

Device and method for transferring disc-shaped elements

The invention relates to a device and a method for transferring disc-shaped elements.

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In production processes it is often necessary to transfer the element to be processed from a transporting apparatus which is feeding it in onto another transporting apparatus. This may be the case, for example, after a delivery of
10 blanks, in order to be able to feed the latter to another process step. Even during the process, transferring operations are occasionally necessary, for example in order to turn a processed element over after a process step has been completed, and then to feed said element to another
15 processing operation.

From DE 10 2005 013545 A1, it is known practice, for the production of semiconductors for example, to lift disc-shaped elements such as semiconductor wafers, by means of
20 vacuum suction devices, off a conveying element which is feeding them in, and to set them down again on another conveying element which conveys them onwards. Under these circumstances, transportation from the first conveying apparatus which feeds them in, to the second conveying
25 apparatus which conveys them onwards, is carried out as a result of translatory movement of the vacuum suction element and thereby of the disc-shaped element which has been lifted up by said suction element. In addition, it is known practice to provide a turning-over device before a
30 disc-shaped element is picked up by the vacuum suction element. After being turned over by this turning-over device, the wafer is then lifted off by a vacuum suction element and transported to the next conveying apparatus. Under these circumstances, the vacuum suction elements are

oriented in such a way that the picking-up of the disc-shaped elements is carried out by lifting them up against the force of gravity. The conveying elements for feeding in and transporting away the wafers are disposed on a
5 common carrier plate. The translatory movement of the disc-shaped elements is carried out by displacing the suction elements, which are fastened to guide rails.

The procedure described has the disadvantage that a
10 considerable suction force has to be applied by the vacuum suction elements in order to permit reliable adhesion of the disc-shaped elements to the vacuum suction element. In order to obtain cycle times which are acceptable from the point of view of production costs, a relatively high speed
15 has to be achieved in the course of the translatory movement. At the same time, however, it is necessary to reliably avoid disruption of the production operation by elements that fall down. This leads to the high suction force which is necessary in order to prevent lateral
20 slipping-off during the acceleration or retardation of the suction element during the translatory movement. In particular, the individual transportation of the wafers by a single suction element prevents a high throughput on the part of the transferring device.

25 The object of the invention is to provide a device and also a method of transferring disc-shaped elements, in which the paths of transportation by the suction elements can be kept as short as possible.

30 This object is achieved by means of the device according to the invention having the features in claim 1, and also by

means of the method according to the invention having the features in claims 11 and 15.

The device according to the invention for transferring the
5 disc-shaped elements from a first conveying device onto a second conveying device has a carrier element which can be rotated about a longitudinal axis. At least one transporting device and at least one suction element are disposed on this carrier element. Under these
10 circumstances, the transporting device and the at least one suction element are oriented in an identical manner with respect to the rotatable carrier element and the distance between a contact face of the at least one suction element and the supporting plane of the transporting device can be
15 varied in such a way that the difference between the distance of the supporting face from the carrier element and the distance of the contact plane from said carrier element can assume both positive and negative values. For the purpose of lifting elements off, it is possible, by
20 means of this arrangement, to first of all lift at least one disc-shaped element off the first conveying device against the force of gravity, through the fact that said element is lifted up by the suction element in the direction towards the rotatable carrier element and the
25 transporting device. For this purpose, the rotatable carrier element is positioned over the first conveying device. The disc-shaped element, which is now held by the at least one suction element, is rotated, as a result of a rotation of the rotatable carrier element, sufficiently far
30 for it to now be located above the transporting device, or rather the supporting plane of the transporting device. The relative distance between the contact face of the

suction element, against which face the disc-shaped element is held, and the supporting plane of the transporting device is preferably varied, when the element is lifted up, in such a way that the disc-shaped element is already
5 slightly drawn, prior to rotation, towards the supporting plane of the transporting device. The onward transportation, that is to say the translatory movement from the first conveying device to the second conveying device is then carried out by the transporting device on
10 which the disc-shaped element is supported as a result of the force of gravity.

Conversely, the at least one element may be delivered to the transporting device by the first conveying device. The
15 at least one element lying on the transporting device is then held in contact against said transporting device by the at least one suction element. The transporting device is then rotated jointly with the at least one suction element. The at least one element is then lifted off from
20 the transporting device by the suction element and put down on the second conveying device.

Advantageous further developments of the device according to the invention and of the method according to the
25 invention are dealt with in the subclaims.

It is, in particular, advantageous if the distance between a contact face of the at least one suction element and the carrier element is variable. It is thereby possible, by
30 means of vertically adjustable suction elements, to carry out both the lifting-off or putting-down of the disc-shaped elements from the infeed device, and also the laying of

said elements on a supporting plane of the transporting device. In this case, said transporting device may be embodied in a particularly simple manner and be disposed at a fixed distance from the axis of rotation or the carrier element on the device.

However, it may also be advantageous, depending upon the application, if the distance of the supporting plane of the at least one transporting device from the carrier element is variable, for example if only a small lifting movement by the suction elements is possible. In this case, the putting-down of the disc-shaped elements on the transporting device is carried out by increasing the distance of the supporting plane of said transporting device from the rotatable carrier element, with a constant distance of the contact face from the rotatable carrier element. By this means, a lifting movement of one suction element is necessary, merely for support purposes, when lifting the disc-shaped elements off the first conveying device or putting them down on the second conveying device, and use may be made of suction elements with a limited stroke. If the suction force of the suction elements is already sufficient, on its own, for lifting off the disc-shaped elements, use may also be made of rigidly mounted suction elements.

It is preferable, in particular, to combine a number of suction elements to form a group of suction elements. This group of suction elements has an identical orientation to the at least one transporting device, which is disposed on the rotatable carrier element. By means of such a group of suction elements, it is possible to lift up a number of

disc-shaped elements and bring them over the transporting device in a joint rotating movement. The disc-shaped elements, of which there are a number, are then put down on the transporting device, preferably at the same time, by
5 reducing the distance, as in the case of a single suction element. In the course of the putting-down operation, a number of disc-shaped elements may, first of all, be fed to the transporting device serially. The said number of elements are then held in contact against the transporting
10 device by the suction elements and, after a rotating movement by the latter, are put down on the second conveying device simultaneously or individually or in groups one after another.

15 It is particularly preferable to dispose a number of groups of suction elements and a number of transporting devices on the carrier element, one group of suction elements and one transporting device, in each case, having an identical orientation. In this way it is possible to dispose, for
20 example, four transporting devices and four groups of suction elements on a single rotatable carrier element. Said transporting devices and the corresponding groups of suction elements are then disposed, for example, on four sides of the rotatable carrier element. After a quarter-
25 rotation of the carrier element in each case, new disc-shaped elements can already be picked up again by the suction elements of the adjacent group. For this purpose the rotating movement is carried out in a clocked manner.

30 It is also preferable for the suction elements belonging to a group to be activatable individually. The individual activatability may relate to the generation of the suction

force or to a lifting movement for changing the distance between the supporting face and the contact face, or to both. As a result of such individual activatability of the suction elements, it is possible, in a simple manner, to
5 reliably lift even disc-shaped elements which have not been aligned off the infeed device, if said disc-shaped elements pass into the sphere of influence of the suction elements of the group in a temporally offset manner in relation to one another. Alignment of the disc-shaped elements as
10 regards their distance from the suction elements of the group can thus be dispensed with.

The at least one transporting device is preferably constructed as a string drive. It is thereby possible to
15 dispose the at least one suction element between the at least two strings of the string drive, so that said suction element is able to pass through between the two strings of said string drive. This facilitates changing the relative distance between the contact face of the suction element
20 and the supporting face of the transporting device.

It is also advantageous if the direction of conveyance of that conveying device which preferably transports a number of disc-shaped elements in a parallel manner and the
25 direction of transportation of the at least one transporting device are approximately perpendicular to one another. It is thereby possible simultaneously or approximately simultaneously to bring into a take-over region of the device according to the invention, or
30 transport away after they have been put down, a number of disc-shaped elements which are transported side by side by the conveying device. In the case of the feeding-in

operation, it is then possible for the disc-shaped elements which have been fed in in a parallel manner to be lifted up by the suction elements of a group simultaneously or in a slightly temporally offset manner in relation to one
5 another, and to be disposed, in a joint rotating movement, over the transporting device of the rotatable carrier element. Whereas a number of disc-shaped elements are delivered in a parallel manner on the first conveying device, transporting-away is, on the other hand, carried
10 out in a serial manner by the transporting device on the rotatable carrier element. Conversely, in the case of a serial infeed of elements, these are transported away in a parallel manner by the second conveying device after being put down.

15 According to another form of embodiment, it is preferable for the carrier element to be endlessly rotatable about the longitudinal axis, at least in one direction. Such a construction of the rotatable carrier element has the
20 advantage, in particular, that it is possible to operate a number of groups of suction elements and transporting devices in an efficient manner. Under these circumstances, endless rotation in one direction also prevents, in particular, the occurrence of high forces of acceleration
25 on the disc-shaped elements which are held, such as would occur if a direction of rotation were reversed.

A preferred device and also a preferred method for transferring the disc-shaped elements from a first
30 conveying device onto a second conveying device are represented, in a simplified manner, in the drawings. The device according to the invention and the method according

to the invention will be explained in greater detail in the description that follows. In the drawings:

5 fig. 1 shows a diagrammatic representation of a device according to the invention, in a plan view;

10 fig. 2 shows a simplified representation of a rotary beam of the device according to the invention at a first point in time in the method according to the invention;

15 fig. 3 shows a simplified representation of the rotary beam of the device according to the invention at a second point in time in the method according to the invention; and

20 fig. 4 shows a diagrammatic representation regarding the individual alignment of disc-shaped elements in the course of transfer.

25 In the exemplified embodiment that follows, the starting point adopted is a parallel infeed of a number of disc-shaped elements via a first conveying device. Said conveying device is therefore referred to as the "infeed device". The serial transporting-away operation is brought about by a second conveying device which is referred to as an "onward-conveying transporting device".

30 An example of a device according to the invention is represented in a plan view in fig. 1. Represented in this figure are a number of conveying elements 1 to 6, on which a number of disc-shaped elements are transported. For the

purposes of the invention, "disc-shaped elements" are, in particular, semiconductor wafers, but also other approximately flat elements, the extent of whose length and breadth is large compared to their thickness, such as
5 printed circuit boards for example.

The conveying elements 1 to 6 are constructed as string drives and jointly form an infeed device 8. Said infeed device 8 transports disc-shaped elements, which are lying
10 on each of the conveying elements 1 to 6, in the direction towards a rotary beam 17. Said disc-shaped elements may, for example, be fed in from a manufacturing installation after a process step has been completed. The disc-shaped elements disposed on the conveying elements 1 to 6 are
15 transferred with the aid of the rotary beam 17, i.e. are picked up by the infeed device 8 and put down on an onward-conveying transporting apparatus 16, in order to then be able to feed them, by means of said onward-conveying transporting apparatus 16 to a subsequent process step for
20 example.

In order to explain the device according to the invention, it is assumed, in the case of the exemplified embodiment in fig. 1, that the infeed device 8 comprises a plurality of
25 conveying apparatuses 1 to 6. It will also be assumed that, after the transferring operation, the disc-shaped elements will be transported onwards by the onward-conveying transporting apparatus 16. However, it is likewise also possible for the infeed apparatus 8 to
30 transport the disc-shaped elements in the direction towards the rotary beam 17 by means of a so-called "carrier" which is moved, for example, by just one single conveying element

1'. In this case, the taking-over and transfer of the disc-shaped elements is made easier, since said disc-shaped elements are disposed in a carrier at fixedly predetermined positions. Instead of transfer onto an onward-conveying transporting apparatus 16, it is also possible, with the aid of the transporting device 7 of the rotary beam 17, to stack or individually put down the disc-shaped elements in a cassette or other container.

10 The rotary beam 17 comprises a rotatable carrier element 15 on which the transporting device 7 is disposed. In the exemplified embodiment represented, said transporting device 7 is a string drive constructed from two strings which are disposed parallel to one another. A number of suction elements 9 to 14 are disposed in the intervening space between the two strings which are disposed parallel to one another. Said suction elements 9 to 14 are disposed on the same side of the rotatable carrier element 15 of the rotary beam 17 and are variable with respect to their distance in relation to said rotatable carrier element 15. This will be explained again in detail below with reference to figs. 2 and 3. The direction of transportation, which is indicated by the arrow in fig. 1, of the transporting device 7 is preferably located perpendicularly to the direction of transportation, which is likewise indicated with the aid of arrows, of the infeed device 8. It is thereby possible for disc-shaped elements which are lying on the conveying elements 1 to 6 of the infeed device 8, which elements are disposed in a parallel manner, to be lifted off the conveying elements 1 to 6 by the suction elements suction elements 9 to 14 simultaneously or in a

temporally offset manner. The suction elements 9 to 14 form a group of suction elements.

The suction elements 9 to 14 are disposed, as also is the transporting device 7, on the rotatable carrier element 15, it being possible for said rotatable element 15 to be oriented in such a way that disc-shaped elements can be lifted off the conveying elements 1 to 6 by means of the suction elements 9 to 14. The exemplified embodiment represented indicates that a total of 5 conveying elements 1.1 to 1.5 are disposed one after another on the first conveying element 1 (as they are also on the rest of the conveying elements 2 to 6). Because of the force of gravity, the disc-shaped elements 1.1 to 1.5 of the first conveying element 1 lie on the strings of the string drive of the first conveying element 1. When all the disc-shaped elements are conveyed simultaneously on the conveying elements 1 to 6, the disc-shaped elements 1.1, 2.1, 3.1, ..., 6.1 which are the first elements, in each case, in the direction of transportation of the infeed device 8, are conveyed, one after another, right into a take-over region. What is referred to as the "take-over region" is that region in which lifting of the disc-shaped elements off the conveying elements 1 to 6 of the infeed device 8 is possible. The rotary beam 17 is disposed above said infeed device 8, so that the first disc-shaped elements 1.1, ..., 6.1 can be transported right under the suction elements 9 to 14 by the corresponding conveying elements 1 to 6. The feeding-in of the disc-shaped elements by the infeed device 8 may be carried out both in a clocked manner and continuously.

For the purpose of lifting off the disc-shaped elements 1.1 to 6.1, the suction elements 9 to 14 are lowered in the direction of the conveying elements 1 to 6 and thereby of said disc-shaped elements 1.1 to 6.1 in each case. When a disc-shaped element 1.1, ..., 1.6 is located under the suction element 9 to 14 associated with the corresponding conveying element 1 to 6, the relevant suction element 1 to 6 is activated and the disc-shaped element 1.1 to 6.1 is lifted off. The lifting-off operation is carried out against the force of gravity and lifts the disc-shaped element 1.1 to 6.1 up in the direction towards the rotatable carrier element 15. For this purpose there is generated, when activation occurs, a lifting movement of the suction elements 9 to 14 which varies the distance of a contact face of the suction element from the carrier element 15. A disc-shaped element which is lifted off the infeed device 8 by the suction force generated is held by said suction force in contact against the contact face or gripping face of the suction element 9 to 14.

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As is shown in fig. 1, the disc-shaped elements may even be disposed on the conveying elements 1 to 6 at irregular distances and may therefore pass into the take-over region in a temporally offset manner in relation to one another. In order to be able to lift up a number of disc-shaped elements 1.1 to 6.1 by means of the group of suction elements 9, ..., 14, it is either possible to provide, upstream of the take-over region, a device for aligning the position of the first disc-shaped elements 1.1, ... 6.1, in each case, or else the suction elements 9 to 14 are individually activatable. In the case of the explanations from now on, it will be assumed that the suction elements 9

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to 14 are individually activatable. The individual activation of the suction elements 9 to 14 may comprise the generation of the suction force, the lifting movement for lifting up the disc-shaped elements, or both.

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In the representation in fig. 1, there are already disposed, on the transporting device 7 of the rotary beam 17, four disc-shaped elements 20 to 23 which are being transported away in the direction of the onward-conveying transporting apparatus 16. The transporting-away operation is carried out with the aid of the transporting device 7 which moves the disc-shaped elements 20 to 23 in the direction towards the onward-conveying transporting apparatus 16. There, the disc-shaped elements 20 to 23 are taken over, one after another, so that the transporting device 7, which is fastened to the rotatable carrier element 15, is now empty. After the transporting device 7 has been run until empty in this way, the rotatable carrier element 15 is rotated in such a way that the suction elements 9 to 14 lie opposite the conveying elements 1 to 6. If the disc-shaped elements 1.1 to 6.1 are fed in in an unsynchronised manner, the activation of the suction elements 9 to 14 is triggered, in each case, by the position of a disc-shaped element 1.1 to 6.1. In the exemplified embodiment represented, this means that that disc-shaped element 3.1 of the third conveying element 3 which passes into the take-over region first, when the speed of transportation of the conveying elements 1 to 6 is identical, has arrived first under the suction element designated by 11. As soon as a certain position underneath this corresponding suction element 11 is reached, said suction element 11 is activated and the disc-shaped element

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3.1_[size 1] is lifted off the third conveying element 3 against the force of gravity, and up to the rotatable carrier element 15.

5 The detection of position does not have to coincide, spatially, with the point at which the elements are actually lifted up. Triggering can therefore also be carried out in a temporally offset manner in relation to the detection of a specific position which lies on the
10 infeed path, upstream of the take-over region at which the element is lifted up. A simple temporal offset is sufficient for a constant speed of conveyance. If, on the other hand, the speed at which the elements are transported from the detection of position to the take-over region
15 varies, the temporal offset must be calculated from the speeds of conveyance and the distance to be covered until the lifting-up point is reached.

For describing the device and method, it will be assumed
20 that the infeed device 8 is disposed in a horizontal plane. The terms "above", "over", "underneath" and "under" refer to a direction which is predetermined by the force of gravity.

25 Whereas the remaining first disc-shaped elements 1.1 to 6.1 of the conveying elements 1 to 6 are lifted up one after another in this way by the corresponding suction elements 9, 10 and 12 to 14 which are still unoccupied, the first disc-shaped element 3.1 which is lifted off by the third
30 conveying element 3 is held over said third conveying element 3 by the suction element designated by 11, and drawn towards the transporting device 7. The frictional

force generated between the transporting device 7 and the disc-shaped element 3.2 prevents lateral slipping-off of the element 3.1 in the course of the subsequent rotating movement. The putting of the elements onto the

5 transporting device 7 may also, in the case of all the suction elements 9 to 14 which are equipped with elements, be carried out simultaneously, prior to rotation of the rotary beam 15.

10 When all the suction elements 9 to 14 in the group of suction elements which are disposed on the rotatable carrier element 15 are equipped with a disc-shaped element in each case, said rotatable carrier element 15 is rotated about its longitudinal axis. In the first exemplified
15 embodiment represented, which shows a simple version of the rotary beam 17, the rotatable carrier element 15 is rotated about 180°.

Under these circumstances, the longitudinal axis about
20 which a rotating movement takes place does not have to extend within the rotatable carrier element 15. In order to obtain the smallest possible movement of the semiconductor wafers held by the suction elements 9 to 14, the longitudinal axis may, for example, even extend through
25 the plane of the disc-shaped elements held.

As a result of the rotation about 180°, the disc-shaped elements, which are held by the suction elements 9 to 14 in a manner resting against the transporting device 7, are now
30 disposed above said transporting device 7. The suction elements 9 to 14, and thereby the contact faces constructed at that point, are variable as regards their distance from

the rotatable carrier element 15. By reducing the distance of the suction elements 9 to 14 in the direction towards the rotatable carrier element 15, the disc-shaped elements held are held in a manner resting against the transporting device 17 and, after rotation of the rotary beam 15, are put down, by reducing the suction force, in a supporting plane defined by the string drive.

After the disc-shaped elements have been put down on the transporting device 7, the suction elements 9 to 14 are moved in the direction towards the rotatable carrier element 15 sufficiently far for there to be no fear of the transporting-away of the disc-shaped elements being influenced. The suction elements 9 to 14 are preferably switched off, so that the onward transportation of the disc-shaped elements is now, once again, carried out solely under the effect of the force of gravity. As has already been explained in respect of the disc-shaped elements 20 to 23, the disc-shaped elements are now transported away by the transporting device 7. The latter may also be operated, in particular, in a clocked manner.

In the representation in fig. 1, five disc-shaped elements 16.1 to 16.5 have already been put down on the onward-conveying transporting apparatus 16. The latter likewise consists of a string drive with two strings 18, and transports onwards, in a serial manner, the disc-shaped elements which have been put down thereon. A position-correcting device 19 may, in a particularly advantageous manner, be disposed in the region of the additional transporting apparatus 16.

The suction elements 9 to 14 are preferably constructed as Bernoulli suction devices. These have the advantage that it is possible to lift the disc-shaped elements up from the infeed device in a particularly gentle manner.

5 Furthermore, the area of contact between the suction element and the wafer is diminished, in contrast to vacuum-type suction devices, as a result of which possible contamination is reduced. In addition, Bernoulli suction devices are operated by means of compressed air. The
10 sucking of particles of dirt into the system of the suction elements can therefore likewise not occur. Whereas the rotating movement of the rotary beam 17 is carried out relatively slowly when the suction elements 9 to 14 are equipped with disc-shaped elements, said rotary beam 17 can
15 be rotated in the opposite direction at a considerably higher speed of rotation after the disc-shaped elements have been transported away by the transporting device 7. The direction of rotation of the rotary beam 17 can be chosen in such a way that the direction of movement of the
20 suction elements 9 to 14 corresponds to the direction of transportation of the conveying elements 1 to 6 during the lifting of the disc-shaped elements off said conveying elements. In particular, the direction of rotation of the rotary beam 17 may also be constant. A rotating movement
25 in the forward and backward directions has the advantage that it is not necessary to carry out electrical conducting operations by means of sliding contacts. Slow rotation of the rotatable carrier element 15 when the suction elements 9 to 14 are occupied has the advantage that a change in
30 location of the disc-shaped elements with respect to the suction elements 9 to 13 is avoided. The putting-down

operation on the transporting device 7 is, accordingly, more precise.

The disc-shaped elements are preferably lifted up with the aid of the suction elements 9 to 14 sufficiently far for said disc-shaped elements to already be in contact with the strings of the transporting device 7 during the rotating movement. Lateral movement of the disc-shaped elements is then prevented as a result of friction against the strings of the transporting device 7. Alternatively, slipping of the disc-shaped elements during the almost vertical orientation in the course of the rotating movement is prevented through the fact that there are provided, on the suction elements 9 to 14, contact elements with an elevated coefficient of friction, against which the elements rest. The contact face is then defined by the contact elements.

Before a rotating movement of the rotatable carrier element 15 can be started, after the lifting of the semiconductor wafers off the infeed device 8, it is necessary to lift the disc-shaped elements sufficiently far off the conveying elements 1 to 6 for contact with the latter in the course of rotation to be precluded. The rotating movement is preferably started after the suction elements 9 to 14 have been lifted up into their end position. In this end position, the elements rest against the string drive of the transporting device 7. The reaching of the end position is ascertained, for example, by limit switches on the individual suction elements 9 to 14 or their lifting devices. This lifting movement may either be carried out, as described above, by reducing the distance of the suction elements 9 to 14 from the rotatable carrier element 15, if

the rotary beam 17 is fixedly disposed with respect to its position above the infeed device 8, or else may be brought about by lifting up the entire rotary beam 17. In this case, all that is carried out is a slight lifting-up of the
5 disc-shaped elements from the conveying elements 1 to 6 by the suction elements 9 to 14.

If all the suction elements 9 to 14 are equipped with a disc-shaped element in each case, the rotatable carrier
10 element 15 is, in this case, lifted off as a whole, and the distance between the disc-shaped elements held by said suction elements 9 to 14 is then increased by the conveying elements 1 to 6. If contact is no longer possible, the carrier element 15 is rotated in the manner already
15 described and the disc-shaped elements held are put down on the transporting device. This may also be carried out by increasing the distance of the supporting face from the carrier element 15.

20 In the exemplified embodiment in fig. 1, it is advantageous if the distance between consecutive disc-shaped elements of a conveying element 1 to 6 is increased, in the region of the infeed device 8, by accelerating the disc-shaped elements which are disposed, one after another, on a
25 conveying element 1 to 6 in each case. This can be achieved by means of conveying-element sections which are disposed in a line one after another and which are operated at different speeds of transportation. Through the provision of an enlarged gap of this kind, the time window
30 available for lifting a disc-shaped element off the respective conveying element 1 to 6 is increased, and a collision of the disc-shaped elements prevented. A

collision of this kind can even lead to damage in the case of the brittle semiconductor wafers. Furthermore, a synchronising apparatus may be disposed in the region of the infeed device 8. With the aid of said synchronising
5 apparatus, the disc-shaped elements 1.1 to 6.1 which are first, in each case, can be aligned from entry into the takeover region. Alignment is necessary since, in the case of non-synchronised conveying elements 1 to 6, the first disc-shaped elements 1.1 to 6.1 can arrive in the takeover
10 region underneath the rotary beam 17 one after another, time-wise, if the suction elements 9 to 14 are not individually activatable. Under these circumstances, it is particularly preferred for the arrival of a first disc-shaped element to be detected by sensor and for a time-
15 controlling operation, which fixes an admissible period until the aligned disc-shaped elements are transported away, to be triggered.

The infeed device 8 may also have another sensor system for
20 detecting damaged wafers, which are then automatically removed from the installation. The picking-out operation may be carried out, for example, by onward transportation of the damaged wafer by the corresponding conveying element 1 to 6 of the infeed device 7. For picking-out purposes,
25 the lifting of the element off the conveying element 1 to 6 is then merely suppressed. At the end of the conveying element 1 to 6, the element picked out then slips, for example, into a collecting device.

30 A time-controlling operation initiated by the first wafer that runs in ensures that, in the case of an element which is missing as a result of rejection, rotation and

transporting-away of the elements is carried out, even with one or more suction elements 9 to 14 which are not equipped with elements. The time-controlling operation fixes the latest point in time for the beginning of rotation, in
5 order to ensure that the rotary beam is repositioned in time for the other elements of the infeed device 8 that are being fed in.

A rotary beam 17 of a device according to the invention is
10 represented in a side view in fig. 2, at a point in time at which a number of disc-shaped elements 24 to 28 have reached a position underneath the rotary beam 17 in the takeover region. In the exemplified embodiment represented, the disc-shaped elements are not transported,
15 as in fig. 1, by conveying elements 1 to 6. On the contrary, the disc-shaped elements 24 to 28 are disposed in a so-called "carrier" 30. In a carrier 30 of this kind, a number of clearances 40 are provided in a matrix. The disc-shaped elements 24 to 28 are disposed in the said
20 clearances 40. Provided in the clearances 40 are retaining elements which prevent said disc-shaped elements 24 to 28 from falling out. In the exemplified embodiment represented, the said retaining elements are constructed as supports 41, 42 in the edge region of the clearances 40 in
25 the carrier 30. In fig. 2, this is indicated in an exemplary manner by means of reference symbols only in the case of the right-hand clearance 40.

In the exemplified embodiment represented in fig. 2, five
30 disc-shaped elements 24 to 28 are picked up simultaneously by the corresponding suction elements 9 to 13. In this case, the disc-shaped elements 24 to 28 are shown in a

position in which they are located after being lifted off the retaining elements of the carrier 30. In the case of the suction element 14 represented on the right in fig. 2, a contact face 31 of said suction element 14 is represented diagrammatically. As has already been explained, the contact face 31 may also be formed by partial faces of contact elements. The suction elements 9 to 14 are identical in structure. In order to avoid unnecessary repetitions, therefore, only the suction element 14, together with its fixing arrangement on the carrier element 15, will be described in detail.

The position of the suction element 14 relative to the rotatable carrier element 15, and thereby the distance d_1 between said rotatable carrier element 15 and the contact face 31, can be varied by a lifting device 32 which is constructed, for example, as a pneumatic cylinder. The suction element 14 is connected, via the lifting device 32, to the rotatable carrier element 15 and fixed at that point. The lifting device 32 is designed so as to be adjustable in its length, so that the distance d_1 of the contact face 31 of the suction element 14 from the rotatable carrier element 15 can be adjusted. Said suction element 14 can therefore be lowered in the direction towards the carrier 30. In the process, a distance d_1 between that side 33 of the rotatable carrier element 15 which is oriented towards the carrier 30 and the contact face 31 of the suction element 14 is increased. Under these circumstances, the distance d_1 of the contact face 31 from the carrier element 15 is greater, for the purpose of lifting off a disc-shaped element, than the distance d_2 of

the supporting face from the rotatable carrier element
($d_1 - d_2 > 0$).

By increasing the distance d_1 between the contact face 31
5 and the rotatable carrier element 15, said contact face 31
and the suction element 14 are thereby brought into the
vicinity of the surface of the disc-shaped element in such
a way that said disc-shaped element is lifted off the
retaining elements of the carrier 30 and held in contact
10 with the contact face 31 of the suction element 9 to 14.
For the sake of improved clarity, the disc-shaped element
in that clearance 40 in the carrier 30 which is on the
extreme right is not represented.

15 It can be seen, in figure 2, that the lifting-up of the
disc-shaped elements 24 to 28, against the force of
gravity, out of the carrier 30 is carried out in the
direction towards the rotatable carrier element 15. Under
these circumstances, the distance d_1 of the contact face 31
20 from said rotatable carrier element 15 is greater than
another distance d_2 between the rotatable carrier element 15
and a supporting face of the transporting device 7. In the
exemplified embodiment represented, said transporting
device 7 is disposed in such a way that the supporting
25 plane 29 is disposed at a fixed distance d_2 from the
rotatable carrier element 15.

The transporting device 7 consists of the string drive
already described, which is driven by a driving roller 35.
30 A rerouting roller 36 is constructed at the opposite end of
the string drive. The driving roller 35 and rerouting
roller 36 are disposed on the rotatable carrier element 15

via mounting arrangements 37, 38. Additional guide rollers may be provided, depending upon the overall length of the string drive. After the disc-shaped elements 24 to 28 are located, in each case, in contact with the contact faces 31
5 of the suction elements 9 to 13, the lifting devices 32 are activated and the suction elements 9 to 14 are moved in the direction towards the rotatable carrier element 15.

In the process, the disc-shaped elements 24 to 28 are, at
10 the same time, lifted up at least sufficiently far above the carrier 30 for them not to collide with the latter when a rotating movement of the rotary beam 17 occurs.

As is represented in fig. 2, in contrast to the exemplified
15 embodiment in fig. 1, onward transportation after the transfer of the disc-shaped elements 24 to 28 is not carried out via the string drive 18, but the disc-shaped elements 24 to 28 are put down individually in a cassette 34. For this purpose, said cassette 34 is variable as
20 regards its position relative to the carrier element 15 or the transporting device 7. In this case, the additional transporting device is formed by the cassette 34 and a drive that moves the latter.

25 After sufficient distance between the carrier 30 and the disc-shaped elements 24 to 28 has been achieved by activating the lifting devices 32 of the suction elements 9 to 14, the rotary beam 17 is rotated about the longitudinal axis 29. In order to keep low the speed of the disc-shaped
30 elements 24 to 28 which are being held, the longitudinal axis 29 may preferably extend, when there is only one group of suction elements 9 to 14, in the vicinity of the contact

faces 31 of said suction elements 9 to 14 or through the latter.

The disc-shaped elements 24 rest against the contact faces
5 of the suction elements 9 to 14 or against the transporting device 7. In the exemplified embodiment represented, which has only one group of suction elements 9 to 14 and one transporting device 7, a rotation about 180° is now carried out and the disc-shaped elements 24 to 28 are disposed
10 above the supporting plane 39 defined by the strings of the string drive. In order to put the disc-shaped elements 24 to 28 down on the string drive in the supporting plane 39 of the transporting device 30, unless this has already been carried out prior to rotation, the lifting devices 32 of
15 the suction elements 9 to 14 are actuated in such a way that said suction elements 9 to 14 are moved onwards in the direction towards the carrier element 15. In the process, the first distance d_1 is reduced until it is smaller than the other distance d_2 ($d_1 - d_2 < 0$). When the disc-shaped
20 elements 24 to 28 are put down on the transporting device 7, they are transported away by said transporting device 7 in the direction represented in figure 3, as is represented in the latter. The cassette 34 is disposed at the end of the transporting device 7, so that the disc-shaped elements
25 24 to 28 can be introduced into the cassette 34, either directly or by means of a depositing device which is not represented.

As can be clearly inferred from the representation of the
30 device according to the invention at the two points in time in figs. 2 and 3, the disc-shaped element 24 to 28 which is held on the suction element 9 to 14 in each case is first

of all lifted out of the carrier 30, or off a conveying element 1 to 6, by reducing the distance d_1 of the contact face 31 from the carrier element 15. A further reduction in the distance d_1 leads, at the latest after rotation of
5 the carrier element 15 on which the suction elements 9 to 14 and the transporting device 7 are disposed in an identically oriented manner, to the putting-down of the disc-shaped elements on said transporting device 7.

10 Under these circumstances, the lifting of the disc-shaped elements 24 to 28 off the conveying elements 1 to 6, or out of the carrier 30, may also be carried out at the same time as a rotating movement of the rotary beam 17 which has already been initiated. Under these circumstances, all
15 that is necessary is to ensure that the lifting movement by the lifting devices 32 is sufficiently rapid to prevent contact of a rear edge of the disc-shaped elements during the rotating movement.

20 The transporting device 7 may be operated either in a clocked manner or continuously. Clocking of the transporting device 7 is advantageous if, for example, the disc-shaped elements 24 to 28 are to be introduced into the cassette 34. Under these circumstances, a brief pause in
25 transportation on the part of the transporting device 7 is advantageous, after the putting-down of a disc-shaped element 24 to 28 in each case, in order to permit repositioning of the cassette 34 as regards its height with respect to the supporting plane 39.

30

In order to keep low the masses of the rotary beam 17 which are to be moved, it is advantageous to provide, externally,

a compressed air system for generating the required air flow for the Bernoulli suction devices. It is then not necessary to dispose the compressed air system on the carrier element 15 itself, and this reduces the weight of the latter. The driving technology, including a driving motor for the transporting device 7, is preferably disposed on the carrier element 15, so that all that is necessary for connecting and operating the transporting device or the entire device for transferring the disc-shaped elements in the event of the pump being disposed on the carrier element 15, is to connect electric current lines and signal lines for activation purposes to the rotary beam in a movable manner. This is advantageous, above all, in the case of an endlessly rotatable rotary beam 17.

15

In the exemplified embodiment represented, it is assumed that both the infeed and the onward transportation is carried out, in the horizontal direction in each case, either by the additional transporting apparatus 16 or else by the cassette 34. However, such horizontal alignment of the installation is not necessary. The rotation or positioning of the rotary beam 17 with respect to the infeed device 8 and the additional transporting apparatus 16, 34 is then to be adapted accordingly. This also leads to a deviation from 180° rotation after the picking-up of the disc-shaped elements 24 to 28 by the suction elements 9 to 14.

A side view of a simple exemplified embodiment of a rotary beam 17 is represented in figs. 2 and 3. The arrangement in which a transporting device 7 and a group of suction elements 9 to 14 are disposed on one side 33 of the carrier

element 15, can also be expanded by additional transporting devices and groups of suction elements. In particular, for example, it is possible to provide a rotary beam 17 in which a group of suction elements and a transporting device
5 are disposed, in each case, uniformly around the longitudinal axis 29 of said rotary beam 17. Under these circumstances, there is carried out, after the picking-up of the disc-shaped elements by the suction elements in each case, a rotation about 360° , divided by the number of
10 transporting devices and groups of suction elements, so that the next group of suction elements is correctly oriented over the infeed device 8 for the purpose of picking up new disc-shaped elements.

15 In order, as is shown in the exemplified embodiment in figure 1, to be able to lift the first disc-shaped elements 1.1 to 6.1, in each case, off the conveying elements 1 to 6 at the correct time when a position underneath the suction elements 9 to 14 is reached, the lifting devices 32 of the
20 suction elements 9 to 14 are preferably activated individually.

The way in which the disc-shaped elements can be aligned by the suction elements 9 to 14 is represented in fig. 4 in a
25 greatly simplified manner. For this purpose, said suction elements 9 to 14 are not only variable with respect to their distance from the carrier arm, but can also be rotated about their central axis.

30 The positions represented to the left of a dividing line T show, for example, possible positions of a total of five disc-shaped elements 56, 58, 59, 61 and 63. Said disc-

shaped elements are fed in by the infeed device 8 in the direction of the arrow and may be disposed on the conveying elements 51 to 55 in both a rotated and an eccentric manner. No consideration will be given herein to
5 displacement of the disc-shaped elements, relative to one another, in the direction of infeed, since a temporally offset arrival of this kind of the disc-shaped elements in the take-over region is compensated for by the individual temporal control of the suction elements belonging to a
10 group.

The position of the individual disc-shaped elements 56, 58, 59, 61 and 63 is identified, for example, by an image-processing system which is not represented. Said image-
15 processing system may either serve, at the same time, for detecting damaged wafers, or else may be an additional system.

There is fed in, on the conveying element 51 which is shown
20 right at the top in fig. 4, a disc-shaped element 56 which is ideally aligned as regards its position. This relates both to lateral displacement and to rotation about the centre point of the element 56. No correction is necessary. The image-processing system sets an angle of
25 rotation of 0° and the associated suction element (not represented) picks up the element at the point in time at which the centre point of said element coincides with a gripping point M_1 of the associated suction element. Said gripping point M_1 corresponds, in the case of rotationally
30 symmetrical suction elements, to the longitudinal axis of the suction element with the plane of transportation of the transporting device 7. The suction element is activated

only as regards its height above the infeed device 8 and the generation of the suction force.

An additional disc-shaped element 58 lies on the second
5 conveying element 52 in fig. 4 in a laterally displaced manner with respect to the direction of conveyance of said conveying element 52. Since rotation of the element 58 is not necessary, activation of the associated suction element is likewise carried out merely with respect to the
10 generation of the suction force and the lifting-up of the element 58. The lifting-up of the element 58 is carried out at the moment at which the gripping point M_2 coincides with a centre line, which extends transversely to the direction of infeed, of the disc-shaped element 58.

15 It is shown, on the third conveying element 53 of the infeed device 8', that the disc-shaped element 59 fed in at that point is rotated about its centre point. The image-processing system ascertains an angle of rotation α between
20 a centre line 60 of the element transversely to the direction of infeed, which angle should amount to 90° if the disc-shaped element 59 is correctly located. The deviation of the angle α serves as a basis for calculating an angular correction. The suction element which effects
25 lifting-up is activated in a manner corresponding to this angular correction, so that the element which is lifted up by said suction element is brought into a correct angular location again. The point in time at which the disc-shaped element 59 is lifted up is determined by the coincidence of
30 the centre line 60 with the gripping point M_3 of the associated suction element. Under these circumstances, the gripping points M_1 to M_5 of all the suction elements

belonging to a group preferably lie on a theoretical identifying line 57.

In the case of the element 61 fed in on the fourth
 5 conveying element 54, the image-processing system identifies, on the one hand, an angular error β and, on the other hand, a lateral displacement in the direction towards the fifth conveying element 55. As was already the case with the preceding element 59, however, only the rotation
 10 of the element 61 is corrected. For this purpose, the associated suction element is rotated once again on the basis of the angular error ascertained. The last disc-shaped element 63 again shows a pure angular error which, however, amounts to exactly 45° in this case.

15
 In the case of a lateral offset, such as is shown by the elements 58 and 61, the disc-shaped elements are held eccentrically, transversely to the direction of infeed, by the suction elements. The activation, time-wise, of the
 20 suction elements at the moment at which the centre lines 60, 62 and 64 coincide with the gripping points $M_3, 4, 5$ respectively, guarantees that the elements 59, 61 and 63 are positioned centrally after being put down on the transporting device 7, transversely to the direction of
 25 transportation of the latter. The location of the transferred elements 56', 58', 59', 61' and 63' after they have been put down on the transporting device 7 and the rotary beam 17 has been rotated, is represented in fig. 4 to the right of the dividing line T. On the other hand, a
 30 correction which has not been made, of a lateral offset on the conveying elements 51 to 55 of the infeed device 8' leads to an irregular distance between elements on the

transporting device 7 of the rotary beam 17. However, this does not matter, or can be corrected with little effort, particularly if the elements are transported away by the transporting device in a clocked manner.

5

In the above embodiments, the disc-shaped elements were basically brought into the take-over region in a parallel manner via the infeed device. In said take-over region, the elements were lifted off by the suction elements and, after rotation of the rotary beam, transported away with the aid of the transporting device to the onward-conveying transporting apparatus. However, it is likewise possible for the sequence to be reversed. The disc-shaped elements are then fed serially, for example via an individual string drive or from cassettes as the first conveying device, to the transporting device, on which they lie as a result of the force of gravity. Said elements are then drawn towards the string drive by the suction elements and the rotary beam is rotated. After that, the disc-shaped elements are put down on a second transporting device by the suction elements. Said second transporting device may then comprise a carrier or a plurality of conveying elements. A renewed representation of all the details will be dispensed with, since this follows from the above-described performance of the method, by reversing it.

The device and method are not limited to the exemplified embodiment represented. In particular, individual features of the device and of the method according to the invention can also be combined with one another.

30

Claims

1. Device for transferring the disc-shaped elements from
a first conveying device (8; 16, 34) onto a second
5 conveying device (16, 34; 8), said transferring device
having a carrier element (15) which can be rotated
about a longitudinal axis (29) and on which at least
one transporting device (7) and at least one suction
element (9, ..., 14) are disposed, wherein the
10 orientation of the at least one transporting device
(7) and of the at least one suction element (9, ...,
14) with respect to the rotatable carrier element (15)
is identical and a distance (d_1) between a contact face
(31) of the suction element (9, ..., 14) and a
15 supporting plane (39) of the transporting device (7)
can be varied.
2. Device according to claim 1,
characterised in that
20 the distance (d_1) of a contact face (31) of the at
least one suction element (9, ..., 14) relative to the
carrier element (15) can be varied.
3. Device according to claim 1 or 2,
25 characterised in that
the distance (d_2) of a supporting plane (39) of the at
least one transporting device (7) relative to the
carrier element (15) can be varied.
- 30 4. Device according to one of claims 1 to 3,
characterised in that

a number of suction elements (9, ..., 14) belonging to a group of suction elements (9, ..., 14) are disposed on the carrier element (15), wherein said group of suction elements (9, ..., 14) has an identical orientation to the at least one transporting device (7).

5. Device according to one of claims 1 to 4, characterised in that a number of groups of suction elements (9, ..., 14) and a number of transporting devices (7) are disposed on the carrier element (7), one group of suction elements (9, ..., 14) and one transporting device (7), in each case, having an identical orientation.

6. Device according to claim 4 or 5, characterised in that the suction elements (9, ..., 14) belonging to a group can be activated individually.

7. Device according to one of claims 1 to 6, characterised in that the at least one transporting device (7) comprises a string drive and the at least one suction element (9, ..., 14) is disposed in such a way that the at least one suction element (9, ..., 14) is able to pass through between the at least two strings of the string drive.

8. Device according to one of claims 1 to 7, characterised in that

the direction of conveyance of the first conveying device (8) and the direction of transportation of the at least one transporting device (7) are approximately perpendicular to one another in the case of a parallel infeed of elements via said first conveying device (8), or the direction of conveyance of the second conveying device and the direction of transportation of the at least one transporting device (7) are approximately perpendicular to one another in the case of a parallel transporting-away of a number of disc-shaped elements.

9. Device according to one of claims 1 to 8, characterised in that the carrier element (15) is endlessly rotatable, at least in one direction.
10. Device according to one of claims 1 to 9, characterised in that the at least one suction element (9, ..., 14) is disposed in a rotatable manner on the carrier element (15).
11. Method of transferring disc-shaped elements from a first conveying device (8) onto a second conveying device (16, 34), said method comprising the following steps:
 - the feeding-in of at least one disc-shaped element by the first conveying device (8);
 - the lifting of the at least one disc-shaped element off the first conveying device (8) by at least one

suction element (9, ..., 14) against the force of gravity;

- the rotation of a carrier element (15) on which the at least one suction element (9, ..., 14) and a transporting device (7) are disposed;
- the putting-down of the at least one disc-shaped element on the transporting device (7) by the reduction of a relative distance (d_1) between a contact face (31) of the at least one suction element (9, ..., 14) and the transporting device (7); and
- the transporting-away of the at least one disc-shaped element by the transporting device (7) towards a second conveying device (16, 34).

12. Method according to claim 11, characterised in that the distance (d_2) of the supporting plane (39) from the carrier element (15) is increased for the purpose of putting the disc-shaped elements down on the transporting device (7).

13. Method according to either of claims 11 or 12, characterised in that a number of disc-shaped elements are aligned with respect to their position in relation to a plurality of suction elements (9, ..., 14), and that the aligned disc-shaped elements are, at the same time, lifted off the infeed device (8) by a number of suction elements (9, ..., 14).

14. Method according to one of claims 11 to 13, characterised in that

one disc-shaped element in each case is lifted up by a number of suction elements (9, ..., 14), prior to the rotation of the carrier element (15), the said number of suction elements (9, ..., 14) being activated
5 individually, time-wise, for the purpose of lifting the disc-shaped elements off on their arrival.

15. Method of transferring disc-shaped elements from a first conveying device (16, 34) onto a second
10 conveying device (8), said method having the following steps:
- the feeding-in of at least one disc-shaped element by the first conveying device (16, 34);
 - serial transportation by a transporting device (7);
 - 15 - the holding of the at least one disc-shaped element in contact against the transporting device (7);
 - the rotation of a carrier element (15) on which the at least one suction element (9, ..., 14) and a transporting device (7) are disposed;
 - 20 - the putting-down of the at least one disc-shaped element on the second conveying device (8) by at least one suction element (9, ..., 14) by the increasing of a relative distance (d_1) between a contact face (31) of the at least one suction element (9, ..., 14) and the
25 transporting device (7); and
 - the transporting-away of the at least one disc-shaped element by a second conveying device (8).

16. Method according to one of claims 11 to 15,
30 characterised in that,
for the purpose of lifting off the at least one disc-shaped element and of reducing the distance (d_1) of the

contact face (31) from the carrier element (15), the
at least one suction element (9, ..., 14) is moved in
the direction towards said carrier element (15) or,
for the purpose of increasing the distance (d_1) and of
5 putting the at least one disc-shaped element down on
the second conveying device (8), the at least one
suction element (9, ..., 14) is moved away from said
carrier element (17).

10 17. Method according to one of claims 11 to 16,
characterised in that,
after being lifted up or before being put down, the
disc-shaped elements are aligned individually with
respect to their angular location in relation to a
15 direction of transportation by rotation of the suction
elements (9, ..., 14).