

CLAIMS:

1. A substrate processing system comprising:
a transfer region housing defining a transfer region, wherein a sidewall of the transfer region housing defines a sealable access for providing and receiving substrates;
5 a plurality of substrate supports disposed within the transfer region; and
a transfer apparatus comprising:
a central hub including a first shaft and a second shaft extending about and concentric with the first shaft, wherein the second shaft is counter-rotatable with the first shaft,
10 a first end effector coupled with the first shaft, the first end effector comprising a plurality of first arms having a number of first arms equal to a number of substrate supports of the plurality of substrate supports, and
a second end effector coupled with the second shaft, the second end effector comprising a plurality of second arms having a number of second arms equal to
15 the number of first arms of the first end effector.
2. The substrate processing system of claim 1, wherein the second end effector is vertically offset from the first end effector along the central hub.
3. The substrate processing system of claim 2, wherein the first end effector further comprises a plurality of first end pieces, each first end piece coupled with a separate first
20 arm of the plurality of first arms, and wherein the second end effector further comprises a plurality of second end pieces, each second end piece coupled with a separate second arm of the plurality of second arms.
4. The substrate processing system of claim 3, wherein each first end piece and each second end piece extend vertically to a similar plane extending orthogonally to the
25 central hub, and wherein each first end piece and each second end piece define a recessed ledge and a shelf.
5. The substrate processing system of claim 3, wherein each first end piece and each second end piece are characterized by an arcuate exterior profile.

6. The substrate processing system of claim 3, wherein each first end piece comprises a force-generating plunger configured to releasably engage a substrate against a corresponding second end piece.

7. The substrate processing system of claim 1, wherein the central hub is
5 vertically translatable along a central axis of the central hub.

8. A method of transferring a substrate, the method comprising:
receiving a substrate at a first substrate support within a transfer region of a
substrate processing system, the substrate processing system including a transfer apparatus
comprising:

10 a central hub including a first shaft and a second shaft extending about and
concentric with the first shaft,

a first end effector coupled with the first shaft, the first end effector
comprising a plurality of first arms, and

a second end effector coupled with the second shaft, the second end
15 effector comprising a plurality of second arms;
rotating the first shaft in a first direction about a central axis of the central hub;
rotating the second shaft in a second direction about the central axis of the central
hub;

engaging the substrate with a first arm of the plurality of first arms and a second
20 arm of the plurality of second arms;

co-rotating the first arm and the second arm about the central axis to reposition
the substrate; and

delivering the substrate to a second substrate support of the substrate processing
system.

25 9. The method of transferring a substrate of claim 8, further comprising
disengaging the substrate from the transfer apparatus by rotating the first shaft in the second
direction about the central axis and rotating the second shaft in the first direction about the
central axis.

10. The method of transferring a substrate of claim 8, further comprising, subsequent engaging the substrate, lifting the substrate from the first substrate support by translating the transfer apparatus vertically within the transfer region.

5 11. The method of transferring a substrate of claim 8, further comprising, subsequent engaging the substrate, recessing the first substrate support from the substrate.

12. The method of transferring a substrate of claim 8, wherein the first end effector comprises a plurality of first end pieces, each first end piece coupled with a separate first arm of the plurality of first arms, wherein the second end effector comprises a plurality of second end pieces, each second end piece coupled with a separate second arm of the plurality of second arms, wherein each first end piece and each second end piece define a recessed ledge and a shelf, and wherein engaging the substrate comprises extending the shelf of the first end piece of the first arm and the shelf of the second end piece of the second arm beneath an exterior edge of the substrate.

13. The method of transferring a substrate of claim 8, further comprising, prior to delivering the substrate to the second substrate support, delivering the substrate to an alignment hub positioned between the first substrate support and the second substrate support.

14. A substrate processing system comprising:
a transfer region housing defining a transfer region, wherein a sidewall of the transfer region housing defines a sealable access for providing and receiving substrates;
20 a plurality of substrate supports disposed within the transfer region; and
a transfer apparatus comprising:
a central hub including a first shaft and a second shaft extending about and concentric with the first shaft, wherein the second shaft is independently rotatable from the first shaft, and wherein the central hub is vertically translatable along the central axis
25 of the central hub,
a first end effector coupled with the first shaft, the first end effector comprising a plurality of first arms extending radially outward from the central hub to a distal end of each first arm of the plurality of first arms, wherein each first arm is

characterized by an arcuate shape extending along a first arc path to the distal end of each first arm, and

5 a second end effector coupled with the second shaft, the second end effector comprising a plurality of second arms extending radially outward from the central hub to a distal end of each second arm of the plurality of second arms, wherein each second arm is characterized by an arcuate shape extending along a second arc path to the distal end of each second arm, and wherein the second arc path is the first arc path mirrored about a lateral axis extending from the central hub normal to a central axis of the central hub.

10 15. The substrate processing system of claim 14, wherein the first end effector further comprises a plurality of first end pieces, each first end piece coupled with a separate first arm of the plurality of first arms, and wherein the second end effector further comprises a plurality of second end pieces, each second end piece coupled with a separate second arm of the plurality of second arms.

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