AFFIDAVIT

STATE OF NEW MEXICO)
) SS:
COUNTY OF BERNALILLO)

I, Robert W. Becker of 47 East Ridge, Edgewood, New Mexico 87015, being duly sworn, depose and say that:

1. I am of legal age;

2. I am familiar with both the German and English languages;

3. I have prepared the attached translation of the German text of International Patent Application PCT/EP99/09450 filed December 3, 1999.

4. I believe that to the best of my knowledge, the translation referred to in paragraph 3 above is a complete and true translation of the German text.

Robert W. Becker

Sworn to and subscribed before me this 3RD day of July 2001

Commission Expires: 7/23/2002

Notary Public

APPARATUS FOR PROCESSING SUBSTRATES

The present invention relates to an apparatus for processing substrates in a liquid container with a substrate receiving device that can be placed over the liquid container and that has at least one pair of lateral guide elements.

In production processes, particularly in the semi-conductor industry, it is necessary to treat substrates with a processing liquid. One example of this is wet-processing of substrates during production of chips.

Described in EP-B-0 385 536 and DE-A-197 03 646 are apparatus for wet-processing of substrates in a container containing a processing liquid in which the substrates can be introduced into the container together with a substrate carrier. The substrates, for instance semi-conductor wafers, are placed into the container containing the processing liquid by means of a raising and lowering device and are then treated with the processing liquid. After the wet-processing, the semi-conductor wafers are removed from the processing liquid by means of a knife-like apparatus and are dried, for instance in accordance with the Marangoni method known from EP-B-0 385 536, after which they are received in a hood having lateral guides for the wafers, which hood is located above the container. In these apparatus, the basins and the hoods are designed for processing

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substrates of specific dimensions, such as, for instance, semi-conductor wafers with diameters of 65 mm, 84 mm, 95 mm, 130 mm, or 200 mm.

In the known apparatus, it would be desirable to be able to process substrates having different dimensions in order to increase apparatus flexibility. In fact, this is fundamentally possible, whereby one apparatus can only be used to process substrates whose dimensions are smaller or identical to the dimensions of the substrates for which the apparatus is designed. Semi-conductor wafers with smaller diameters would be lowered into and removed from the container with the substrate carriers exactly as semi-conductor wafers with larger diameters. However, when removing the substrates from the processing liquid and receiving them in the hood, there is the problem that different hoods must be provided for wafers having different dimensions so that the wafers are guided inside the hood.

Furthermore, known from JP 2-46727 A is a gripping apparatus for gripping semi-conductor wafers, which apparatus has two pairs of gripping arms that can be actuated separately and that are placed in contact with the wafers via an actuating mechanism and that can be triggered thereby. While the apparatus is operating, the gripper is dipped into a basin filled with liquid and a lower pair of the gripper pairs is closed in order to grip the wafers. Then the gripper is raised until the

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upper pair of grippers is situated above the surface of the liquid. Then the upper gripper pair is closed in order to grip the wafers and the lower gripper pair is opened. Now the wafers are completely raised out of the processing liquid. This complicated gripping mechanism is provided in order to ensure that the grippers are not in contact with the wafer while it passes through the surface of the liquid, since liquid could collect at the contact surface between gripper and wafer, which has a negative impact on drying the wafer.

JP-5-36668A discloses a substrate gripper similar to that described in the foregoing in which, however, in addition to the two pairs of grippers, a rigid pair of receiving elements is provided in order to receive an upper end of the substrate.

Known from JP-2-90522A is a wafer gripper that comprises an upper pair of rigid receiving elements and a movable pair of lower grippers.

JP-7-169731A discloses a wafer carrier for holding semi-conductor wafers in a processing liquid that has a lower holding element and two lateral, displaceable holding elements in order to receive wafers having different diameters.

Starting with the known apparatus, the present invention is therefore based on the object of providing a simple and efficient apparatus for processing substrates in a liquid container with a

substrate receiving device that can be placed over the liquid container and that has at least one pair of lateral guide elements, whereby the substrate receiving device is able in a simple manner to receive and securely guide substrates of different diameters.

The invention achieves this object in that the guide elements are movable by contact with the substrates and by their movement relative to one another. This results in the advantage that the guide elements automatically adapt to the size and contour of the substrate without separate actuating and control mechanisms. Thus the apparatus makes it possible in a simple manner for substrates having different diameters to be received and guided.

Advantageously a second pair of guide elements that are movable relative to one another are provided in order to provide a guide across a larger area and thus to improve stability. Advantageously, the second pair of guide elements is situated above the first pair of guide elements. The guide elements for each pair are essentially movable toward and away from one another in order to receive substrates having different dimensions and in order to make possible a movement of the guide elements along the exterior perimeter of the substrate.

In accordance with one embodiment of the invention, the guide elements are conducted in guide tracks of the substrate receiving

device, which is preferably a hood in which the guide tracks are embodied in the ends of the hood. Conducting the guide elements in guide tracks of the hood results in relatively simple and uncomplicated guidance of the guide elements that prescribes the relative movement of the guide elements.

In accordance with another preferred embodiment of the invention, the guide elements of at least one pair are borne pivotable around a mutual pivot point, whereby the mutual pivot point is preferably located above the guide elements. The pivotable bearing results in a particularly simple design of the relative movement of the elements, whereby preferably a mutual pivot point can be employed for one pair of guide elements. In another embodiment of the invention, the guide elements of at least one pair are pivotable around separate pivot points in order to achieve a specific type of pivot motion, such as, for instance, a relatively flat motion.

Advantageously, the pivot point or points of the first pair of guide elements are arranged at the highest point within the substrate receiving device in order to provide a relative movement of the substrates that is relatively flat, that is, with a height component that is as limited as possible. It is also advantageous for the guide elements to be disposed near the surface of a processing liquid so that the substrates moving out of the processing liquid can be received and

guided by the guide elements as early as possible. The pivot point or points of the second pair of guide elements advantageously lie below the pivot point or points of the first pair of guide elements in order to make possible a particular position of the guide elements when a substrate is completely received in the substrate receiving device.

Advantageously, connecting legs are provided between the guide elements and pivot points, whereby the connecting legs of the first pair of guide elements are longer. In combination with the position of the pivot points, this ensures a relatively flat pivoting action by the first pair of guide elements slightly above a surface of a processing liquid. With the second pair of guide elements it is ensured that the guide elements are situated largely on or slightly below a horizontal mid-line of the substrate when substrates are completely received. This results in a particularly good and secure grasp of the substrates.

In order to hold the substrates received in a substrate receiving device, at least one pair of the lateral guide elements is lockable. This makes it possible in a simple manner for the substrates to be held securely in the receiving device in order, for instance, to be transported together with the receiving device without it being necessary to have an additional locking element.

For uniform guidance of the substrates by the guide elements, the guide elements of at least one pair are arranged symmetrically

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relative to a center plane of the substrate receiving device.

In accordance with one particularly advantageous embodiment of the invention, the guide elements of at least one pair are pre-stressed relative to one another, whereby the pre-stress is preferably achieved by the weight of the guide elements, that is, by gravity. If the effect of gravity is not sufficient, the guide elements are advantageously pre-stressed relative to one another by means of a spring.

The guide elements when in their rest position are separated by a slight distance in order to make it possible for the guide elements in each pair of guide elements to move apart easily simply by introducing the substrates. This ensures that it is easy to introduce the substrates between the guide elements so that they can then be moved apart.

In another particularly preferred embodiment of the invention, the guide elements are bars with a plurality of guide slots, whereby the bars are advantageously embodied in a roller shape so that the structure of the guide elements is simple. Advantageously, the guide slots are embodied such that they encircle the guide elements so that it is not necessary to have a special design for the guide elements for a substrate to be received and guided.

In order to prevent or reduce friction between the guide elements and a substrate to be guided, the guide elements are

preferably rotatable around their longitudinal axis.

The invention is described in the following using a preferred embodiment with respect to the drawings, in which:

Fig. 1 schematically illustrates an apparatus for processing substrates with a substrate receiving device in accordance with a first exemplary embodiment of the invention;

Fig. 2 schematically illustrates a substrate receiving device in accordance with a second exemplary embodiment of the invention;

Fig. 3 schematically illustrates a substrate receiving device in accordance with another exemplary embodiment of the invention;

Figs. 4a - d schematically illustrate the sequence of events for receiving and guiding the inventive substrate receiving device;

Fig. 5 schematically illustrates the positions of wafers having different diameters prior to being removed from a processing liquid, and the rest position of the substrate receiving device.

In accordance with Fig. 1, an apparatus 1 for processing substrates 2 has a tank or basin 3 and a canopy or hood 4 situated

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above the basin 3 for receiving the substrates 2. The basin 3 is formed by a largely V-shaped floor 5 and side walls 6 and 7 attached thereto. Provided in the floor 5 are nozzles 9 and an outlet 10 for introducing and draining off a processing liquid such as, for instance, deionized water.

The upper edges of the side walls 6 and 7 respectively form a lip 12 or 13 that defines the maximum fill height of the basin 3. The processing liquid that flows over the lips 12 and 13 is drained off in a known manner.

Disposed inside the basin 3 is a raising and lowering apparatus 20 for a substrate carrier 23, and a knife-like element 25, hereinafter known as a knife. The substrate carrier 23 and the knife 25 can be raised and lowered separately as known from prior art. A raising and lowering device 20 suitable therefor is described, for instance, in DE-A 197 37 802, from the same applicant. In order to avoid repetition, the pertinent contents of DE-A-197 37 802 are cited as subject of this application.

In the substrate carrier 23, a plurality of wafers 2 (of which only one is visible in the drawing) can be received one after the other in the viewing direction and can be carried by bars 30 that have slots.

Figure 1 illustrates how the knife 25 is in contact with the lowest point of a wafer 2 and the wafer 2 is moved out of the substrate carrier

23 in the manner described in DE-A-197 37 802 and partially moved into the hood 4 as described in more detail in the following.

The hood 4 disposed above the basin 3 has a feed 32 for IPA a gas or gas mixture that is provided for drying the wafers 2 in accordance with the Marangoni method, known from EP-B-0 385 536, cited in the foregoing.

For laterally guiding the substrates 2, the hood 4 has in its interior a first pair of guide bars 35, 36 and a second pair of guide bars 39, 40. The guide bars 35, 36 and 39, 40 each have circumferential guide slots (not shown in greater detail).

The guide bars 35, 36 of the first pair are pivotably attached via connecting legs 45 and 46 to a bolt 47 that is affixed to an end wall of the hood 4. The position of the bolt 47 and the length of the connecting legs 45 and 46, which define the pivoting motion of the guide bars, is selected such that a pivoting motion by the guide bars 45, 46 around the bolt 47 is kept relatively flat and near to the surface of the liquid.

The guide bars 39, 40 are pivotably attached in the same manner via connecting legs 49 and 50 to a bolt 51 that is affixed to an end wall of the hood 4. In terms of height, the bolt 51 is below the bolt 47 and the length of the connecting legs 49, 50 is shorter than the length of the connecting legs 45, 46. The position of the bolt 51 and the length of the connecting legs 49, 50 is selected such that the guide

bars 39, 40 are disposed above the guide bars 35, 36 in terms of height and such that, when a wafer is received in the hood, the guide bars 39, 40 lie on or slightly below a horizontal mid-line in the wafer.

The guide bars 35, 36 and/or the guide bars 39, 40 are borne on the connecting legs so as to be rotatable around their longitudinal axis and can be locked such that the wafer 2 received in the hood 4 can be held by the guide bars 35, 36 and/or the guide bars 39, 40 alone.

Fig. 2 illustrates an alternative exemplary embodiment of the invention in which pairs of guide bars 55, 56 and 59, 60 are slidably received in guide tracks 62, 63 and 65, 66 that are formed on opposing walls 67 (of which only one is shown in the drawing) of an alternative hood 68. Although the guide tracks are shown curved, they can also be linear, and in particular the lower guide tracks can be embodied horizontally in order to maintain guidance of the substrates as close as possible to the surface of the liquid. In this case the guide elements could be pre-stressed relative to one another by springs or other suitable means.

Fig. 3 illustrates another alternative embodiment of the invention in which guide bars 75, 76, 79, and 80 are pivotably attached to bolts 81, 82, 83, and 84. The bolts 81 through 84 are each attached to opposing walls 87 (of which only one is shown in the drawing) of an alternative hood 88.

The series of drawings in Figures 4a through d demonstrates how the wafers are received and guided in the hood for a specific wafer diameter. Figs. 4 a through d illustrate the sequence of events in an apparatus in accordance with Fig. 1. The wafers 2 disposed one behind the other are raised by a knife (not shown) out of a processing liquid, the surface of which is labeled 90.

As can be seen in Fig. 4a, the upper edges of the wafers are brought into contact with the first pair of guide bars 35, 36 and received in their guide slots.

As can be seen in Fig. 4b, a continuing upward motion by the guide bars 35, 36 of the first pair guides the wafers 2 laterally. The guide bars 35, 36 are pressed apart by the wafers 2. Furthermore, the upper edge of the wafers 2 are brought into contact with the second pair of guide bars 39, 40 and received in their guide slots. The wafers 2 are now guided laterally by both pairs of guide bars while they press both pairs apart.

As can be seen in Fig. 4c, if the first pair of guide bars cross a horizontal mid-line of the wafers 2, the guide bars 35, 36 slide along a lower side of the wafers 2. The guide bars 35, 36 move toward each other due to gravity while they continue to guide the wafers 2.

As can be seen in Fig. 4d, the wafers 2 are raised even farther until they are completely removed from the processing liquid. The

wafers 2 are raised so far that the guide bars 39, 40 also cross the mid-line of the wafers 2 and slide along the lower side of the wafers 2. Furthermore, the wafers are raised high enough that they are only guided by the second, that is, the upper pair of guide bars 39, 40.

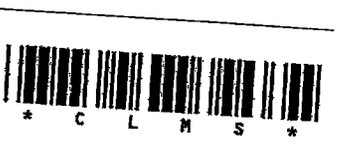
Naturally the wafers can also be raised only high enough that they are just barely lifted out of the processing liquid and still are guided by two pairs of guide bars. In this position, or in the position in accordance with Fig. 4d, at least one of the pairs of guide bars is locked by an apparatus (not shown in greater detail), such as a stop pin, so that the guide bars cannot move any farther apart. The knife is retracted and the guide elements securely hold the wafers 2 in the hood 4. In this manner the wafers can be transported with the hood, if necessary, or can subsequently be placed onto the substrate carriers 23, which by now have dried.

For removing and lowering the wafers 2, the knife is moved into contact with the wafers 2, and the lock for the guide bars is released, whereby the wafers are again carried by the knife. When the wafers are subsequently lowered, these are again guided by the guide bars. The relative motion between the wafers and guide bars occurs as described above, but in the reverse sequence.

Fig. 5 illustrates the wafer positions of wafers with different diameters prior to their removal from the processing liquid. The guide

bars are shown in their rest positions, which are spaced apart from one another so that the wafers can be introduced between the guide bars in order to press them apart. As can be seen in Fig. 5, wafers with very different diameters can be received and guided in the hood.

The invention was explained using a preferred exemplary embodiment of the invention. However, numerous modifications and embodiments are possible for one skilled in the art without departing from the basic inventive idea. In addition to other forms of the processing apparatus and hoods, in particular a combination of different guide devices are possible for the guide bars such that, for instance, one pair of guide bars are borne around a common pivot point while another pair is borne around separate pivot points. Furthermore, wall elements that can be moved relative to one another and that have guide slots can be provided rather than the illustrated and described guide bars. The pre-stressing of the guide elements relative to one another can be effected by a pneumatic device that uses compressed air or N_2, for instance, instead of springs.



Patent claims

1. Apparatus (1) for processing substrates (2) in a liquid container (3) with a substrate receiving device (4, 68, 88) that can be placed over said liquid container (3) and that has at least one pair of lateral guide elements (35, 36; 55, 56; 75, 76), characterized in that said guide elements (35, 36; 55, 56; 75, 76) are movable by contact with the substrates and by their movement relative to one another.

2. Apparatus (1) in accordance with claim 1, characterized by a second pair of lateral guide elements (39, 40; 59, 60; 79, 80) that are movable relative to one another.

3. Apparatus (1) in accordance with claim 2, characterized in that said second pair of guide elements (39, 40; 59, 60; 79, 80) is arranged above said first pair of guide elements (35, 36; 55, 56; 75, 76).

4. Apparatus (1) in accordance with any of the preceding claims, characterized in that said guide elements (35, 36; 55, 56; 75, 76; 39, 40; 59, 60; 79, 80) for each pair are essentially movable toward and away from one another.

5. Apparatus (1) in accordance with any of the preceding claims, characterized in that said guide elements (55, 56, 59, 60) are conducted in guide tracks (62, 63, 65, 66) of said substrate receiving device (68).

6. Apparatus (1) in accordance with claim 5, characterized in that said substrate receiving device (68) is a hood and in that said guide tracks (62, 63, 65, 66) are formed in end walls (67) of said hood.

7. Apparatus (1) in accordance with any of the preceding claims, characterized in that said guide elements (35, 36, 39, 40) of at least one pair are pivotable around a mutual pivot point (47, 51).

8. Apparatus (1) in accordance with any of the preceding claims, characterized in that said guide elements (75, 76, 79, 80) of at least one pair are pivotable around separate pivot points (81, 82, 83, 84).

9. Apparatus (1) in accordance with claim 7 or 8, characterized in that said common pivot point (47, 51) or said separate pivot points (81, 82, 83, 84) is or are disposed above said guide elements.

10. Apparatus (1) in accordance with any of the preceding claims 7 through 9, characterized in that said pivot point (47) or pivot points (81, 82) of said first pair of guide elements (35, 36; 75, 76) is or are arranged at the highest point inside said substrate receiving device (4; 88).

11. Apparatus (1) in accordance with any of the preceding claims 7 through 10, characterized in that said pivot point (51) or pivot points (83, 84) of said second pair of guide elements is or are arranged below said pivot point (47) or pivot points (81, 82) of said first pair of

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guide elements.

12. Apparatus (1) in accordance with any of the preceding claims 7 – 11, characterized by connecting legs (45, 46; 49, 50) between said guide elements (35, 36; 39, 40) and said pivot points (47; 51).

13. Apparatus (1) in accordance with claim 12, characterized in that said connecting legs of said first pair of guide elements are longer than those of said second pair.

14. Apparatus (1) in accordance with any of the preceding claims, characterized in that at least one pair of said lateral guide elements (35, 36; 55, 56; 75, 76; or 39, 40; 59, 60; 79, 80) is lockable.

15. Apparatus (1) in accordance with any of the preceding claims, characterized in that said guide elements (35, 36; 55, 56; 75, 76; or 39, 40; 59, 60; 79, 80) of at least one pair are arranged symmetrically in terms of a center plane in said substrate receiving device (4, 68, 88).

16. Apparatus (1) in accordance with any of the preceding claims, characterized in that said guide elements (35, 36; 55, 56; 75, 76 or 39, 40; 59, 60; 79, 80) of at least one pair are pre-stressed relative to one another.

17. Apparatus (1) in accordance with any of the preceding claims, characterized in that said guide elements are pre-stressed

relative to one another by means of a spring.

18. Apparatus (1) in accordance with any of the preceding claims, characterized in that said guide elements (35, 36; 55, 56; 75, 76 or 39, 40; 59, 60; 79, 80) of each pair are separated by a minimal distance when in their starting position.

19. Apparatus (1) in accordance with any of the preceding claims, characterized in that said guide elements (35, 36; 55, 56; 75, 76 or 39, 40; 59, 60; 79, 80) are bars with a plurality of guide slots.

20. Apparatus (1) in accordance with claim 19 characterized in that said bars are cylindrical or roller-shaped.

21. Apparatus (1) in accordance with any of claims 19 or 20, characterized in that said guide slots are embodied encircling said guide elements (35, 36; 55, 56; 75, 76 or 39, 40; 59, 60; 79, 80).

22. Apparatus (1) in accordance with any of the preceding claims, characterized in that said guide elements (35, 36; 55, 56; 75, 76 or 39, 40; 59, 60; 79, 80) are rotatable around their longitudinal axis.

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