CLAIMS

1. A substrate support assembly, comprising:

a substrate support moveable between a raised position, a lowered position below the raised position, and an intermediate position between the raised and lowered positions, the substrate support including a support surface configured to receive a substrate, and a reference surface; and

a lift pin assembly comprising:

a lift plate; and

a plurality of lift pins, each lift pin disposed in a corresponding hole through the substrate support, wherein each lift pin includes:

a first end coupled to a first surface of the lift plate; and

a second end on an opposite end of the lift pin from the first end;

a stop plate positioned below the support surface of the substrate support, the stop plate configured to limit an upward movement of the lift plate; and

a plurality of biasing members coupled to a second surface of the lift plate opposite the first surface of the lift plate;

wherein:

the lift plate is disposed between the plurality of biasing members and the reference surface of the substrate support;

in use, the substrate support assembly transitions between first and second configurations;

in the first configuration, the plurality of biasing members biases the lift plate against the reference surface of the substrate support while the substrate support moves between the lowered position and the intermediate position; and

in the second configuration, the stop plate prevents upward movement of the lift plate while the substrate support moves between the intermediate position and the raised position.

2. The substrate support assembly of claim 1, wherein:

in the first configuration, the lift plate is engaged with the reference surface of the substrate support; and

in the second configuration, the lift plate is not engaged with the reference surface of the substrate support.

3. The substrate support assembly of claim 1, wherein each biasing member is one of a spring, a bellows, or a flexure.

4. The substrate support assembly of claim 1, wherein:

the stop plate is coupled to a base below the lift plate;

the lift plate is moveable to engage the stop plate at a contact point; and

the stop plate includes an adjustment mechanism configured to alter a distance between the base and the contact point.

5. The substrate support assembly of claim 1, wherein the stop plate is coupled to a rod extending from the second surface of the lift plate.

6. The substrate support assembly of claim 5, wherein in the first configuration, the stop plate moves with the lift plate.

7. A substrate support assembly, comprising:

a substrate support moveable between a raised position and a lowered position, and including a support surface configured to receive a substrate, and a reference surface; and

a lift pin assembly comprising:

a lift plate; and

a plurality of lift pins, wherein:

each lift pin of the plurality of lift pins has a first end that is coupled to a first surface of the lift plate and a second end that is on an opposite end of the lift pin from the first end; and

a hole formed through the substrate support is configured to receive a lift pin of the plurality of lift pins;

a stop plate positioned below the support surface of the substrate support, the stop plate configured to limit an upward movement of the lift plate; and

a plurality of biasing members;

wherein:

the lift plate is disposed between the plurality of biasing members and the stop plate;

the plurality of biasing members comprises three or more biasing members; and

the plurality of biasing members is configured to bias the lift plate against the reference surface of the substrate support when the reference surface is positioned below a contact surface of the stop plate, and bias the lift plate against the contact surface of the stop plate when the reference surface is positioned above the contact surface of the stop plate.

8. The substrate support assembly of claim 7, wherein each biasing member is one of a spring, a bellows, or a flexure.

9. The substrate support assembly of claim 7, wherein the second end of each of the plurality of lift pins extends above the support surface of the substrate support when the reference surface of the substrate support is below the contact surface of the stop plate.

10. The substrate support assembly of claim 9, wherein the support surface of the substrate support is positioned above the second end of each of the plurality of lift pins when the reference surface of the substrate support is above the contact surface of the stop plate.

11. The substrate support assembly of claim 10, wherein:

the stop plate includes an adjustment mechanism configured to alter a position of the contact surface of the stop plate.

12. The substrate support assembly of claim 7, wherein the plurality of biasing members is configured to bias the first surface of the lift plate against the contact surface when the reference surface of the substrate support is above the contact surface of the stop plate.

13. The substrate support assembly of claim 7, wherein the plurality of biasing members is configured to bias the first surface of the lift plate against the reference surface of the substrate support when the reference surface is below the contact surface of the stop plate.

14. The substrate support assembly of claim 7, further comprising a sensor positioned on the second end of one of the plurality of lift pins, the sensor including one of a temperature sensor or a strain gauge.

15. A method of manipulating a substrate, comprising:

moving a substrate support upwards from a lowered position to an intermediate position, wherein:

a plurality of lift pins protrudes from a support surface of the substrate support;

the plurality of lift pins is positioned on an upper surface of a lift plate; and

the lift plate and the plurality of lift pins move simultaneously with the substrate support;

contacting the substrate with the plurality of lift pins while the substrate support and the plurality of lift pins move simultaneously;

moving the substrate support upwards from the intermediate position towards a raised position while the plurality of lift pins remains stationary; and

lifting the substrate by the substrate support off the plurality of lift pins while the substrate support moves towards the raised position.

16. The method of claim 15, further comprising using a sensor on at least one lift pin of the plurality of lift pins to detect one of:

a presence of the substrate on the lift pin; or

a temperature of the substrate.

17. The method of claim 15, further comprising moving the substrate support downwards from the raised position towards the intermediate position while the plurality of lift pins remains stationary.

18. The method of claim 17, contacting the substrate with the plurality of lift pins and lifting the substrate off the substrate support by the plurality of lift pins while moving the substrate support downwards towards the intermediate position.

19. The method of claim 18, further comprising moving the substrate support downwards from the intermediate position towards the lowered position, wherein the plurality of lift pins and the substrate support move simultaneously.

20. The method of claim 19, further comprising transferring the substrate from the plurality of lift pins to a carrier while moving the plurality of lift pins simultaneously with the substrate support.