substrate magazine or to push them out of said compartment onto the conveyor belt. If a substrate magazine is provided with a plurality of compartments, the distance in height of adjacent compartments from one another is often selected to be as small as possible for installation space-related reasons, so that a plurality of compartments is made possible. It is then difficult or impossible in this case to insert the conveyor belt into the substrate magazine itself below a substrate. It is also more cost efficient not to displaceably mount a conveyor belt in such a way that it can be moved completely into a substrate magazine. A gripper arm, which can be formed to be significantly narrower than the conveyor belt, can also be inserted, for example between two compartments, in order to pull a substrate out of one of the compartments. The interaction of gripper arm and conveyor belt thus has the advantage that a loading and unloading is made possible in a cost-efficient manner, and in particular also a loading and unloading in a substrate magazine, which only offers little free space.

The invention is based on the object of creating an improved loading and unloading device, which in particular also provides for the separation of substrates from a substrate stack, which can be stored in a substrate magazine.

Summary

In an aspect, the present disclosure refers to a loading and unloading device for a substrate magazine, wherein the substrate magazine has several compartments, into which several substrates can be inserted for storage or temporary storage, comprising at least one controllable conveyor belt, onto which substrates can be deposited, and comprising at least one controllable gripper arm, which is formed to insert substrates from the conveyor belt into a compartment of the substrate magazine or to push them out of the compartment onto the conveyor belt, wherein the conveyor belt and the gripper arm are arranged on a common and movably mounted carrier, characterized in that the gripper arm is arranged at least essentially below the conveyor belt in order to grip a substrate from below, and that a movable vacuum gripper, which is formed to grip a substrate in the substrate magazine and/or on the conveyor belt from the top and to move it, is arranged above the conveyor belt.

In another aspect, the present disclosure refers to a substrate magazine system for assembly lines of flat substrates, such as printed circuit boards, solar cells, or wafers, comprising at least one

substrate magazine, which has several compartments, in which several substrates and/or at least one substrate stack can be arranged in each case for storage or temporary storage, characterized by a loading and unloading device according to the previous aspect.

The object on which the present disclosure is based is solved by means of a loading and unloading device comprising the features of the above aspect. Said aspect has the advantage that the loading and unloading device provides for the handling of individual substrates as well as for the handling of substrate stacks. The possible use of the loading and unloading device is thus increased and the necessity of an additional loading and unloading device is overcome. As a whole, an assembly line can thus be realized in a cost-efficient and installation space-saving manner.

According to the present disclosure, it is provided for this purpose that the gripper arm is arranged at least essentially below the conveyor belt in order to grip a substrate from below, and that a movable vacuum gripper is arranged above the conveyor belt in order to grip a substrate in the substrate magazine or on the conveyor belt from the top and to move it. It is thus possible by means of the gripper arm to grip a separated substrate as well as a substrate stack from below, in that the substrate lying on the very bottom is seized and is pushed in the direction of the conveyor belt. Aside from a higher expenditure of force, nothing about the construction of the loading and unloading device changes for this purpose. Due to the additional vacuum gripper it is now possible to remove individual substrates from a substrate stack from the top or to place them onto the substrate stack from the top. A substrate stack as well as individual substrates can thus be removed

from a substrate stack and can be moved into the substate magazine or the other way round, by means of the loading and unloading device.

According to a preferred further example of the present disclosure, the vacuum gripper is formed to separate substrates from a substrate stack. For this purpose, the vacuum gripper has, for example, a movable suction head comprising one or several suction points, which can be placed onto the surface of a substrate, in particular of the topmost substrate of a substrate stack, in order to suck in the substrate and to remove it from the substrate stack or to transport it, respectively. The vacuum gripper optionally has retaining means, which are assigned or can be assigned to the rear side of the substrate to be gripped, and which ensure that a substrate located therebelow does not get stuck on the gripped substrate. The retaining means can be, for example, a compressed air device, which generates an airflow in the intermediate space between the substrate to be gripped and the substrate located therebelow, in order to safely separate the two substrates from one another. In the alternative, the retaining means are preferably formed mechanically and retain the lower substrate, when the substrate located on the top is lifted by means of the vacuum gripper.

The vacuum gripper is particularly preferably formed to move into the substrate magazine. It is thus possible to perform the separation of substrates from a substrate stack within the substrate magazine, and to place separated substrates onto the conveyor belt for further use. It goes without saying that the reverse process is thus also made possible, during which separated substrates are picked up by the vacuum gripper and are moved into the substrate magazine for creating or further forming a substrate stack. In the alternative, the vacuum gripper is preferably formed to perform a separation of a substrate stack only on the conveyor belt.

Particularly preferably, the vacuum gripper is height-adjustably mounted on the carrier. The vacuum gripper can thus be optimally adapted to the substrate stack, in dependently of the conveying height of the conveyor belt.

It is further preferably provided that the gripper arm has at least one gripper hook, which can be transferred from a gripping position for displacing a substrate into a release position for displacing the gripper arm independently of a substrate, and back. The gripping of a substrate for displacing the substrate into the substrate magazine or out of the substrate magazine thus takes place by the transfer of the gripper hook. In the release position, this provides the advantage that the gripper arm is formed to be of a particularly low construction, in particular in height, so that it can also be moved, for example, between two substrates located one on top of the other in the substrate

magazine. It is in particular avoided thereby that the gripper arm as a whole has to be height-adjusted in order to grip a substrate or in order to be released from the latter. Particularly preferably, the gripper hook is pivotably mounted on the gripper arm.

According to a preferred further development of the present disclosure, the gripper arm has several such gripper hooks, which are arranged on the gripper arm spaced apart from one another in the pushing direction. The gripper hooks are thereby formed in particular as described above and are mounted on the gripper arm. The advantage results thereby that several substrates can be gripped and displaced simultaneously by means of the gripper hooks, without the substrates abutting against one another. On the contrary, the gripper hooks are preferably arranged on the gripper arm in such a way that at least one gripper hook can in each case be introduced between adjacent substrates in a compartment by means of the transfer, and that as a result, all substrates can be pulled out onto the conveyor belt at the same time due to the displacement or pull-out of the gripper arm, respectively. A safe handling of several substrates at the same time is thus ensured, which avoids that substrates are damaged by abutting against one another or by being pushed one on top of the other during transport.

Particularly preferably, one of the gripper hooks is mounted in a longitudinally displaceable manner on the gripper arm. An adaptation of the distance of adjacent gripper hooks to one another is thus made possible, so that the gripper arm can be adapted, for example, to different substrates, which are stored in a compartment of the substrate magazine and which, viewed in the pushing direction are formed to be of different lengths. It therefore goes without saying that the same also applies for the insertion of several different substrates into the substrate magazine.

According to an advantageous further development of the present disclosure, the gripper arm has at least one sensor for detecting a substrate. Due to the fact that the sensor is assigned to the gripper arm, the sensor is moved together with the gripper arm. The sensor is in particular arranged on the top side of the gripper arm, thus assigned to a substrate to be gripped. If the gripper arm is now moved past a substrate, in particular the beginning and the end of a substrate is detected by means of the sensor during the movement, and the substate contour and position in the substrate magazine and/or on the conveyor belt is thus determined, for example with the help of a control unit. A simple and safe transport of the substrate is ensured thereby. With the help of the data from the sensor, it is in particular determined at which position the gripper hook is to be transferred or can be transferred into the gripping position, without abutting against the substrate from below. For this purpose, the beginning of a substrate is detected for example when inserting the gripper arm

into the substrate magazine, and the end of the substrate is either also detected by means of the sensor, or the end of the substrate is calculated as a function of data, which is known to the control unit, of the substrate to be gripped, so that the gripper hook is only transferred into the gripping position when the gripper hook has passed the substrate completely. The conveyor belt is in particular formed in such a way that it has two conveyor belt runs, which are arranged parallel at a distance from one another, so that the gripper arm is arranged between the two conveyor belt runs, so that the respective substrate in each case bears with its side edges in the substrate magazine as well as on the conveyor belt. The distance of the conveyor belt runs from one another thereby does not necessarily have to correspond to the distance of sliding guides of the substrate magazine, which in each case form a compartment. On the contrary, the distance of the conveyor belt runs can also be selected to be smaller.

According to a preferred further development of the present disclosure, at least one distance measuring sensor is assigned to the gripper arm. The movement path of the gripper arm can be determined by means of the distance measuring sensor, and the positioning of the gripper hook with respect to a substrate to be gripped can thus in particular also be determined and set optimally as a function of the data from the sensor.

It is furthermore preferably provided that at least one in particular electromotive actuator is assigned to the gripper arm for the displacement thereof and/or for the transfer of the at least one gripper hook. The positioning of the gripper arm and in particular of the gripper hook located on the gripper arm, or optionally of the several gripper hooks, is thus ensured in particular in consideration of the data from the distance sensor as well as from the sensor. For the transfer of the respective gripper hook, the gripper arm optionally has at least one further electrically operable actuator. If the gripper arm has several gripper hooks, either a separate actuator is assigned to each gripper hook or the gripper hooks are collectively connected mechanically to a common actuator, so that the gripper hooks are moved, in particular pivoted simultaneously by means of the actuator.

The loading and unloading device preferably furthermore has a control unit, which is connected via signals at least to the actuator, to the sensor, and to the distance measuring sensor, and which is formed to control the at least one actuator as a function of data detected by the sensor to individually or jointly push substrates from a certain shelf of the substrate magazine onto the conveyor belt or into the compartment from the conveyor belt. With the knowledge of the positioning of the substrates in the substrate magazine or conveyor belt, the control unit controls the loading and unloading device to individually or, as described above, simultaneously push the

The substrate magazine 1, 2 furthermore has a locating and unloading device 7, which serves the purpose of transferring substrates 4 into the substrate magazine 2 or to remove them from the substrate magazine 2, and to convey them, for example, to an assembly device of the assembly line. For this purpose, the loading and unloading device 7 has a conveyor belt 8, which has two conveyor belt runs 9, which are aligned parallel to one another and which are arranged spaced apart from one another. As endless drives, the conveyor belt runs 9 can be controlled to set the conveyor belt in a rotational motion, whereby objects bearing on the conveyor belt 8 can also be transported by means of the conveyor belt 8. The conveyor belt runs 9 are arranged so close to one another that substrates from the substrate magazine 2 bear on their side edges on both conveyor belt runs 9 and can thus be transported by means of the conveyor belt 8.

A pushing unit 10 is arranged between the conveyor belt runs 9. The pushing unit 10 has a gripper arm 11, which is formed as telescopic arm. The gripper arm 11 thereby lies below the bearing surface 12 of the conveyor belt 8 and is aligned parallel to the latter. On its free end, the gripper arm 11 has a gripper hook 13, which can be transferred. The gripper hook 13 can in particular be pivoted by pivoting the gripper arm 11 about its longitudinal axis, as shown by means of a double arrow 14 in Figure 1. The gripper hook 13 can thus be pivoted from the release position illustrated in Figure 1 into a raised gripping position illustrated in a dashed manner in Figure 1. An electromotive actuator 15, which provides for the pivoting of the gripper hook 13 according to arrow 14, is moreover assigned to the gripper arm 11. The gripper arm 11 can be longitudinally displaced with the gripper hook 13 parallel to the conveyor belt 8 by means of the actuator 15. The pushing unit 10 and the conveyor belt 8 are thereby arranged on the same carrier 17 of the loading and unloading device 7.

Figure 2 shows the pushing unit 10 in a perspective illustration, separately from the remaining loading and unloading device 7. The gripper arm 11 has a first arm part 20 and a second arm part 21. The arm part 20 is mounted in a longitudinally displaceable manner on a support carrier 22, which is fastened to the carrier 17, according to double arrow 16. According to the present exemplary embodiment, the displacement thereby takes place by means of a belt drive 23, which can be electric motor-driven by means of an actuator 24. The gripper arm part 21 is mounted on the gripper arm part 20 so as to be pivotable about its longitudinal central axis and is fixedly connected to the gripper hook 13, in order to pivot the latter by means of its rotational movement, which is effected by the actuator 15, from the release position into the gripping position, and the

other way round. The gripper arm part 21 is thereby in particular pivotably or rotatably mounted, respectively, on the gripper arm part 20 by means of several radial bearings 25.

The loading and unloading device 7 furthermore has a vacuum gripper 18, as shown in Figure 1. The vacuum gripper 18 has a movable suction head 19, which is arranged above the gripper arm 11 and which is mounted in a longitudinally displaceable manner at least parallel to the gripper arm 11 according to double arrow 16. The suction head 19 is thereby located above the bearing surface 12 of the conveyor belt 8 and is optionally mounted in a height-adjustable manner on the carrier 17, so that the distance between the suction head 19 or the vacuum gripper 18, respectively, and the conveyor belt 8 can be changed. By means of the vacuum device 18 it is possible to suck in substrates 4 from the top and to transport them. By means of the gripper arm 11, it is made possible with the help of the gripper hook 13 to displace substrates in a positive manner, wherein the gripper hook 13 is pivoted from the bottom to the top into the gripping position, as described above, so as to be able to apply a pushing force to a substrate 4. For this purpose, at least one control unit 34 controls the actuators of the loading and unloading device 7. For this purpose, the control unit 34 is connected via signals to all actuators and sensors, which are described in more detail below, in order to systematically control the actuators in particular also as a function of information from the sensors, in order to perform a loading and/or unloading process by means of the loading and unloading device 7 at the substrate magazine 2. For this purpose, the control unit 34 has, for example, a processing unit, in particular a microcontroller, as well as a data memory, wherein in particular a computer program is stored in the data memory, which is used by the processing unit in order to drive the loading and unloading device 7 as described below.

The mode of operation of the advantageous substrate magazine system 1 will be described below on the basis of Figures 3A and B.

Figure 3A shows an application example of the substrate magazine system 1, in the case of which individual substrates are handled. In this exemplary embodiment, separated substrates 4 are arranged in compartments 3 of the substrate magazine 2. In this case, the substrate magazine is thereby shown in a simplified manner. In some compartments, several substrates 4 are thereby located next to one another spaced apart from one another, while only one substrate 4 can be arranged in other compartments 3. To remove the substrates for a further use, for example in an assembly line, the gripper arm 11 is now pushed into the substrate magazine 2 with the help of the actuator 24. On its top side, the gripper arm 11 has at least one sensor 26, which is formed, for example, as optical sensor or distance sensor. The sensor 26 is in particular arranged close to the

the end of the substrate stack, is preferably assigned to the suction head 19. The suction head 19 can thus be optimally positioned above the substrate 4 to be gripped with simple means. A displacement measuring system 27, which detects the path of the suction head 19 and determines the center of the substrate stack 29, for example as a function of beginning and end of the substrate stack 29, and positions the suction head 19 centrally above the substrate stack 29 for removal of a substrate 4, is in particular also assigned to the suction head 19. The suction head 19 is subsequently guided downwards to the uppermost substrate 4, and the substrate 4 located on the very top is sucked against the suction head 19 by means of the vacuum device 18. Subsequently, the suction head 19 is preferably lifted a little bit in order to release the substrate 4 from the substrate 4 located therebelow. The suction head 19 is subsequently moved out of the substrate magazine 2, as shown by means of an arrow 32. The substrate 4 is thus separated from the substrate stack 29 and is in particular deposited on the conveyor belt 8 by means of the suction head 19.

Particularly preferably, the removal of the individual substrates from the substrate magazine 2 begins from the bottom, thus with the substrate 4, which is located in the lowermost compartment 3 of the substrate magazine 2, so that the largest possible free space is offered to the gripper arm 11 during insertion into the substrate magazine 2. It is furthermore ensured that no substrate, which could be damaged by means of the gripper arm when gripping the substrate located thereabove, is located below the gripper arm. It is also prevented thereby that dirt particles or the like can fall onto a substrate 4 located therebelow during the displacement of a substrate 4 in the substrate magazine. Advantages with regard to the purity of the substrates 4 as well as with regard to the mobility of the gripper arm 11 are thus attained.

Different loading and unloading processes can be realized by means of the advantageous substrate magazine system 1. While the substrates can only be moved into a single insertable end position or up to a stop by means of a gripper arm in the case of conventional substrate magazine systems, the present formation of the substrate magazine system 1 allows that the substrates are systematically pushed onto predetermined positions within a compartment. The insertion position can be programmed freely or can be set by means of the control unit 34, for example as a function of the size of the respective substrate. As a function of the available space in a compartment 3, several end positions of the gripper arm 11 can be programmed and set as a function of the desired number of substrates 4. The position of the gripper hook 13 and thus the position of a moved substrate is thereby monitored with the help of the displacement measuring system 27, so that the substrate 4 remains at a desired position. It is thus possible in particular to place individual