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

~~a component pane handling apparatus configured to handle component panes, the component pane handling apparatus comprising at least one handler having at least one suction element projecting therefrom, the at least one suction element 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; and~~

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

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.

~~2. The system as in claim 1, wherein the at least one handler of the component pane handling apparatus comprises a first handler configured to handle component panes, the first handler comprising:~~

~~an end effector configured and displaceable for transferring the component pane to the alignment station; and~~

~~a registration element configured to engage with the component pane,~~

~~wherein the at least one alignment element of the plurality of alignment elements is displaceable relative to the registration element to thereby effectuate spatial alignment of the component pane.~~

~~3. The system as in claim 2, wherein the at least one alignment element of the plurality of alignment elements can be laterally displaced relative to the registration element to displace and push the component pane against the registration element to thereby effectuate spatial alignment of the component pane.~~

~~4. The system as in claim 3, wherein the component pane comprises an alignment feature, and wherein the registration element of the first handler is configured to matingly engage with the alignment feature of the component pane.~~

~~5. The system as in claim 4, wherein the lateral displacement of the at least one alignment element relative to the registration element of the first handler one of effectuates and enhances mating engagement between the alignment feature of the component pane and the registration element of the first handler.~~

~~6. The system as in claim 5, wherein the spatial alignment of the component pane at the alignment station is completed while the alignment feature of the component pane is matingly engaged to the registration element of the first handler.~~

~~7. The system as in claim 2, further comprising a loading station configured to hold at least one component pane, the end effector configured to retrieve the component pane from the loading station and transfer the component pane from the loading station to the alignment station.~~

~~8. The system as in claim 7, further comprising:~~

~~a vacuum table assembly comprising a vacuum table and a translation apparatus configured to translate and position the vacuum table.~~

~~9. The system as in claim 8, wherein the at least one handler of the component pane handling apparatus comprises a second handler configured to transfer the component pane from the alignment station to the vacuum table.~~

~~10. The system as in claim 9, wherein the second handler comprises at least one suction element, the at least one suction element configured to apply a vacuum force to the top surface of the component pane for holding the component pane to the second handler.~~

~~11. The system as in claim 10, wherein the at least one suction element of the second handler one of facilitates and effectuates placement of the component pane on the vacuum table in the absence of ejector pins.~~

~~12. The system as in claim 11, wherein the vacuum table does not require a use of alignment elements for spatially aligning the component pane carried thereby.~~

~~13. The system as in claim 12, wherein the vacuum table is configured for carrying each of a film frame and a wafer in the absence of vacuum table modification.~~

~~14. The system as in claim 8, further comprising a processing station configured to one of facilitate and effectuate processing of the component pane.~~

~~15. The system as in claim 14, wherein the translation apparatus is configured to translate the vacuum table and position the component pane with respect to the processing station for one of facilitating and effectuating processing of the component pane.~~

~~16. The system as in claim 2, wherein the spatial alignment of the component pane at the alignment station enables removal of a need for spatial alignment of the component pane in relation to a registration element after removal of the component pane from the alignment station.~~

~~17. The system as in claim 2, wherein the plurality of alignment elements comprises at least a first displaceable alignment element, a second displaceable alignment element, and a third displaceable alignment element, and wherein each of the first, second, and third displaceable alignment elements is positioned and configured to spatially align component panes of a first size, a second size, and a third size respectively.~~

~~18~~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

~~handling component panes using a component pane handling apparatus, the component pane handling apparatus comprising 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;~~

~~positioning the component panes at an alignment station, the alignment station comprising a plurality of alignment elements; and~~

~~displacing at least one alignment element within the plurality of alignment elements relative to the component panes positioned at the alignment station to thereby effectuate spatial alignment of the component panes~~.

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.

~~19. The method as in claim 18, wherein the component pane handling apparatus comprises a first handler configured to handle component panes, the first handler comprising:~~

~~an end effector; and~~

~~a registration element configured to engage with the component panes,~~

wherein the at least one alignment element of the plurality of alignment elements is displaceable relative to the registration element to thereby effectuate spatial alignment of the component pane.

20. The method as in claim 19, wherein the component panes comprise an alignment feature, the registration element of the first handler configured to matingly engage with the alignment feature of the component panes.

21. The method as in claim 20, further comprising laterally displacing the at least one alignment element within the plurality of alignment elements relative to the registration element of the first handler to thereby one of effectuate and enhance mating engagement between the alignment feature of the component panes and the registration element of the first handler.

22. The method as in claim 21, wherein spatial alignment of the component pane is at least substantially completed when the alignment feature of the component pane is matingly engaged with the registration element of the first handler.

23. The method as in claim 18, wherein spatial alignment of the component pane is at least substantially completed when the component pane is at the alignment station.

24. The method as in claim 23, wherein the spatial alignment of the component pane at the alignment station enables removal of a need for spatial alignment of the component pane in relation to a registration element after removal of the component pane from the alignment station.

25. The method as in claim 19, further comprising transferring the component pane from the alignment station to a vacuum table using a second handler of the component pane handling apparatus.

~~26. The method as in claim 25, wherein the spatial alignment of the component pane at the alignment station enables omission of registration element based alignment mechanisms for aligning the component pane at the vacuum table.~~

~~27. The method as in claim 18, wherein the plurality of alignment elements comprises at least two sets of support pins, each set of support pins configured and positioned for one of coupling to and supporting component panes of a different size.~~

~~28. The method as in claim 19, wherein the alignment station comprises a displaceable platform that is configured to engage with portions of the component pane, the displaceable platform vertically displaceable between a first position and a second position, wherein the first and second positions correspond to different heights.~~

~~29. The method as in claim 28, further comprising:~~

~~positioning the displaceable platform at the first position for facilitating receipt of the component pane by the displaceable platform; and~~

~~positioning the displaceable platform at the second position for facilitating retrieval of the component pane by the second handler.~~

~~30. The method as in claim 22, wherein the second handler comprises at least one suction element configured to apply a vacuum force onto the component pane to thereby hold the component pane thereto.~~

~~31. The method as in claim 30, wherein transferring the component pane from the alignment station to a vacuum table comprises:~~

~~applying suction force to the component pane by the at least one suction element for retrieving the component pane from the alignment station; and~~

~~ceasing application of the suction force onto the component pane by the at least one suction element upon placement of the component pane on the vacuum table.~~

~~32. The method as in claim 31, further comprising avoiding receipt of the component pane by a set of ejector pins during transfer of the component pane to the vacuum table by the second handler.~~

~~33. The method as in claim 32, wherein the component pane is one of a film frame and a wafer.~~

~~34. The method as in claim 33, wherein the vacuum table is configured such that the vacuum table is able to receive both film frames and wafers in the absence of vacuum table modification.~~

~~35. A system for handling film frames, each film frame comprising an alignment recess, the system comprising:~~

~~an alignment station configured to receive a film frame, the alignment station comprising 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; and~~

~~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 comprising 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,~~

~~wherein the mating engagement between the alignment recess of the film frame and the registration element thereby effectuates spatial alignment of the film frame at the alignment station.~~

~~36. The system as in claim 35, wherein the spatial alignment of the film frame is at least substantially completed at the alignment station.~~

~~37. The system as in claim 36, wherein the vacuum table is configured to omit use of alignment elements for spatially aligning the film frame carried thereby.~~

~~38. The system as in claim 35, further comprising:~~

~~a loading station configured to hold at least one film frame; and~~

~~a first handler configured to retrieve the film frame from the loading station and transfer the film frame from the loading station to the alignment station.~~

~~39. The system as in claim 38, wherein the first handler comprises an end effector configured to couple to the film frame to thereby one of facilitate and effectuate retrieval of the film frame from the loading station, and wherein the registration element is one of coupled to and carried by the end effector.~~

~~40. The system as in claim 39, wherein lateral displacement of the displaceable member relative to the registration element one of displaces and pushes the film frame against the registration element to thereby one of effectuate and enhance mating engagement between the alignment recess of the film frame and the registration element of the first handler.~~

~~41. The system as in claim 40, wherein the registration element comprises an elongated C-channel configured to matingly engage with the alignment recess of the film frame.~~

~~42. The system as in claim 40, wherein the spatial alignment of the film frame at the alignment station is completed while the alignment recess of the film frame is matingly engaged with the registration element of the first handler.~~

~~43. The system as in claim 35, wherein the alignment station further comprises at least two sets of support pins, each set of support pins configured and positioned for facilitating spatial alignment of film frames of a different size.~~

~~44. The system as in claim 43, wherein the alignment station further comprises a displaceable platform configured to receive portions of the film frame, the displaceable platform vertically displaceable between at least two different heights.~~

45. The system as in claim 44, wherein the displaceable platform is configured to facilitate receipt of the film frame when disposed at a first height and removal of the film frame therefrom when disposed at a second height.

46. The system as in claim 45, wherein the at least one suction element of the second handler one of facilitates and effectuates pick up of the film frame from the displaceable platform of the alignment station and subsequent placement of the film frame on the vacuum table.

47. The system as in claim 46, wherein the at least one suction element of the second handler is configured such that the placement of the film frame on the vacuum table can be effectuated and completed independent of ejector pins.

48. The system as in claim 35, wherein the vacuum table is coupled to a translation apparatus, the translation apparatus configured to translate and position the vacuum table at a processing station, the processing station configured to process the film frame.

49. The system as in claim 48, wherein the vacuum table is configured to receive each of a film frame and a wafer in the absence of vacuum table modification.

50. A method for handling film frames that each comprises an alignment recess, the method comprising:

positioning a film frame at an alignment station, the alignment station comprising a plurality of alignment elements;

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; and

handling the film frame with a film frame handling apparatus comprising 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.

51. The method as in claim 50, wherein the spatial alignment of the film frame at the alignment station enables removal of further need for spatial alignment of the film frame in relation to a registration element after removal of the film frame from the alignment station.

52. The method as in claim 51, wherein the spatial alignment of the film frame at the alignment station enables omission of a set of alignment mechanisms configured for mating engagement with the alignment recess of the film frame carried by the vacuum table.

53. The method as in claim 52, further comprising retrieving the film frame from a loading station using a first handler of the film frame handling apparatus, the first handler comprising an end effector that one of couples to and carries the registration element.

54. The method as in claim 53, wherein spatially aligning the film frame at the alignment station comprises laterally displacing at least one alignment element within the plurality of alignment elements towards the film frame to thereby one of effectuate and enhance mating engagement between the alignment recess of the film frame and the registration element.

55. The method as in claim 53, wherein the plurality of alignment elements comprises at least two sets of support pins, each set of support pins configured and positioned for facilitating spatial alignment of film frames of a different size.

56. The method as in claim 55, wherein the alignment station comprises a displaceable platform that is configured to receive portions of the film frame, the displaceable platform displaceable to different heights.

~~57. The method as in claim 56, further comprising:~~

~~positioning the displaceable platform at a first position for facilitating transfer of the film frame from the first handler to the displaceable platform; and~~

~~positioning the displaceable platform at a second position for facilitating retrieval of the film frame from the displaceable platform by the second handler,~~

~~wherein the first and second positions corresponds to different heights.~~

~~58. The method as in claim 57, wherein transferring the film frame from the alignment station to the vacuum table comprises:~~

~~applying suction force to portions of the film frame by at least one suction element of a second handler of the film frame handling apparatus for retrieving the film frame from the alignment station; and~~

~~ceasing application of the suction force onto the film frame by the at least one suction element of the second handler upon placement of the film frame by the second handler onto the vacuum table.~~

~~59. The method as in claim 58, wherein transferring the film frame from the alignment station to the vacuum table comprises transferring a lower surface of the film frame directly to a film frame support surface of the vacuum table using only the second handler, the film frame support surface spanning a planar area that is at least approximately as large as a planar area of the lower surface of the film frame.~~

~~60. The method as in claim 59, further comprising avoiding receipt of the film frame by a set of ejector pins during transfer of the film frame to the vacuum table by the second handler.~~