially inside edge (7r) of the outer circular ring surface (7a).

5. The device as claimed in one of the preceding claims, wherein there are control means for

controlling application amounts and/or application pressure and/or application speed and/or application angles and/or application instants of the first and/or second application means (4, 5).

6. The device as claimed in one of the preceding claims, wherein there are curing agents for curing of the coating material (9).

7. The device as claimed in one of the preceding claims, wherein the second application means (4) have at least one line (41) which can be arranged pointing with one outlet end (4e) toward the circular ring surface (7a).

8. The device as claimed in one of the preceding claims, wherein the second application means (4) have especially on each outlet end (4e) an especially controllable nozzle (4d).

9. A method for coating of an inner circular surface (7i) of a coating surface (3b) of a carrier wafer (3) with a coating material (9) with the following steps, especially the following sequence:

- application of the coating material (9) to the inner circular surface (7i) by the first application means (5) and distribution of the coating material by rotating the carrier wafer (3) around the axis (R) of rotation by rotating means (2, 6),

wherein during the distribution of the coating material (9) by the second application means (4) an outer circular ring surface (7a) which surrounds the inner circular surface (7i) is supplied with a coating inhibitor which at least inhibits the coating of the outer circular ring surface (7a).

10. The method as claimed in Claim 9, wherein the coating material (9) is applied in the region of the axis (R) of rotation especially concentrically to the carrier wafer (1).

11. The method as claimed in Claim 9 or 10, wherein the application of the solvent at least in one peripheral section (7u) of the outer circular ring surface (7a) takes place in the region of a radially inner edge (7r) of the outer circular ring surface (7a), especially offset in time for

application of the coating material (9).