SYSTEM AND METHOD FOR HANDLING AND ALIGNING COMPONENT PANES SUCH AS FILM FRAMES AND WAFERS

Technical Field

The present disclosure relates generally to a system and method for handling and aligning component panes such as film frames and semiconductor wafers. More particularly, embodiments of the present disclosure are directed to systems, devices, and techniques for handling and aligning component panes such as film frames and wafers prior to their transfer to a vacuum table, in a manner that eliminates the need for additional alignment at (e.g., on or above) the vacuum table.

Background

The manufacture of semiconductor components (e.g., semiconductor wafers) typically includes one or more inspection processes for determining and/or ensuring the quality of the semiconductor components. Generally, the inspection of the semiconductor components involves capturing images of the semiconductor components, and processing the captured images for detecting defects that may be present on the semiconductor components. The processing of captured images facilitates evaluation of the quality of the semiconductor components.

An inspection process can involve the examination of semiconductor components carried by a wafer or a film frame (e.g., a film frame carrying a whole, partial, or diced wafer). The semiconductor wafer or the film frame is typically disposed on a displaceable table, for example a vacuum table or chuck, during the inspection process. The vacuum table is displaced along Cartesian coordinates to enable the corresponding displacement of the wafer or film frame and the inspection of individual semiconductor components carried thereby.

Semiconductor components need to be spatially aligned relative to an inspection system's imaging elements or devices in order to ensure the effectiveness and/or accuracy of an inspection process. Therefore, semiconductor components, and film

frames carrying semiconductor components, need to be spatially aligned when disposed on the vacuum table.

Multiple devices and techniques exist that facilitate the placement and/or alignment of semiconductor wafers as well as film frames on vacuum tables. For example, existing vacuum tables carry or include a plurality of ejector pins that are configured and/or positioned to movably extend above the plane or surface of a vacuum table (e.g., in a retractable manner). The ejector pins can be extended a given distance above the surface of the vacuum table to receive a semiconductor wafer or film frame from a robotic handler. After receiving a wafer or film frame, the ejector pins can be lowered to a level at or just below the surface of the vacuum table in order to place the wafer or film frame on the vacuum table. Similarly, the ejector pins can be extended to lift a wafer or film frame off of the surface of vacuum table, such that a robotic handler can retrieve or remove the wafer or film frame.

Semiconductor wafers and film frames carrying semiconductor wafers can be of different sizes (e.g., diameters). For instance, common wafer sizes include 6 inch (150 mm), 8 inch (200 mm), and 12 inch (300 mm) wafers. Film frames are correspondingly sized for carrying a particular size of wafer, and have a larger overall diameter than the wafer size for which the film frame is configured to carry. More particularly, film frames include a metal or plastic ring or border that is configured to support a polymer film or tape. A wafer (e.g., a whole or diced wafer) can be carried by the polymer film, for instance, in a centrally disposed manner relative to the film frame ring.

Accordingly, ejector pins need to be positioned at appropriate locations (e.g., relative distances to each other) on the vacuum table to accommodate wafers or film frames of different sizes. As a result, vacuum tables commonly include multiple sets of ejector pins, that is, a separate set of ejector pins for each size of wafer or film frame that the vacuum table is configured to carry.

There are a number of limitations, disadvantages, and/or problems associated with ejector pins. Firstly, ejector pins typically introduce gaps or openings on the vacuum table, thereby reducing the suction capability and/or vacuum uniformity on one or more portions of the vacuum table. In addition, when not properly (e.g., fully) retracted into the vacuum table, the ejector pins can cause unwanted damage or defects to semiconductor components carried by a wafer or film frame. Furthermore, because of the different sizes of wafers and film frames, a given vacuum table is typically adapted or configured for exclusively carrying wafers or film frames. An inspection system configured for handling wafers can be reconfigured to handle film frames, but such reconfiguration typically involves the removal of one vacuum table configured for wafer handling from the inspection system, and the insertion of another vacuum table configured for film frame handling into the inspection system. Such vacuum table "swap out" is an inefficient and time consuming process.

In addition to the foregoing, existing system designs include sensors and/or alignment elements carried by a vacuum table or vacuum table assembly to facilitate film frame and/or wafer alignment. Such sensors and alignment elements can unnecessarily increase system complexity and/or cost.

Existing systems, apparatuses, and methods for handling, transporting, or transferring wafers and film frames have associated limitations, disadvantages, and/or problems. Accordingly, there is a need for new, modified, and/or improved systems, apparatuses, and methods for handling, transporting, or transferring wafers and film frames.

Summary

In accordance with a first aspect of the present disclosure, there is disclosed a system for handling a component pane handling apparatus configured to handle component panes. The component pane handling apparatus includes at least one handler having at least one suction element projecting therefrom. The at least one suction element is configured to apply a vacuum force to a top surface of the component panes to hold the component panes to the at least one handler. The component pane handling apparatus also includes

an alignment station comprising a plurality of alignment elements, at least one alignment element of the plurality of alignment elements displaceable relative to component panes disposed at the alignment station to thereby effectuate spatial alignment of said component panes.

In accordance with a second aspect of the present disclosure, there is disclosed a method for handling component panes. The method includes handling component panes using a component pane handling apparatus. The component pane handling apparatus includes at least one handler having at least one suction element configured to apply a suction force to a top surface of the component panes to hold the component panes to said at least one handler. The method also includes positioning component panes at an alignment station, the alignment station including a plurality of alignment elements; and displacing at least one alignment element within the plurality of alignment elements relative component panes positioned at the alignment station to thereby effectuate spatial alignment of the component panes.

In accordance with a third aspect of the present disclosure, there is disclosed a system for handling film frames that include an alignment recess. The system includes an alignment station configured to receive a film frame, the alignment station including a displaceable member that is laterally displaceable relative to the film frame to one of effectuate and enhance mating engagement between the alignment recess of the film frame and a registration element external to the alignment station. The system also includes a second handler configured to retrieve the film frame from the alignment station and transfer the film frame from the alignment station to a vacuum table. The second handler includes at least one suction element configured to apply a vacuum force onto a top surface of the film frame to hold the film frame to the second handler. The mating engagement between the alignment recess of the film frame and the registration element effectuates spatial alignment of the film frame at the alignment station.

In accordance with a fourth aspect of the present disclosure, there is disclosed a method for handling film frames that each comprises an alignment recess. The method includes

positioning a film frame at an alignment station that includes a plurality of alignment elements. The method also includes displacing at least one alignment element within the plurality of alignment elements relative to the film frame to thereby one of effectuate and enhance a mating engagement between the alignment recess of the film frame and a registration element located external to the alignment station. The mating engagement between the alignment recess of the film frame and the registration element at least substantially completes spatial alignment of the film frame at the alignment station. The method also includes handling the film frame with a film frame handling apparatus that includes at least one handler having at least one suction element configured to apply a suction force onto a surface of the film frame to hold the film frame to said at least one handler.

Brief Description of the Drawings

Embodiments of the present disclosure will be described below with reference to the figures, in which:

FIG. 1 is a schematic illustration of a system for handling semiconductor-related components or component panes (e.g., film frames) according to an embodiment of the present disclosure;

FIG. 2A shows alignment of a first handler, more specifically an end effector of the first handler, with a film frame loading station prior to retrieval of a film frame from the film frame loading station according to an embodiment of the present disclosure;

FIG. 2B shows displacement of the end effector of FIG. 2A to an extended position for retrieving the film frame from the film frame loading station;

FIG. 2C shows the film frame carried by the end effector of FIG. 2B subsequent the retrieval of the film frame from the film frame loading station;

FIG. 2D shows the rotation of the end effector of FIG. 2C for displacing the film frame such that the film frame is aligned with a film frame alignment station;

FIG. 2E shows placement of the film frame on a displaceable platform of the film frame alignment station by the end effector of FIG. 2D, the displaceable platform including a displaceable pin that can be displaced relative to a film frame registration element carried by the end effector to spatially align the film frame;

FIG. 2F shows the film frame subsequent its release from the end effector, the film frame carried by the displaceable platform of the film frame alignment station as shown in FIG. 2E;

FIG. 2G shows a second handler that is positioned for retrieving the film frame from the displaceable platform of the film frame alignment station as shown in FIG. 2E;

FIG. 2H shows the film frame carried by the second handler with the use of a set of suction elements according to particular embodiments of the present disclosure;

FIG. 2I shows displacement of the second handler for placing the film frame onto a vacuum table according to particular embodiments of the present disclosure;

FIG. 2J shows displacement of the vacuum table of FIG. 2I for positioning of the film frame at an inspection or processing station for inspection of the film frame using an optical image capture device;

FIG. 3 is an enlarged view of a film frame that is carried by a displaceable platform of an alignment station, the displaceable platform carrying a plurality of alignment elements configured to facilitate or effectuate spatial alignment of the film frame in accordance with an embodiment of the present disclosure;

FIG. 4 shows a displaceable platform that includes three sets of supports pins, each set of support pins positioned and/or configured to carry film frames of a particular size, according to particular embodiments of the present disclosure;

FIG. 5 is a flowchart of a process for handling semiconductor components or component panes (e.g., film frames) in accordance with an embodiment of the present disclosure; and

FIG. 6 is a flowchart of a process associated with relative operation (e.g., relative displacement) of the first handler and the second handlers of the system of FIG. 1.

Detailed Description

Embodiments of the present disclosure relate to systems, devices, apparatuses, methods, processes, and techniques for handling and/or transferring components, component carriers, or component panes. In various embodiments in accordance with the present disclosure, the term "component pane" encompasses a device, apparatus, structure, or member such as a frame or chassis that can carry, support, hold, retain, or at least partially surround, enclose, or define a border relative to a peripheral portion of a component such as a semiconductor wafer or similar type of substrate. A component pane can provide or enable the provision of one or more surfaces (e.g., flat of substantially flat surfaces) that can carry (e.g., by way of a tensioned sheet of material such as an adhesive film) a portion of a component such as a semiconductor wafer. In representative embodiments, component panes can be film frames. In some embodiments, the term "component panes" can also encompass substrates themselves, such as wafers, solar panels, or electrical components such as printed circuit boards.

In various embodiments, the components, component carriers, or component panes (e.g., wafers or film frames) are precisely, accurately, and/or sufficiently aligned, oriented, or positioned prior to transfer or placement thereof onto a vacuum table for inspection or processing such that additional alignment involving adjustment of alignment, orientation,

or position of the components, component carriers, or component panes (e.g., wafers or film frames) relative to the vacuum table is unnecessary.

For purposes of clarity and brevity, the description of various embodiments of the present disclosure provided below is primarily with reference to film frames. It will however be understood that the systems, devices, apparatuses, methods, processes, and techniques of the present disclosure can also be used with other components, component carriers, or component panes, for instance semiconductor-related components such as packaged semiconductor chips, electronic devices such as printed circuit boards, and/or solar panels. Certain embodiments of the present disclosure can also be used or applied to other types of components or component panes such as ceramic tiles or machined parts that can have multiple predetermined or standard sizes.

In many embodiments, the system transfers component panes (e.g., film frames) from a component pane loading station (e.g., a film frame loading station such as a film frame cassette or magazine) to a component pane alignment station, location, or position (e.g., a film frame alignment station, location, or position), before transferring said component panes (e.g., film frames) to the vacuum table. At the component pane alignment station (e.g., film frame alignment station), the component pane (e.g., film frame) is aligned prior to transfer thereof to the vacuum table, in a manner that satisfies the alignment conditions of the component pane (e.g., film frame) relative to the vacuum table for subsequent inspection or processing operations on the vacuum table. The alignment of the component pane (e.g., film frame) prior to its transfer to the vacuum table eliminates a need for further relative alignment between the component pane (e.g., film frame) and the vacuum table after the component pane (e.g., film frame) has been transferred away from the component pane alignment station (e.g., film frame alignment station) toward or to the vacuum table. Such removal of the need for further alignment of the component pane (e.g., film frame) relative to the vacuum table can increase the efficiency, robustness, simplicity of design, and/or cost-effectiveness of systems, devices, apparatuses, methods, processes, and techniques of many embodiments of the present disclosure.

In multiple embodiments, the component pane alignment station (e.g., film frame alignment station) includes a displaceable platform (also referred to as a displaceable plate, base, and/or support) that is configured to facilitate or effectuate positioning, aligning, and/or orienting the component pane (e.g., film frame). The displaceable platform can include at least one alignment element, and in many embodiments a plurality of alignment elements, configured to carry or contact one or more portions of the component pane (e.g., film frame).

A first handler, more specifically a first component pane handler (e.g., first film frame handler), can transfer the component pane (e.g., film frame) from the component pane loading station (e.g., film frame loading station) to the film frame alignment station. The first handler can include an end effector that is configured and displaceable for retrieving the component pane (e.g., film frame) from the component pane loading station (e.g., film frame loading station) and transferring said component pane (e.g., film frame) to the component pane alignment station (e.g., film frame alignment station). The first handler can include a holding element or engagement element that facilitates coupling or holding of the component pane (e.g., film frame) to the end effector. In some embodiments, the first handler itself carries one or more alignment or registration elements (e.g., film frame alignment or registration elements), which facilitate component pane (e.g., film frame) alignment in association with the displaceable platform's plurality of alignment elements.

A second handler, more specifically a second component pane handler (e.g., a second film frame handler), can transfer the component pane (e.g., film frame) from the first component handler (e.g., first film frame handler) and/or the component pane alignment station (e.g., film frame alignment station) to the vacuum table. In several embodiments, the second handler is configured to effectuate the placement of the component pane (e.g., film frame) directly onto the vacuum table without a need for vacuum table ejector pins. More specifically, the second handler can place or position a component pane (e.g., film frame) directly onto the surface of the vacuum table in a manner that eliminates a need

for ejector pin interaction with the component pane (e.g., film frame), and which maintains or preserves the relative alignment between the component pane (e.g., film frame) and the vacuum table established at the film frame alignment station or position.

With respect to wafers, a wafer frame can be transferred from a wafer loading station (e.g., which includes a FOUP or SMIF pod) to a wafer alignment station before being transferred from the wafer alignment station to the vacuum table. The wafer alignment station is configured to facilitate or effectuate wafer alignment in a manner that satisfies the alignment conditions of the wafer relative to the vacuum table for subsequent inspection or processing operations on the vacuum table. Such wafer alignment eliminates a need for further relative alignment between the wafer and the vacuum table after the wafer has been transferred away from the wafer alignment station toward or to the vacuum table.

In multiple embodiments, a first wafer handler can transfer the wafer from the wafer loading station to the wafer alignment station, and a second wafer handler can transfer the wafer from the wafer alignment station to the vacuum table. The second wafer handler can be configured to effectuate the placement of the wafer directly onto the surface of the vacuum table in a manner that eliminates a need for ejector pin interaction with the wafer, and which maintains or preserves the relative alignment between the wafer and the vacuum table established at the wafer alignment station.

In view of the foregoing, various embodiments of the present disclosure include a vacuum table (e.g., a porous vacuum table) or vacuum table assembly that omits or excludes ejector pins. The vacuum table or vacuum table assembly can additionally or alternatively omit or exclude alignment or registration elements (e.g., film frame alignment or registration element), and/or sensing devices or elements that facilitate relative alignment between a component pane, for example a wafer, film frame, or other object, and the vacuum table. In multiple embodiments, the same vacuum table can carry component panes of various sizes, for instance wafers and film frames of various sizes, thereby enhancing mechanical simplicity and cost effectiveness while eliminating

inefficiency associated with vacuum table or vacuum table assembly "swap out" or modification when converting a system between different types of component pane handling configuration, for instance when converting a system between a wafer handling configuration and a film frame handling configuration or vice versa.

Representative aspects of systems, devices, apparatuses, processes, methods, and/or techniques for handling a component pane or component frames, for instance a semiconductor-related component such as film frames and wafers, are described in detail hereinafter with reference to FIG. 1 to FIG. 6, in which like or analogous elements or process portions are shown numbered with like or analogous reference numerals. Relative to descriptive material corresponding to one or more of FIGs 1 to 6, the recitation of a given reference numeral can indicate simultaneous consideration of a FIG. in which such reference numeral was previously shown. The embodiments provided by the present disclosure are not precluded from applications in which particular fundamental structural and/or operational principles present among the various embodiments described herein are desired. In addition, the present disclosure relates to and incorporates in their entirety by reference Singapore patent applications entitled "A Component Pane Handler Configured To Handle Component Panes of Multiple Sizes" (Attorney Reference No. STI-P013SG) and "A System and Method Using Multiple Component Pane Handlers Configured to Handle and Transfer Component Panes" (Attorney Reference No. STI-P014SG), each filed 12 May 2011 by Applicant "Semiconductor Technologies and Instruments Pte Ltd".

Aspects of Representative System Embodiments

FIG. 1 is a schematic illustration of a system 10 for handling, aligning, positioning, and placing components or component panes, more specifically film frames 20, according to particular embodiments of the present disclosure. FIG. 2A to FIG. 2J show portions of the system 10 in particular positions, configurations, and/or handling stages or process portions during component, more specifically film frame 20, handling and/or alignment operations.

Although the following description of particular system embodiments is directed at film frame handling, transferring, alignment, positioning, or placement, it will be understood that the system 10 according to various embodiments of the present disclosure can additionally, or alternatively, be used for handling, aligning, positioning, or placing other types of components or component panes, for example semiconductor-related components such as wafers, electrical components such as printed circuit boards, and solar panels and cells, within the scope of the present disclosure.

The system 10 includes a component pane loading station (e.g., a semiconductor-related component pane loading station), more specifically a film frame loading station 50; a component pane handling apparatus (e.g., a semiconductor-related component pane handling apparatus), more specifically a film frame handling apparatus 100; a component pane alignment station (e.g., a semiconductor-related component pane alignment station), more specifically a film frame alignment station 200; and a vacuum table assembly 300.

The system 10 can further include at least one inspection or processing apparatus or station 400 and an offloading station, more specifically a film frame offloading station (not shown). In multiple embodiments, the system facilitates or effectuates transfer of film frames 20 from the film frame loading station 50 to the film frame alignment station 200, and subsequently from the film frame alignment station 200 to the vacuum table assembly 300 for transfer to the inspection station 400, and finally from the vacuum table assembly 300 to the film frame offloading station.

Additionally, the system 10 includes a control unit (not shown) such as a computer system (e.g., a personal computer or a computer workstation) that is configured to cooperatively control the operation of system elements by way of executing stored program instructions that define at least one component pane (e.g., film frame) handling and/or alignment sequence in accordance with the present disclosure, as further detailed below.

Aspects of the Component Pane Loading Station (E.g., Film Frame Loading Station)

The component pane loading station 50, more specifically the film frame loading station 50, includes a film frame loading / unloading interface or port that is disposed at a predetermined location with respect to other elements of the system 10, and which is configured to carry a film frame storage unit or repository 55 such as a film frame cassette or magazine, in which film frames 20 can reside in a predetermined orientation (e.g., vertically stacked and offset) relative to each other. The film frame loading station 50 can be configured to accept and automatically detect or recognize film frame cassettes or storage units (e.g., film frame cassettes), and correspondingly, film frames 20 of different sizes, for instance, corresponding to 6-inch, 8-inch, or 12-inch wafers. The component pane loading station 50 (e.g., film frame loading station 50) is configured to store, hold, or carry a number of component panes (e.g., film frames 20).

Aspects of the Component Pane Handling Apparatus (E.g., Film Frame Handling Apparatus)

The component pane handling apparatus 100, more specifically the film frame handling apparatus 100, includes at least one handler, more specifically component pane handler (e.g., film frame handler), coupled to a robotic transfer system, device, or assembly. The at least one handler can include one or more robotic transfer devices configured to transport or transfer component panes (e.g., film frames 20) between particular locations, components, or portions of the system 10.

In multiple embodiments, the film frame handling apparatus 100 includes a plurality of handlers, including a first handler 120 (or first film frame handler 120) and a second handler 130 (or second film frame handler 130), each of which is configured to transport or transfer film frames 20 between particular locations, components, or portions of the system 10.

In several embodiments of the present disclosure, the first handler 120 is configured to transfer film frames 20 from the film frame loading station 50 to the film frame alignment station 200, and the second handler 130 is configured to transfer film frames

20 from the film frame alignment station 200 and/or the first handler 120 to the vacuum table assembly 300.

The relative motions, movement, or operation of the each film frame handler, for instance the first handler 120 and the second handler 130, can be synchronized relative to each other in order to retrieve, transport, transfer, and/or release film frames 20 in accordance with portions of a programmably defined film frame transfer and/or alignment sequence.

It will be understood that film frame handling apparatuses 100 including more than two film frame handlers, for instance two of more of the first handler 120 and/or two or more of the second handler 130, are also included within the scope of the present disclosure. The relative motions, movement, or operation of each of the plurality film frame handlers can be synchronized relative to each other in order to retrieve, transport, align, and/or release film frames 20 in accordance with portions of a programmably defined film frame transfer and/or alignment sequence.

Aspects of a Representative First Handler 120

The first handler 120 is configured to receive or retrieve component panes, more specifically film frames 20, from the film frame loading station 50. The first handler is also configured for transferring film frames 20 from the film frame loading station 50 to the alignment station 200.

As shown in FIG. 2A to FIG. 2J, in several embodiments, the first handler 120 includes an end effector 150 configured to facilitate or effectuate receipt or retrieval of film frames 20 from the film frame loading station 50. The end effector 150 can be shaped and/or configured to couple, hold, or secure the film frame 20 thereto during displacement and/or rotation of the end effector 150 for transfer of the film frame 20 from the film frame loading station 50 to the film frame alignment station 200. In some embodiments the end effector 150 can include holding or engagement element(s) or means to couple, hold, or secure the film frame 20 thereto during displacement and/or

rotation of the end effector 150 for transfer of the film frame 20 from the film frame loading station 50 to the film frame alignment station 200.

The end effector 150 can be displaced between a first position (or retracted position) and a second position (or extended position). The extended position of the end effector 150 can correspond to the film frame loading station 50. Accordingly, the displacement of the end effector 150 to, or towards, the extended position can bring the end effector 150 to, or towards, the film frame loading station 50, in a manner that enables the end effector 150 to receive or retrieve film frames 20 from the film frame loading station 50.

The first handler 120 can be coupled to an actuator (e.g., the robotic transfer system, device, or assembly). Coupling of the first handler 120 to the actuator effectuates coupling of the end effector 50 of the first handler 120 to the actuator. The actuator is configured for facilitating or effectuating displacement of the end effector 150 of the first handler 120. For example, the actuator can include, or use, a pneumatic, hydraulic, spring, gear, driven, or electrical mechanism for facilitating or effectuating the displacement of the end effector 150, for instance from the retracted position to, or towards, the extended position for retrieving film frames 20 from the film frame loading station 50.

The end effector 150 can be spatially aligned or orientated relative to the film frames 20 stored in the film frame loading station 50, more specifically in the film frame storage unit 55, prior to displacement of the end effector 150 to, or towards, the film frame loading station 50. The spatial alignment of the end effector 150 prior to displacement thereof to, or towards, the film frame loading station 50 can aid accurate and/or efficient retrieval of film frames 20 from the film frame loading station 50.

As described above, the first handler 120 can be configured to handle film frames 20 of different sizes. The first handler 120 can be removably or interchangeably coupled to a particular end effector 150 selected from a plurality of end effectors 150. Each end effector 150 can be configured for receiving, retrieving, and/or coupling to, film frames

20 of a particular size, for example 6 inches, 8 inches, or 12 inches. Each end effector 150 within the plurality of end effectors 150 can be removably, reversibly, or interchangeably screwed, attached, connected, or coupled to the first handler 120 to thereby enable the first handler 120 to handle film frames 20 of a corresponding size.

The first handler 120 is configured for facilitating or effectuating transfer of film frames 20 from the film frame loading station 50 to the film frame alignment station 200 for film frame alignment operations, as described in detail below.

In multiple embodiments, the first handler 120, more specifically the end effector 150 of the first handler 120, includes or carries a film frame registration element 140 that is configured to couple to the film frame 20. The film frame registration element 140 can be shaped and/or configured to facilitate or aid a general film frame alignment upon coupling of the film frame 20 to the first handler 120.

The film frame registration element 140 can include at least one vacuum inlet or opening 170. The vacuum opening(s) 170 are shaped, configured, and/or positioned for securing, holding, or coupling the film frame 20 to, or onto, the end effector 150. In several embodiments, at least one vacuum opening 170 is positioned at a periphery of the film frame 20 when the film frame 20 is coupled to the end effector 150.

In some embodiments, for example in system embodiments as shown in FIG. 1, FIG. 2A to 2J, and more clearly in FIG. 3, the film frame registration element 140 includes, or is, an elongated C-channel that is shaped, dimensioned, and/or configured for coupling to the film frame 20. As shown in FIG. 3 and FIG. 4, the film frame 20 can include at least one alignment recess 22 (also referred to alignment features, alignment elements, or alignment grooves). The alignment recesses 22 of the film frame 20 can be shaped, dimensioned, and/or configured to accommodate, receive, or couple to the film frame registration element 140. More specifically, the alignment recesses 22 of the film frame 20 are configured to matingly engage to the film frame registration element 140.

In multiple embodiments, the end effector 150 is displaced and/or rotated during transfer of film frames 20 from the film frame loading station 50 to the film frame alignment station 200. The displacement and/or rotation of the end effector 150 can be controlled automatically by way of executing program instructions that are stored in the control unit of the system 10. The vacuum openings 170 of the end effector 150 can be configured to help maintain the attachment or coupling of the film frame 20 to the end effector 150 during the displacement and/or rotation of the end effector 150 during the transfer of film frames 20 from the film frame loading station 50 to the film frame alignment station 200.

Aspects of the Component Pane Alignment Station (E.g, Film Frame Alignment Station)

The first handler 120 transfers the component panes, more specifically the film frames 20, from the component frame loading station, more specifically the film frame loading station 50, to the component pane alignment station, more specifically the film frame alignment station 200. The film frame alignment station 200 is configured to receive, contact, carry, or couple to, the film frame 20 in a manner that spatially aligns, orients, or positions the film frames 20 relative to the vacuum table assembly 300. More specifically, the film frames 20 can be spatially aligned, orientated, or positioned at the film frame alignment station 200 in a manner that satisfies the alignment conditions of the film frame 20 relative to the vacuum table assembly 300, more particularly to a vacuum table 310 of the vacuum table assembly 300, for subsequent inspection or processing operations on the vacuum table 310.

The spatial alignment, orientation, or position of the film frame 20 at the film frame alignment station 200 can eliminate a need for further relative alignment between the film frame 20 and the vacuum table assembly 300, more specifically the vacuum table 310 of the vacuum table assembly 300, after the film frame 20 has been transferred away from the film frame alignment station 200. The spatial alignment, orientation, or position of the film frames 20 can be completed, or substantially completed, at the film frame alignment station 200. Accordingly, in multiple embodiments, there is no need for further alignment of the film frames 20 when placed on, carried by, or coupled to, the

vacuum table 310. The film frames 20 do not need to be further aligned relative to the film frame registration element 140 after spatial alignment at the alignment station 200.

In many embodiments, the film frame alignment station 200 includes a displaceable platform 210 (also known as a displaceable plate, base, or support, or a mountable plate, base, or support). The displaceable platform 210 is shaped, dimensioned, and/or configured to receive, hold, support, or couple to, portions of the film frame 20 from the first handler 120, more specifically from the end effector 150 of the first handler 120.

The displaceable platform 210 can be displaced in a vertical, or substantially vertical, direction (i.e., along a Y-axis). The displaceable platform 210 can be positioned (e.g., vertically displaced) to facilitate placement or coupling of the film frame 20 to the displaceable platform 210 and/or removal of the film frame 20 from the displaceable platform 210. For example, a particular position or vertical elevation of the displaceable platform 210 enhances ease and/or accuracy of removal of the film frame 20 from the displaceable platform 210.

The displaceable platform 210 can include or carry at least one alignment element, and in many embodiments a plurality of alignment elements. The plurality of alignment element is configured or operable for facilitating or effectuating spatial alignment of film frames 20 at the film frame alignment station 200. In many embodiments, at least one alignment element can cooperatively operate, function, or be displaced relative to the film frame registration element 140 of the end effector 150 to facilitate or effectuate film frame alignment at the film frame alignment station 200. More specifically, at least one alignment element can be vertically or laterally displaced relative to the film frame registration element 140 and/or the end effector 150 for facilitating or effectuating film frame alignment at the film frame alignment station 200. In some embodiments, at least one alignment element can be laterally displaced in a direction towards the film frame registration element 140 of the end effector 150, to effectuate film frame alignment. Alternatively, at least one alignment element can be vertically displaced, for instance from a retracted position corresponding to a level flushed with a surface of the

displaceable platform 210 to an extended position corresponding to a level elevated from the surface of the displaceable platform 210, to effectuate film frame alignment.

In several embodiments, the plurality of alignment elements of the displaceable platform 210 includes multiple groups or sets of support pins 222, for example a first group or set of support pins 222a, a second group or set of support pins 222b, and a third group or set of support pins 222c that are each configured to support, carry, or couple to film frames 20. More specifically, each group or set of support pins 222a, 222b, and 222c is configured and positioned to support, carry, or couple to film frames 20 of a different size (e.g., 6 inches, 8 inches, and 12 inches).

FIG. 3 shows an enlarged view of a film frame 20 placed on, carried by, or coupled to, a displaceable platform 210 according to particular embodiments of the present disclosure. FIG. 4 shows three film frames 20a, 20b, and 20c of different sizes (e.g., 6 inches, 8 inches, and 12 inches) that are placed on, carried by, or coupled to the displaceable platform 210.

Each set of support pins 222 can be configured and/or positioned for receiving, carrying, or coupling to, film frames 20 of a particular size or diameter. For example, as shown in FIG. 4, the first set of support pins 222a is configured and positioned for receiving, carrying, or coupling to, film frames 20a of a first diameter (e.g., 6 inches), the second set of support pins 222b is configured and positioned for receiving, carrying, or coupling to film frames 20b of a second diameter (e.g., 8 inches), and the third set of support pins 222c is configured and positioned for receiving, carrying, or coupling to film frames 20 of a third diameter (e.g., 12 inches). In addition, each set of support pins 222 (i.e., the first set of support pins 222a, the second set of support pins 222b, and the third set of support pins 222c) can be disposed or positioned at a specific height (e.g., a different height) to facilitate receipt, and subsequent alignment, of film frames 20 of a corresponding size or diameter.

Increasing the number of groups or sets of support pins 222 of the film frame alignment

station 200 can increase the number of different sizes of film frames 20 that the system 10, more particularly the film frame alignment station 200 of the system 10, is able to receive, handle, and/or align. For example, where the film frame alignment station 200 of a particular system 10 includes four, five, or more sets of support pins 222, said film frame alignment station 200 will correspondingly be able to receive, handle, and/or align film frames 20 of four, five, or more different sizes. The sizes of the film frames 20 can be chosen from a group including, but not limited to, six, eight, ten, twelve, and fourteen inches.

The system 10 of multiple embodiments of the present disclosure is capable of handling component panes, more specifically film frames 20, of multiple sizes without a need to constantly change components, configuration, and/or set-up of the component pane alignment station, more specifically film frame alignment station 200. This allows the system 10 to handle component panes, more specifically film frames 20, of multiple sizes at least one of robustly, efficiently, and cost-effectively.

In many embodiments, the plurality of alignment elements of the film frame alignment station 200 can also include at least one displaceable alignment pin, lever, arm, element, or member 224 that is configured to exert a force against an edge or exterior border 24 of a film frame 20 in a manner that facilitates an adjustment of the film frame's position, alignment, and/or orientation with respect to the film frame registration element 140.

The at least one displaceable alignment pin 224 can be located or positioned for conveniently and/or accurately exerting force against the edge or exterior border 24 of a film frame 20. In several embodiments, the at least one displaceable alignment pin 224 can be displaced laterally for exerting force against the edge of a film frame 20 such that the alignment recesses 22 of the film frame 20 become mated (e.g., tightly mated) with the film frame registration element 140.

In several embodiments, the displaceable platform 210 includes one displaceable alignment pin 224 for each group or set of support pins 222. Accordingly, as shown in

FIG. 3 and FIG. 4, in embodiments wherein the displaceable platform 210 carried three sets of support pins (i.e., the first set of support pins 222a, the second set of support pins 222b, and the third set of support pins 222c), the displaceable platform 210 also includes three displaceable alignment pins, namely a first displaceable pin 224a, a second displaceable pin 224b, and a third displaceable pin 224c. It will be understood that displaceable platforms 210 that include alternative numbers of sets of support pins 222 and/or displaceable pins 224 are also included within the scope of the present disclosure.

Aspects of the Second Handler 130

The second handler 130 of the system 10 is configured to facilitate or effectuate transfer of the component pane, more specifically the film frame 20, from the component pane alignment station, more specifically the film frame alignment station 200, and/or the first handler 120 to the vacuum table assembly 300. In several embodiments, the second handler 130 is configured to transfer film frames 20 from the displaceable platform 210 of the film frame alignment station 200 to, or onto, the vacuum table 310 of the vacuum table assembly 300.

As described above, film frames 20 are spatially aligned, oriented, or positioned prior to transfer from the film frame alignment station 200 to the vacuum table assembly 300. More specifically, the completion, or substantial completion, of spatial alignment of the film frames 20 can occur by way of the film frame alignment station 200. In multiple embodiments, the second handler 130 is configured to maintain the spatial alignment of film frames 20 that is established or achieved at the film frame alignment station 200 during the transfer of the film frames 20 from the film frame alignment station 200 to the vacuum table assembly 300.

In several embodiments, the second handler 130 includes, or carries, at least one suction element 160 (also known as suction probes or suction pads). The at least one suction element 160 of the second handler 130 is configured to facilitate or effectuate loading, coupling, or attachment of the component pane, more specifically film frame 20, to the second handler 130. More specifically, the at least one suction element 160 of the second

handler 130 is configured to apply or provide suction force to portions of the film frame 20, for example at locations along a film frame periphery, to thereby facilitate or effectuate loading, coupling, or attachment of the film frame 20 to the second handler 130. The application of suction force by the at least one suction element 160 to the film frames 20 can also help to secure the film frame 20 to the second handler 130 during transfer of the film frame 20 from the film frame alignment station 200 to the vacuum table assembly 300.

Although suction elements 160 are described for facilitating or effectuating the loading, coupling, or attachment of component panes, more specifically film frames, 20 to the second handler 130, it will be understood that alternative methods for loading, coupling, or attaching component panes such as film frames 20 to the second handler 130 can be used or applied within the scope of the present disclosure. For example, the second handler 130 can include grippers or adhesive elements (not shown) for facilitating or effectuating the loading, coupling, attachment, and/or securing of component panes such as film frames 20 to the second handler 130.

In particular embodiments, the application of suction force (e.g., the quantity and/or duration of suction force applied) by the at least one suction element 160 can be controlled, for instance depending upon operation or location of the second handler 130, speed of the second handler 130, and/or size of film frame 20 handled or transferred by the second handler 130. For example, the quantity of suction force applied by the at least one suction element 160 can be adjusted, more specifically increased, with increasing size of film frames 20 that is handled or transferred by the second handler 130.

The suction force is applied by the at least one suction element 160 in order to retrieve or pickup the film frame 20 from the film frame alignment station 200, more specifically the displaceable platform 210 of the film frame alignment station 200. The suction force is maintained during transfer of the film frame 20 from the film frame alignment station 200 to the vacuum table assembly 300. The maintenance of the suction force helps to secure the film frame 20 to the second handler 130 during displacement of the second

handler for transferring the film frame 20 from the film frame alignment station 200 to the vacuum table assembly 300.

As described above, in many embodiments, the component pane, more specifically film frame 20, is spatially aligned prior to transfer thereof from the film frame alignment station 200 to the vacuum table assembly 300 in a manner that satisfies the alignment conditions of the film frame 20 relative to the vacuum table 310 for subsequent inspection or processing operations on the vacuum table 310. The use of suction force for retrieving the component pane, more specifically film frame 20, from the film frame alignment station 200, and for coupling or holding the film frame 20 to the second handler 130 during transfer from the film frame alignment station 200 to the vacuum table assembly 300 can help to preserve the established, completed, or substantially completed, spatial alignment or orientation of the component pane, more specifically film frame 20, achieved at the film frame alignment station 200. In several embodiments, the alignment of the component pane, more specifically film frame 20, is achieved and/or completed at the film frame alignment station 200 in a manner that removes any need for alignment (e.g., spatial alignment or orientation) of the film frame 20 relative to the vacuum table 310, for instance upon or after placement of the film frame 20 on the vacuum table 310.

The vacuum table 310 is configured to detect (e.g., by way of sensors) the presence, placement, or transfer of the component pane, more specifically the film frame 20, onto the vacuum table 310. Upon detection of placement of the film frame 20 onto the vacuum table 310, the application of suction force by the at least one suction element 160 of the second handler 130 can be terminated, or substantially reduced, to enable release of the film frame 20 from the second handler 130.

Aspects of the vacuum table assembly 300

In multiple embodiments of the present disclosure, there is no need for further spatial alignment or orientation between the film frame 20 and the vacuum table 310 at the vacuum table assembly 300. Accordingly, in such embodiments, the vacuum table

assembly 300, more specifically the vacuum table 310, does not include alignment means, tools, or elements. The vacuum table assembly 300 omits or excludes registration elements (e.g., component pane registration elements such as film frame registration elements). In addition, the vacuum table assembly 300 can also omit or exclude ejector pins and machined surface recesses, rings, or grooves (e.g., vacuum distribution rings). Therefore, the system 10 of various embodiments of the present disclosure is not associated with at least one of the limitations, disadvantages, and/or problems of existing systems of handling component panes or components, for instance semiconductor-related components such as film frames, more specifically existing systems that require availability and use of alignment elements at the vacuum table.

The vacuum table assembly 300 includes the vacuum table 310 and a translation apparatus 320 that is coupled to the vacuum table 310. The translation apparatus 320 is configured to enable x-, y-, z-, and θ-axis translation or displacement of the vacuum able 310. The translation apparatus 320 is configured to control and effectuate selective displacement and positioning of the vacuum table 310 with respect to particular portions of the processing or inspection station 400.

The vacuum table 310 includes a planar or generally planar surface that is configured to carry a film frame 20, and which is further configured to apply vacuum forces to the film frame 20 and its associated polymer film such that the components carried by the film frame 20 are held, retained, or maintained in a fixed position or orientation with respect to the vacuum table 310 during vacuum table translation and/or component inspection or processing operations.

In multiple embodiments, the vacuum table assembly 300 omits or excludes film frame registration elements, film frame alignment elements, and other like spatial alignment, orientation, or positioning elements or tools. In addition, in several embodiments, the vacuum table 310 omits or excludes ejector pins. The vacuum table 310 can additionally omit or exclude machined surface recesses, rings, or grooves (e.g., vacuum distribution rings). The removal of the need for further spatial alignment or orientation of the film

frame 20 relative to vacuum table 310 when the film frame 20 is transferred to the vacuum table assembly 300, and accordingly the removal of any need for the vacuum table assembly 300 to carry film frame registration elements, film frame alignment elements, and other like spatial alignment, orientation, or positioning elements or tools can increase the efficiency, robustness, simplicity of design, and/or cost-effectiveness of systems 10 of the present disclosure.

In multiple embodiments, the vacuum table 310 can include a porous medium such as a porous ceramic material that provides a uniform or essentially uniform planar porous surface that can carry film frames 20 of various sizes. Vacuum forces can be applied to, or through, the porous medium to securely hold the film frame 20 and the components carried thereby on or against the surface of the vacuum table 310. Alternatively, or additionally, the vacuum table 310 can define a plurality of pores (not shown) configured to allow an application of a vacuum or suction force to be applied to the film frame 20 that is placed on, or carried by, the vacuum table 310. The application of the vacuum or suction force to the film frame 20 carried by the vacuum table 310 can help to maintain the spatial alignment, position, or orientation of the film frame 20 on the vacuum table 310.

As previously mentioned, the vacuum table 310 can be configured to detect (e.g., by way of sensors) placement of the component pane, more specifically film frame 20, onto the vacuum table 310. Upon detection of placement of the film frame 20 onto the vacuum table 310, the application of suction force by the at least one suction element 160 of the second handler 130 can be terminated, or substantially reduced, to enable release of film frame 20 from the second handler 130. By ensuring that suction force by the at least one suction element 160 is only terminated, or substantially reduced, after the film frame 20 is placed on and/or secured to the vacuum table 310, the spatial alignment, position, or orientation of the film frame 20 relative to the vacuum table 310 can be preserved.

In some embodiments, the transfer of the film frame 20 to the vacuum table 310 includes transferring a lower surface of the film frame 20 directly onto the vacuum table 310

using only the second handler 130. The vacuum table 310 can include a component pane support surface or component support surface that receives the component pane (e.g., film frame 20) from the second handler 130, wherein the component support surface spans a planar area that is at least approximately as large as a planar area of the lower surface of the film frame 20. The second handler 130, together with the at least one suction element 160 of the second handler 130, can be sufficient for effecting transfer of the film frame 20 from the alignment station 200 directly onto the vacuum table 310, more specifically the component support surface of the vacuum table 310.

In several embodiments, the translation apparatus 320 is configured to selectively translate or position the vacuum table 310 with respect to the inspection station 400. The vacuum table 310, and hence the component pane (e.g., film frame 20) carried thereby, can be displaced to, or towards, the inspection station 400.

The film frame 20 carried by the vacuum table 310 can be inspected or processed at the inspection station 400. In several embodiments, the inspection station 400 includes at least one optical image capture device 410. The image capture device 410 can be used to capture images of the film frame 20. The captured images of the film frame 20 can subsequently be processed to facilitate or effectuate detection of any defects that may potentially be present on the film frame 20.

In some embodiments, the vacuum table 310, and accordingly the component pane (e.g., film frame 20) that is carried by the vacuum table 310, can be displaced across a plurality of predetermined inspection positions (e.g., image capture positions), at which images(s) of the film frame 20, more specifically images of particular portions of the film frame 20, can be captured by the optical image capture device 410. The spatial alignment, orientation, or position of the film frame 20 during inspection, for instance image capture of the film frame 20, is important for accurately determining defect position(s) on the film frame 20. In many embodiments, the spatial alignment, for instance the completion or substantial completion of spatial alignment, of the film frame 20 at the film frame alignment station 200 enables the vacuum table 310 to omit presence or use of an

alignment mechanism, structure, or module configured for mating engagement with the alignment recess 22 of the film frames 20.

Subsequent inspection of the component pane or component frame (e.g., film frame 20) at the inspection station 400, the vacuum table 310 can be displaced, translated, and/or positioned to allow the second handler 130 to retrieve, remove, or pick up the film frame 20 from the vacuum table 310.

A suction or vacuum force is applied by the at least one suction element 160 of the second handler 130 in order to retrieve, remove, or pick up film frames 20 from the vacuum table 310. The second handler 130 then transfers the film frame 20 from the vacuum table 310 to the film frame offloading station. Suction force applied by the at least one suction element 160 of the second handler 130 can help to hold or secure the film frame 20 to the second handler 130 during displacement of the second handler 130 for transferring the film frame 20 from the vacuum table 310 to the film frame offloading station.

In several embodiments of the present disclosure, the vacuum table 310 is capable of receiving and carrying film frames 20 of multiple different sizes, for example, six, eight, and/or twelve inches. The system 10 according to many embodiments of the present disclosure facilitates or allows the processing or inspection of film frames 20 of multiple different sizes without a need to change or modify the vacuum table 310. In addition, the vacuum table 310 of multiple embodiments can be used to carry wafers of different sizes.

Accordingly, the ability of the vacuum table 310 of multiple embodiments to carry film frames 20 of various sizes as well as wafers of various sizes increases at least one of robustness, cost-effectiveness, and/or mechanical simplicity of the system while eliminating inefficiency associated with vacuum table or vacuum table assembly “swap out” or modification when converting a system between a wafer handling configuration and a film frame handling configuration or vice versa.

Aspects of Alternative System 10 Embodiments

As previously mentioned, the system 10 of particular embodiments can include more than two component pane handlers, more specifically film frame handlers. For instance, the system 10 can include more than one first handler 120 and/or more than one second handler 130.

In certain embodiments, the system 10 can include two first handlers 120 that are each configured to transfer component panes such as film frames 20 from the component pane loading station (e.g., film frame loading station 50) to the component pane alignment station (e.g., film frame alignment station 200), for instance in a coordinated cyclical manner. Each of the two first handlers 120 and the second handler 130 can operate (e.g., be displaced) relative to each other in a controlled and synchronized, or substantially synchronized, manner.

The inclusion, and use, of multiple (e.g., two) first handlers 120 can increase speed or efficiency at which component panes, more specifically film frames 20, are transferred from the film frame loading station 50 to the film frame alignment station 200, thereby increasing the efficiency and/or throughput of the system 10.

Although the above description is directed at systems 10 for handling film frames, it will be understood that systems configured to handle other component panes or components, including semiconductor-related components such as wafers and electrical components such as printed circuit boards, are also included in the scope of the present disclosure.

For instance, the end effector 150 of the first handler 120 can be changed, substituted, or modified in order to allow the first handler 120 to handle, retrieve, transfer, and/or align wafers instead of, or in addition to, film frames 20. In other words, the first handler 120 (which can be referred to as first wafer handler) can be adapted for handling, transferring, and/or aligning wafers. In addition, the displaceable platform 210 and the second handler 130 can be configured or adapted to handle, transfer, align, or carry wafers instead of, or in addition to, film frames 20. The second handler 130 that is

configured or adapted to handle, transfer, or couple to, wafers can be referred to as second wafer handlers. The vacuum table 310 of several embodiments is also configured to handle, carry, transfer, and/or couple to, both film frames 20 and wafers.

In particular embodiments of the present disclosure, the system 10 can include more than two wafer handlers, each wafer handler configured to handle and/or transfer wafers. For example, the system 10 of specific embodiments can include multiple (e.g., two, three, or more) first wafer handlers that are configured to transfer wafers from a wafer loading station to a wafer alignment station. In addition, or alternatively, the system 10 can include multiple (e.g., two, three, or more) second wafer handlers configured to transfer wafers from the wafer alignment station to a vacuum table. Increasing the number of wafer handlers can help to increase speed and/or efficiency of transfer of wafers, and accordingly the efficiency and/or throughput of the system 10.

Aspects of Representative Process Embodiments

FIG. 5 is a flowchart of a process 500 for handling or transferring component panes, for example film frames 20, according to particular embodiments of the present disclosure.

Although the following description of the process 500 relates to handling or transferring of film frames 20, it will be understood that the process 500 can be applied or used for handling of other component panes or components, including semiconductor-related components or devices such as wafers and electrical devices.

In most embodiments of the present disclosure, the process 500 involves the transfer of component panes, more specifically film frames 20, from the film frame loading station 50 to the film frame alignment station 200, and subsequently from the film frame alignment station 200 to the vacuum table assembly 300. FIG. 2A to FIG. 2J provides representative illustrations of various system configurations and/or arrangements at particular process portions of the process 500.

The process 500 according to various embodiments enables complete, or substantially complete, spatial alignment, orientation, or positioning of the film frames 20 prior to placement of the film frames 20 onto the vacuum table 310 of the vacuum table assembly 300. In such embodiments, the vacuum table assembly 300 and/or the vacuum table 310 does not require any alignment elements, means, or mechanisms.

A first process portion 510 involves retrieving or receiving the component panes, more specifically film frame 20, from the film frame loading station 50, more specifically from the film frame storage unit 55 of the film frame loading station 50.

The first handler 120, more specifically the end effector 150 of the first handler 120, is configured to retrieve the film frame 20 from the film frame loading station 50. The first process portion 510 involves displacement and extension of the end effector 150 to the extended position for retrieving the film frame 20 from the film frame loading station 50. The actuator can control said displacement and extension of the end effector 150 to the extended position for retrieving the film frame 20 from the film frame loading station 50.

The end effector 150 can be spatially aligned relative to the film frame loading station 50 prior to the displacement and extension of the end effector 150 to the extended position (which corresponds to the film frame loading station 50). The spatial alignment of the end effector 150 relative to the film frame loading station 50 can aid the retrieval of the film frame 20 from the film frame loading station 50. For instance, the spatial alignment of the end effector 150 of relative to the film frame loading station 50 can enable accurate, fast, and/or safe retrieval of film frames 20 from the film frame loading station 50.

The spatial alignment of the end effector 150 relative to the film frame loading station 50 before extension thereof to the extended position for retrieval of the film frame 20 from the film frame loading station 50 is shown in FIG. 2A; and FIG. 2B shows the end effector 150 positioned at the extended position for retrieving the film frame 20 from the film frame loading station 50.

In several embodiments, the end effector 150 includes or carries the film frame registration element 140. The film frame registration element 140 can couple to, and in some embodiments matingly engage with, to the alignment recesses 22 of the film frame 20 during retrieval of the film frame 20 from the film frame loading station 50.

In a second process portion 520, the displaceable platform 210 is positioned for receiving or coupling to the component panes, for example film frames 20. More specifically, the displaceable platform 210 can be vertically displaced to a predetermined position (e.g., a receiving position) for receiving the film frame 20 from the first handler 120.

In a third process portion 530, the first handler 120 transfers the component pane, for example film frame 20, from the film frame loading station 50 to the film frame alignment station 200, more specifically to the displaceable platform 210 of the film frame alignment station 200. In several embodiments, the receiving position of the displaceable platform 210 can be selected and/or varied for enhancing ease, speed, and/or accuracy of transferring the film frame 20 from the first handler 120 to the displaceable platform 210.

The end effector 150 of the first handler 120, can be displaced, maneuvered, and/or rotated for transferring the film frame 20 from the film frame loading station 50 to the film frame alignment station 200. Vacuum opening(s) 170 of the end effector 150 can help to hold or secure the film frame 20 to the end effector 150 during transfer of the film frame 20 from the film frame loading station 50 to the film frame alignment station 200.

FIG. 2C shows the film frame 20 upon retrieval thereof from the film frame loading station 50. FIG. 2D shows the end effector 150 positioned at approximately 90 degrees to the end effector position of FIG. 2C. The rotation of the end effector 150 aligns and positions the film frame 20 for transfer to the film frame alignment station 200, more specifically to the displaceable platform 210 of the film frame alignment station 200.

As described above, the film frame registration element 140 carried by the end effector 150 couples or attaches to the component pane or film frame 20, more specifically to the alignment recess 22 of the film frame 20, during transfer of the film frame 20 from the film frame loading station 50 to the film frame alignment station 200. The film frame registration element 140 can facilitate general alignment or orientation of the film frame 20 coupled or attached thereto.

The transfer of the film frame 20 from the film frame loading station 50 to the film frame alignment station 200 can involve position, placement and/or release of the film frame 20 at or on the displaceable platform 210. FIG. 2E and FIG. 2F show the positioning of the film frame 20 at the displaceable platform 210 of the film frame alignment station 200 according to particular embodiments.

The displaceable platform 210 can include multiple groups or sets of support pins 222, each group or set of support pins 222 (e.g., the first set of support pins 222a, the second set of support pins 222b, and the third set of support pins 222c) configured and positioned for receiving and/or supporting portions of a film frame 20 of a particular size (e.g., 6 inches, 8 inches, and 12 inches). In certain embodiments, each set of support pins 222 is disposed or positioned at a different height from the other sets of support pins 222 in order to facilitate the receipt of film frames 20 of a corresponding size.

A fourth process portion 540 involves spatial alignment, orientation, or positioning of the component pane, more specifically film frame 20, by way of the film frame registration element 140 and an appropriate displacement of the displaceable pin 224 carried by the displaceable platform 210 relative to the film frame registration element 140.

The spatial alignment, orientation, or positioning of component panes, more specifically film frames 20, occurs before the component panes, more specifically film frames 20, are placed on the vacuum table 310, more specifically at the film frame alignment station 200. In several embodiments, the spatial alignment, orientation, or positioning of

component panes, more specifically film frames 20, is completed, or substantially completed, at the film frame alignment station 200.

In multiple embodiments, the spatial alignment, orientation, or positioning of the film frame 20 involves or includes displacing the displaceable pin 224 (or displaceable element) relative to the film frame registration element 140 carried by the end effector 150 such that the displaceable pin 224 positions, displaces, pushes, or forces the film frame 20 against the film frame registration element 140 carried by the end effector 150.

In several embodiments, the displacement of the displaceable pin 224 relative to the film frame registration element 140, or relative to the film frame 20 coupled to the film frame registration element 140, effectuates or enhances mating engagement between the alignment recesses 22 of the film frame 20 and the film frame registration element 140 of the first handler 120. The mating engagement between the alignment recesses 22 of the film frame 20 and the film frame registration element 140 of the first handler 120 can facilitate or effectuate spatial alignment of the film frame 20 at the film frame alignment station 200. More specifically, the mating engagement between the alignment recesses 22 of the film frame 20 and the film frame registration element 140 of the first handler 120 can help to complete or substantially complete spatial alignment of the film frame 20 at the film frame alignment station 200.

The completion, or substantial completion, of spatial alignment, orientation, or positioning of the component pane, more specifically film frame 20, at the film frame alignment station 200 removes any need for further alignment of the film frame 20 after the film frame 20 is transferred away from the film frame alignment station 200, for example when the film frame 20 is placed on the vacuum table 310.

The plurality of alignment elements carried by the displaceable platform 210 can also include multiple groups or sets of support pins 222, for example the first set of support pins 222a, the second set of support pins 222b, and the third set of support pins 222c.

Each group or set of support pins 222 can be positioned and configured for receiving, carrying, or coupling to film frames 20 of a corresponding size.

Since the displaceable platform 210 of multiple embodiments includes multiple groups or sets of support pins 222 configured for receiving, carrying, coupling to, or aligning film frames 20 of multiple sizes, the process 500 is correspondingly applicable to film frames 20 of said multiple sizes. Increasing the number of groups or sets of support pins 222 can increase the number of different sizes of film frames 20 for which the process 500 can be applied to, thereby increasing the versatility of the process 500.

A fifth process portion 550 involves displacing the displaceable platform 210 vertically (i.e., along the Y-axis) before the second handler 130 is used for retrieving or picking up the component pane, for example film frame 20, from the displaceable platform 210 in a sixth process portion 560.

FIG. 2G show the configuration of the system 10, or relative orientations of different components of the system 10, during the retrieval or pick up of the film frame 20 from the displaceable platform 210. FIG. 2H show the configuration of the system 10, or relative orientations of different components of the system 10, subsequent pick up of the film frame 20 from the displaceable platform 210.

The displaceable platform 210 can be positioned at different positions, hence at different heights, between the placement or receipt of the film frame 20 on the displaceable platform 210 and the retrieval or removal of the film frame 20 from the displaceable platform 210.

For example, the fifth process portion 550 can involve displacement of the displaceable platform 210 from the receiving position, at which the film frame 20 is placed or received on the displaceable platform 210, to a second position (or elevated position), at which the film frame 20 is retrieved or removed from the displaceable platform 210. The displacement (e.g., elevation) of the displaceable platform 210 to a different position

(e.g., the elevated position) can facilitate, for instance increase the ease of, retrieval or removal of the film frame 20 from the displaceable platform 210 by the second handler 130 in the sixth process portion 560.

As described above, the second handler 130 includes at least one suction element 160 configured to facilitate or effectuate retrieval, removal, or pick up of the film frame 20 from the displaceable platform 210. The position, more specifically vertical elevation, of the displaceable platform 210, and hence the film frame 20 carried by the displaceable platform 210, during the fifth process portion 550 can aid the pickup of the film frame 20 from the displaceable platform 210. For instance, elevating the displaceable platform 210 can bring the film frame 20 that is disposed on the displaceable platform 210 into closer proximity with the at least one suction element 160 of the second handler 130.

In a seventh process portion 570, the component pane, for example film frame 20, is transferred by the second handler 130 from the film frame alignment station 200 to the vacuum table assembly 300, more specifically onto the vacuum table 310. FIG. 2I shows the extension, positioning, or displacement, of the second handler 130 for transferring the film frame 20 carried thereby onto the vacuum table 310.

The suction force can be applied continuously, or substantially continuously, by the at least one suction element 160 of the second handler 130 during the transfer of the film frame 20 from the film frame alignment station 200 to the vacuum table assembly 300. The suction force applied by the at least one suction element 160 during transfer of the film frame 20 from the film frame alignment station 200 to the vacuum table assembly 300 can help to secure the film frame 20 to the second handler 130.

The suction force supplied by the at least one suction element 160 of the second handler 130 can be terminated, or substantially reduced, upon detection of placement of film frame 20 on the vacuum table 310, for instance via sensors. The termination, or substantial reduction, in suction force being applied by the at least one suction element

160 onto the film frame 20 allows release of the film frame 20 from the second handler 130 onto the vacuum table 310.

A suction force can be applied through the pores (not shown) defined within the vacuum table 310 to thereby secure or hold the film frame 20 to the vacuum table 310. The duration and/or quantity of suction force applied to the film frame 20 placed on the vacuum table 310 can be controlled as required, either manually or automatically by using stored program instructions in the control unit.

As described above, the film frame 20 is spatially aligned or orientated prior to placement of the film frame 20 on the vacuum table 310. More specifically, the spatial alignment or orientation of the film frame 20 prior to placement thereof on the vacuum table 310 satisfies alignment conditions of the film frame 20 relative to the vacuum table 310 for subsequent inspection or processing operations of the vacuum table 310.

The second handler 130 is configured to preserve the spatial alignment, configuration, or position of the film frame 20 during transfer of the film frame 20 from the film frame alignment station 200 to the vacuum table 310. In addition, the suction force applied by the vacuum table 310 to the film frame 20 placed thereon can also help to maintain the spatial alignment of the film frame 20 relative to the vacuum table 310 after the film frame 20 has been placed on the vacuum table 310.

In an eighth process portion 580, the vacuum table 310, and accordingly the component pane, for example film frame 20, which is placed thereon, is displaced for transferring the film frame 20 to the processing or inspection station 400. FIG. 2J shows the vacuum table 310, and the film frame 20 placed thereon, positioned at the inspection station 400 for inspection thereat using the optical image capture device 410.

The vacuum table 310 is coupled to the translation apparatus 320, which is able to effectuate displacement of the vacuum table 310 in a Cartesian configuration or manner. The translation apparatus 320 is configured and/or programmed to translate (e.g. along

the x-, y-, z-, and/or θ- axis) the vacuum table 310 to or towards the inspection station 400. Inspection of the film frame 20 occurs at the inspection station 400, for example via image capture of the film frame 20 by one or more optical image capture device 410 that is positioned at the inspection station 400. The images captured of the film frame 20 by the optical image capture device 410 can be processed or analyzed for detecting any defects that may be present on the film frame 20.

After inspection of the component pane, for example the film frame 20, or portions thereof, the component pane, for example the film frame 20, can be removed, retrieved, or picked up from the vacuum table 310 using the second handler 130 in a ninth process portion 590.

The at least one suction element 160 carried by the second handler 130 can be used to apply suction force onto the film frame 20 to thereby retrieve, remove, or pick up the film frame 20 from the vacuum table 310. In addition, the vacuum force that is applied via the pores of the vacuum table 310 is ceased for allowing the retrieval, removal, or pick up of the film frame 20 from the vacuum table 310.

The use of suction force, for instance suction force applied by the at least one suction element 160 of the second handler 130, to retrieve or pick-up film frames 20 from the vacuum table 310 removes or eliminates a conventional or existing need for use of ejector pins to eject or lift semiconductor-related components (e.g., film frames) a distance from conventional vacuum tables to thereby allow a conventional semiconductor-related component handler (e.g., film frame handler) to retrieve said semiconductor-related component (e.g., film frame) from said conventional vacuum table.

Therefore, systems 10, more specifically the vacuum table 310 of said systems 10, of multiple embodiments of the present disclosure can omit ejector pins, or like pins or elements of similar function. The absence of ejector pins enables manufacture of simpler and/or more cost effective vacuum tables 310. In addition, the use of the second handler

130, more specifically the at least one suction element 160, can facilitate or enable a faster, more convenient, and/or more cost effective process for placing component panes (e.g., semiconductor-related components such as film frames 20) onto vacuum tables 310 and retrieving said component panes (e.g., semiconductor-related components such as film frames 20) from vacuum tables 310.

In addition, the use of suction force can enable handling of different types of component panes (e.g., semiconductor-related components such as film frames 20 and wafers), by the second handler 130. Accordingly, the process 500 according to various embodiments does not require a use of an additional handler(s), or a modified handler, to handle, transfer, and/or hold additional type(s) of component panes (e.g., additional types of semiconductor-related component(s)).

Although the present disclosure involves the use of the second handler 130 for retrieving the component pane, more specifically the film frame 20, from the vacuum table 310 and transferring the component pane, more specifically the film frame 20, from the vacuum table 310 to the film frame offload station, it will be understood that other robotic transfer devices, apparatuses, or handlers can be used in addition to, or in substitution of, the second handler 130. Said alternative or additional robotic transfer device, apparatus, or handler is configured for retrieving the component pane, more specifically the film frame 20, from the vacuum table 310 and transferring the component pane, more specifically the film frame 20, from the vacuum table 310 to the film frame offload station.

Relative Operation (e.g., Displacement) of the First and Second Handlers 120, 130

The relative operation, for instance the relative displacement or positioning, of the first handler 120 and the second handler 130 can be controlled or coordinated. For example, the relative displacement or positioning of the first handler 120 and the second handler 130 can occur in tandem and be synchronized, or substantially synchronized, for increasing throughput and/or efficiency of the system 10.

FIG. 6 shows a flowchart of a representative process 600 associated with the relative operation, for instance relative displacement, between the first handler 120 and the second handler 130.

A first process portion 610 involves displacement and/or rotation of the first handler 120 for transferring a first component pane, for example a first film frame 20a, from the film frame loading station 50 to the film frame alignment station 200. The first handler 120 can be extended to the extended position, which corresponds to the film frame loading station 50, for retrieving the first film frame 20a from the film frame loading station 50 and then displaced and/or rotated for transferring the retrieved first film frame 20a to the film frame alignment station 200. More specifically, the end effector 150 of the first handler 120 is displaced to or towards the film frame loading station 50, for retrieving the first film frame 20a from the film frame loading station 50, and then displaced and/or rotated for transferring the retrieved first film frame 20a to the film frame alignment station 200.

In a second process portion 620, the first component pane, for example the first film frame 20a, can be spatially aligned, orientated, or positioned at the film frame alignment station 200 using particular processes or techniques disclosed in the present disclosure. For instance, the spatial alignment, orientation, or position of the first film frame 20a at the film frame alignment station 200 can involve the displacement of the displaceable pin 224 relative to the film frame registration element 140 of the first handler 120.

A third process portion 630 involves a return (i.e., displacement in an opposite direction to the first process portion 610) of the first handler 120 from the film frame alignment station 200 to the film frame loading station 50. The return of the first handler 120 to the film frame loading station 50 positions the first handler 120 for retrieving a next, or a second, component pane, more specifically a next, or second, film frame 20b.

In relation to the second handler 130, the third process portion 630 also involves simultaneous, or synchronized, displacement of the second handler 130 between the film

frame alignment station 200 and the vacuum table assembly 300 for transferring the first film frame 20a from the film frame alignment station 50 to the vacuum table 310.

Accordingly, the third process portion 630 involves a displacement of the first handler 120 from the film frame alignment station 200 to the film frame loading station 50 and a simultaneous or synchronized displacement of the second handler 130 from the film frame alignment station 200 to the vacuum table assembly 300.

A fourth process portion 640 involves displacing the vacuum table 310 carrying the first film frame 20a to the processing or inspection station 400 for inspection (e.g., optical inspection) of the first film frame 20a. The fourth process portion 640 can also include retrieval or removal of the first film frame 20a from the vacuum table 310 subsequent the inspection of the first film frame 20a. The second handler 130 is configured for use in retrieving or removing film frames 20 from the vacuum table 310. Furthermore, the fourth process portion can also involve transfer of the retrieved first film frame 20a from the vacuum table 310 to the film frame offloading station.

In multiple embodiments of the present disclosure, the inspection, retrieval, and offloading of the first film frame 20a coincides with a retrieval and transfer of a second film frame 20b from the film frame loading station 50 to the film frame alignment station 200 using the first handler 120.

Therefore, the fourth process portion 640 involves operation and displacement of the second handler 130 for transferring the first film frame 20a from the vacuum table 310 to the film frame offloading station together, or in a synchronized manner, with the operation and displacement of the first handler 120 for transferring the second film frame 20b from the film frame loading station 50 to the film frame alignment station 200.

Each of the process portions 610 to 640 can be repeated any number of times. Increasing the number of repetitions of one or more of process portions 610 to 640 enables an

increasing number of component panes, for example film frames 20, to be handled, transferred, aligned, and inspected by the system 10.

The relative operation and displacement of the first handler 120 and the second handler 130 allows retrieval from the film frame loading station 50, transfer to the film frame alignment station 200, and spatial alignment at the film frame alignment station 200, of a next or subsequent (e.g., second) film frame 20 to occur in tandem with the inspection at the inspection station 400, retrieval from the vacuum table 310, and transfer to the film frame offloading station 450, of a previous or prior (e.g., first) film frame 20.

The synchronization, or substantial synchronization, of the operation and displacement of the first handler 120 and the second handler 130 can help to increase the efficiency and/or throughput of the system 10 and method 600.

Relative Operation (e.g., Displacement) of more than two handlers

In certain embodiments of the present disclosure, the system 10 can include more than two handlers. For instance, the system 10 of certain embodiments can include two or more of the first handler 120 and/or two or more of the second handler 130.

Each handler can operate, or be displaced, in a synchronized, or substantially synchronized, manner to thereby increase the efficiency of component pane, for example film frame 20, handling, retrieval, transfer, and/or alignment of said systems 10 and processes 500, 600 of the present disclosure.

For example, where the system 10 includes two first handlers 120, one of the first handlers 120a can be displaced from the film frame loading station 50 to, or towards, the film frame alignment station 200 while the other of the first handlers 120b can be displaced from the film frame alignment station 200 to, or towards, the film frame loading station 50. The cyclic, or synchronized, displacement of the two first handlers 120a and 120b can reduce lag time or down time associated with transfer of component

panes, for example film frames 20, from the film frame loading station 50 to the film frame alignment station 200.

Many embodiments of the present disclosure relate to systems, devices, apparatuses, processes, methods, and/or techniques for handling and/or transferring component panes or components, for instance semiconductor-related components such as film frames and wafers and electrical components such as printed circuit boards. Generally, spatial alignment of component panes (e.g., semiconductor-related components such as film frames) prior to processing or inspection (e.g., visual inspection via the use of optical image capture devices) is often important to ensure accurate processing or inspection of said component panes. For instance, accurate spatial alignment, orientation, or positioning of component panes (e.g., semiconductor-related components such as film frames) is important to ensure accurate determination of the position(s) of defect(s) that may be present on said component panes.

Systems, devices, apparatuses, processes, methods, and/or techniques of multiple embodiments of the present disclosure facilitate or effectuate spatial alignment, orientation, or positioning of component panes (e.g., semiconductor-related components such as film frames) before said component panes are transferred, placed, or disposed onto the vacuum table. The spatial alignment, orientation, or positioning of can be completed, or substantially completed, prior to placement of the component panes on the vacuum table. The spatial alignment, orientation, or positioning of component panes (e.g., semiconductor-related components such as film frames) prior to placement of the components on the vacuum table removes or eliminates the need for further alignment of the relative to the vacuum table after placement of the components on the vacuum table. Therefore, the vacuum table of multiple embodiments of the present disclosure does not include or carry alignment elements, means, or mechanisms (e.g., ejector pins) that are conventionally required by existing systems.

In many embodiments, the component panes (e.g., semiconductor-related components such as film frames) are spatially aligned, orientated, or positioned at the alignment

station. The alignment station is configured for facilitating or effectuating spatial alignment, orientation, or positioning of the component panes that are disposed thereat. The alignment station can include a plurality of alignment elements that are configured to facilitate spatial alignment, orientation, or positioning of the component panes.

More specifically, the plurality of alignment elements includes at least one displaceable pin that can be displaced relative to the registration element of the first handler to facilitate or effectuate spatial alignment, orientation, or positioning of the component pane (e.g., semiconductor-related component such as a film frame) at the alignment station. Displacement of the displaceable pin can effectuate exertion of a force onto the edge of the component pane (e.g., semiconductor-related component such as a film frame) to thereby displace, push, or force the component pane against the registration element carried by the end effector to thereby facilitate or effectuate complete, or substantive, spatial alignment, orientation, or positioning of the component pane at the alignment station. The displacement of the displaceable pin can effectuate or enhance mating engagement between the alignment recesses of the component pane (e.g., semiconductor-related component such as a film frame) and the registration element coupled to or carried by the first handler. This mating engagement between the alignment recesses of the component pane (e.g., semiconductor-related component such as a film frame) and the registration element of the first handler can effectuate spatial alignment (e.g., complete or substantially complete spatial alignment) of the component pane at the alignment station.

The second handler is configured to transfer the component pane (e.g., semiconductor-related component such as a film frames) from the alignment station to the vacuum table. In multiple embodiments, the second handler is configured to effectuate placement of the component pane on the vacuum table in a manner than eliminates a need for ejector pin interaction with the component pane, and which maintains or preserves spatial alignment, orientation, or position of the component pane that is established at the alignment station.

More specifically, the second handler of many embodiments includes suction elements that couple, secure, or hold the component panes (e.g., semiconductor-related component such as a film frame) to the second handler. The use of the suction elements can remove a need for ejector pins commonly associated with conventional systems, more specifically conventional vacuum tables. Removal of need for, and inclusion of, ejector pins with systems and processes of multiple embodiments of the present disclosure increases at least one of simplicity, robustness, efficiency, and cost-effectiveness of said systems and processes.

Systems and processes according to various embodiments of the present disclosure are configured or adapted for handling, transferring, and/or aligning component panes (e.g., semiconductor-related components such as film frames and wafers) of multiple different sizes. Furthermore, systems and processes of particular embodiments of the present disclosure are configured or adapted for handling, transferring, and/or aligning different types of component panes (e.g., semiconductor-related components such as film frames and wafers) in a simultaneous, substantially simultaneous, or consecutive manner.

In several embodiments, the end effectors of the first handlers can be replaced, substituted, or changed in order to adapt the first handlers for handling component panes (e.g., semiconductor-related components such as film frames and wafers) of different sizes and/or for handling different types of component panes.

The second handlers can also be configured to handle component panes (e.g., semiconductor-related components such as film frames and wafers) of different sizes as well as different component panes. This can be through varying the position of the at least one suction element carried by the second handler. In addition, the vacuum table can be configured to handle, receive, or carry component panes (e.g., semiconductor-related components such as film frames and wafers) of different sizes as well as different components. For instance, in some embodiments, when handling wafers, the first handler and the second handler do not include a registration element. In addition, the vacuum

table or vacuum chuck can include retractable pin(s) for facilitating placement and retrieval of the wafer onto and from the wafer table respectively.

Particular embodiments of the disclosure are described above for addressing at least one of the previously indicated problems. While features, functions, advantages, and alternatives associated with certain embodiments have been described within the context of those embodiments, other embodiments may also exhibit such advantages, and not all embodiments need necessarily exhibit such advantages to fall within the scope of the disclosure. It will be appreciated that several of the above-disclosed structures, features and functions, or alternatives thereof, may be desirably combined into other different devices, systems, or applications. The above-disclosed structures, features and functions, or alternatives thereof, as well as various presently unforeseen or unanticipated alternatives, modifications, variations or improvements thereto that may be subsequently made by one of ordinary skill in the art, are encompassed by the following claims.

Claims

1. A system for handling and spatially aligning component panes, each component pane having an exterior border that includes a set of alignment features, the system comprising:

    a first robotic handler comprising:

        an end effector configured for configured for retrieving a first component pane from a component pane loading station by carrying the first component pane; and

        a component pane registration element coupled to the end effector and configured for mating engagement with the set of alignment features of the first component pane; and

    an alignment station comprising:

        a platform configured for receiving the first component pane from the end effector, the platform configured for supporting component panes of different sizes at different heights relative to a predetermined surface of the platform; and

        at least one alignment member displaceable relative to the component pane registration element, the at least one alignment member configured for exerting a force upon the exterior border of the first component pane while the first component pane is supported by the platform to matingly engage the set of component pane alignment features of the first component pane with the component pane registration element of the first robotic handler to spatially align the first component pane,

    wherein spatial alignment of the first component pane at the alignment station occurs prior to placement of a lower surface of the first component pane on a planar surface of a vacuum table.

2. The system of claim 1, wherein the component pane registration element is carried by the end effector.

3. The system of claim 1 or 2, wherein the at least one alignment member of the alignment station comprises at least one pin displaceable relative to the component pane registration element of the first robotic handler.

4. The system of any one of the preceding claims, wherein the platform carries a set of component pane support pins configured for supporting the first component pane at a first height relative to the predetermined surface of the platform.

5. The system of claim 4, wherein the set of component pane support pins comprises a first set of component pane support pins and a second set of component pane support pins distinct from the first set of component pane support pins and disposed at a different height than the first set of component pane support pins, and wherein the first set of component pane support pins is configured for supporting a component pane of a first predetermined size and the second set of component pane support pins is configured for supporting a component pane of a second predetermined size different than the first predetermined size.

6. The system of claim 5, wherein the first set of component pane support pins and the second set of component pane support pins are disposed at different heights relative to the platform.

7. The system of claim 5 or 6, wherein the at least one alignment member comprises:

a first alignment member configured for exerting a force upon the exterior border of a component pane of the first predetermined size while the component pane of the first predetermined size is supported by the first set of component pane support pins; and

a second alignment member configured for exerting a force upon the exterior border of a component pane of the second predetermined size while the component pane of the second predetermined size is supported by the second set of component pane support pins.

8. The system of any one of the preceding claims, wherein the platform is vertically displaceable relative to the first robotic handler, and wherein the platform is configured for receiving the first component pane from the first robotic handler while the platform is disposed at a first height relative to the first robotic handler, and the platform is configured for removal of the spatially aligned first component pane from the platform while the platform is disposed at a second height relative to the first robotic handler.

9. The system of any one of the preceding claims, further comprising a second robotic handler configured for transferring the spatially aligned first component pane from the alignment station to a planar surface of a vacuum table, the second robotic handler comprising at least one suction element configured to apply a suction force to a top surface of the spatially aligned first component pane to securely hold the spatially aligned first component pane.

10. The system of claim 9, further comprising a vacuum table assembly comprising and configured for displacing the vacuum table, wherein the vacuum table assembly excludes component pane registration elements.

11. The system of claim 9 or 10, wherein:

the second robotic handler is configured for transferring the spatially aligned first component pane to the vacuum table by transferring the lower surface of the first spatially aligned component pane directly onto the planar surface of the vacuum table, and

the vacuum table is configured for applying a vacuum force to the lower surface of spatially aligned first component pane across a planar vacuum table area that is at least approximately as large as a planar area of the lower surface of the first spatially aligned component pane.

12. The system of claim 11, wherein the second robotic handler is configured to apply the suction force to the top surface of the spatially aligned first component pane to maintain the spatial alignment of the spatially aligned first component pane established at the

alignment station until after the vacuum table applies the vacuum force to the lower surface of the spatially aligned first component pane.

13. The system of claim 11 or 12, wherein the vacuum table excludes ejector pins configured for receiving the spatially aligned first component pane.

14. The system of any one of claims 10 - 13, wherein the first component pane comprises a film frame carrying a set of components, the set of components comprising one of a wafer, a partial wafer, and a diced wafer, and wherein the vacuum table is configured for carrying film frames of different sizes and wafers of different sizes in the absence conversion kit modification of the vacuum table.

15. The system of claim 14, wherein the vacuum table assembly includes ejector pins configured for receiving wafers.

16. The system of claim 14, wherein the vacuum table assembly excludes ejector pins configured for receiving wafers.

17. The system of any one of the preceding claims, wherein the component pane registration element of the first robotic handler comprises an elongated C-channel.

18. The system of claim 17, wherein the set of alignment features of the first component pane comprises a set of recesses configured for mating engagement with the elongated C-channel.

19. A method for handling component panes, each component pane having an exterior border that includes a set of alignment elements, the method comprising:

retrieving a first component pane from a component pane loading station using a first robotic handler comprising an end effector and a component pane registration element configured for mating engagement with the set of alignment elements of the first component pane;

positioning the first component pane at an alignment station using the first robotic handler, the alignment station comprising an alignment member and a platform configured for supporting component panes of different sizes at different heights relative to a predetermined surface of the platform;

displacing the alignment member relative to the component pane registration element of the first robotic handler to exert a force upon the exterior border of the first component pane to matingly engage the set of component pane alignment features of the first component pane with the component pane registration element of the first robotic handler to spatially align the first component pane,

wherein spatial alignment of the first component pane at the alignment station occurs prior to placement of a lower surface of the first component pane on a planar surface of a vacuum table.

20. The method of claim 19, wherein the component pane registration element is carried by the end effector.

21. The method of claim 19 or 20, wherein positioning the first component pane at the alignment station comprises positioning the first component pane at a first height relative to the predetermined surface of the platform.

22. The method of claim 21, wherein positioning the first component pane at the first height comprises positioning the first component pane on a first set of component pane support pins carried by the platform.

23. The method of any one of claims 19 – 22, wherein displacing the alignment member relative to the component pane registration element of the first robotic handler comprises laterally displacing the alignment member toward the component pane registration element of the first robotic handler.

24. The method of any one of claims 19 - 23, further comprising:

applying a suction force to a top surface of the spatially aligned first component pane using a second robotic handler; and

removing the spatially aligned component pane from the alignment station using the second robotic handler while the second robotic handler applies the suction force to the top surface of the spatially aligned first component pane.

25. The method of claim 24, further comprising transferring by way of the second robotic handler the spatially aligned first component pane to the planar surface of the vacuum table by transferring the lower surface of the spatially aligned first component pane directly to the planar surface of the vacuum table.

26. The method of claim 25, further comprising avoiding receipt of the spatially aligned first component pane by a set of ejector pins corresponding to the vacuum table during transfer of the spatially aligned first component pane to the vacuum table.

27. The method of claim 25 or 26, further comprising applying by way of the vacuum table a vacuum force to the lower surface of the spatially aligned first component pane, wherein the vacuum force is applied across a planar vacuum table area that is at least approximately as large as a planar area of the lower surface of the spatially aligned first component pane.

28. The method of claim 27, further comprising continuing to apply the suction force to the top surface of the spatially aligned first component pane by way of the second robotic handler until after the vacuum force is applied to the lower surface of the spatially aligned first component pane by way of the vacuum table.

29. The method of any one of claims 25 - 28, wherein the spatial alignment of the first component pane established at the alignment station removes further need for spatial alignment of the first component pane prior to performance of processing operations on the spatially aligned first component pane while the spatially aligned first component pane resides on the vacuum table.

30. The method of any one of claims 25 – 29, wherein the first component pane comprises a film frame carrying a set of components, the set of components comprising one of a wafer, a partial wafer, and a diced wafer, and wherein the vacuum table is configured for carrying film frames of different sizes, the method further comprising:

removing the spatially aligned first film frame from the vacuum table; and

transferring a wafer to the vacuum table after removal of the spatially aligned first film frame from the wafer table, in the absence of conversion kit modification of the vacuum table prior to transferring the wafer to the vacuum table.

31. The method of claim 30, wherein transferring the wafer to the vacuum table comprises transferring the wafer to the vacuum table in the absence of vacuum table ejector pins configured for receiving wafers.

32. The system of claim 30, wherein transferring the wafer to the vacuum table comprises transferring the wafer to a set of vacuum table ejector pins configured for receiving wafers.

33. The method of any one of claims 19 - 32, wherein the component pane registration element of the first robotic handler comprises an elongated C-channel.

34. The method of claim 33, wherein the set of alignment features of the first component pane comprises a set of recesses configured for mating engagement with the elongated C-channel.

SYSTEM AND METHOD FOR HANDLING AND ALIGNING COMPONENT PANES SUCH AS FILM FRAMES AND WAFERS

Abstract

A system and method for transferring a component pane (e.g., semiconductor component such as a film frame or wafer) from a loading station to a vacuum table, the component pane being spatially aligned before placement thereof onto the vacuum table. The spatial alignment of the component pane can be completed, or substantially completed, prior to placement thereof onto the vacuum table. Accordingly, there is no need for the vacuum table to include alignment elements, means, or mechanisms. The system includes a first handler configured to transfer component panes from the loading station to an alignment station where spatial alignment of the component panes occurs, and a second handler configured to transfer the component panes from the alignment station to the vacuum table. The first handler includes a set of registration elements and the alignment station includes a set of alignment elements. The system is able to handle component panes of different sizes as well as different types of component panes (e.g., both film frames and wafers).

FIG. 1