

Claims

1. A direct drive arrangement for controlling pressure volume within a confinement region of a processing chamber of a plasma processing system during substrate processing, wherein said confinement region is a chamber volume surrounded by a set of confinement rings, said direct drive arrangement comprising:

a pressure sensor configured at least for collecting pressure data about said pressure volume within said confinement region during said substrate processing;

a plurality of plunger assemblies within a plunger arrangement, each of the plurality of plunger assemblies coupled to an uppermost ring of the set of confinement rings;

a pair of sensors positioned on the plunger arrangement, the pair of sensors configured at least to establish a maximum distance for each plunger assembly to move vertically, wherein said pair of sensors include a home sensor and a far sensor, wherein a gap between the pair of sensors provides the maximum distance the plunger assembly may travel, and wherein at least one of the sensors of the pair of sensors may be repositioned;

a plurality of motor assemblies disposed on an upper surface of a top plate of the processing chamber, wherein each motor assembly of said plurality of motor assemblies includes: a motor configured to move a plunger assembly of said plurality of plunger assemblies, an encoder configured to record a set point position value for each plunger assembly, and a motor shaft connecting said motor to said plunger assembly;

a plurality of couplers that are each directly connected to a motor assembly and a plunger assembly;

a set of circuits configured at least to drive said plurality of motor assemblies to move said plurality of plunger assemblies to change said pressure volume within said confinement region, provide power to said plurality of motor assemblies to move said plurality of plunger assemblies, receive a plurality of set point position values from said plurality of encoders, and feedback the plurality of set point position values from said plurality of encoders to a control module; wherein the control module is configured to

receive said plurality of set point position values from said set of circuits,

receive said pressure data from said pressure sensor,

calculate a set of new set point position values for said plurality of plunger assemblies, and

send said set of new set point position values as a set of instructions to said set of circuits,
such that the control module is configured to control the plurality of motor assemblies for vertically moving a plurality of couplers that are each directly connected to a motor assembly and a plunger assembly in order to change said pressure volume within said
5 confinement region by vertically moving said set of confinement rings.

2. The direct drive arrangement of claim 1, wherein each plunger assembly of said plurality of plunger assemblies include:

10 a plunger body configured to be disposed on top of an upper-facing surface of a top plate of said processing chamber, and

a nose-end portion configured to be disposed below said upper-facing surface of said top plate.

15 3. The direct drive arrangement of claim 2, wherein said plunger body includes:

a plunger shaft, wherein the control module is configured to control the plunger shaft at least for moving said set of confinement rings,

a coupler configured at least for directly connecting said motor shaft to said plunger shaft,

20 a flag affixed to an upper part of said plunger shaft, wherein said plunger shaft is at a home position when said flag breaks a first optical beam of the home sensor, wherein an alarm is activated when said flag breaks a second optical beam of the far sensor, and

a housing component configured at least for housing said plunger shaft, said
25 coupler, said pair of sensors, and said flag.

4. The direct drive arrangement of claim 3, wherein said nose-end portion includes:

a shaft-end adapter connected to said plunger shaft, wherein said shaft-end
30 adapter includes a ring adapter configured at least for connecting to said set of confinement rings, wherein the control module is configured to control said set of confinement rings to move in a first direction when said plunger shaft moves in said first direction, and

a bushing component configured at least for guiding said plunger shaft as said
35 plunger shaft moves vertically.

5. The direct drive arrangement of claim 4 wherein said set of circuits is a set of three-axis stepper boards.

5 6. The direct drive arrangement of claim 5, wherein said set of circuits includes:
a home position monitoring module configured at least verifying said home position for said plunger shaft of said each plunger assembly,

an encoder monitoring module configured at least for monitoring said plurality of set point position values,

10 a power monitoring module configured at least for monitoring current flowing to said motor of said each motor assembly, and

a second sensor monitoring module configured at least for monitoring said far sensor of said each plunger assembly.

15 7. The direct drive arrangement of claim 6, wherein said set of circuits includes a visual display, wherein said visual display is configured for at least for displaying:

said plurality of set point position values,

a maximum differential between said plurality of set point position values,

power utilization, and

20 alarm notifications.

8. The direct drive arrangement of claim 1, wherein said motor is a two stepper motor.