rotor mounted on the inner cylinder. The magnetic bearing is a radial magnetic bearing including a magnetic bearing stator mounted on the outer cylinder, and a magnetic bearing rotor mounted on the inner cylinder. The magnetic bearing is configured to magnetically levitate the inner cylinder with an attractive force between the magnetic bearing stator and the magnetic bearing rotor. The inner cylinder is positioned movable up and down inside the outer cylinder. The substrate rotation device includes a control unit. The control unit is configured to control a bias current of the magnetic bearing to move the inner cylinder in an up-down direction between a first position and a second position that is a position higher than the first position.

[0005a] Another embodiment provides a substrate rotation device comprising an outer cylinder; an inner cylinder positioned inside the outer cylinder; a motor for rotating the inner cylinder; a magnetic bearing for magnetically levitating the inner cylinder; and a substrate holder disposed on the inner cylinder. The motor is a radial motor includes a motor stator mounted on the outer cylinder and a motor rotor mounted on the inner cylinder. The magnetic bearing is a radial magnetic bearing includes a magnetic bearing stator mounted on the outer cylinder and a magnetic bearing rotor mounted on the inner cylinder. The magnetic bearing is configured to magnetically levitate the inner cylinder with an attractive force between the magnetic bearing stator and the magnetic bearing rotor. A height at which the magnetic bearing stator is positioned is identical to a height at which the motor stator is positioned, and a height at which the magnetic bearing rotor is positioned is identical to a height at which the motor rotor is positioned.

[0005b] There is also disclosed a substrate cleaning device including the substrate rotation device as described above.

[0005c] Another embodiment provides a control method for a substrate rotation device. The substrate rotation device includes an outer cylinder, an inner cylinder positioned inside the outer cylinder, a motor for rotating the inner cylinder, a magnetic bearing for magnetically levitating the inner cylinder, and a substrate holder disposed on the inner pip. The motor is a radial motor including a motor stator mounted on the outer cylinder, and a motor rotor mounted on the inner cylinder. The magnetic bearing is a radial magnetic bearing

including a magnetic bearing stator mounted on the outer cylinder, and a magnetic bearing rotor mounted on the inner cylinder. The method includes magnetically levitating the inner cylinder with an attractive force between the magnetic bearing stator and the magnetic bearing rotor. The inner cylinder is positioned movable up and down inside the outer cylinder. The method comprises controlling a bias current of the magnetic bearing to move the inner cylinder in an up-down direction between a first position and a second position that is a position higher than the first position.

BRIEF DESCRIPTION OF DRAWINGS

[0006] Fig. 1 is a top view schematically illustrating a substrate processing device;

Fig. 2 is a front view schematically illustrating a substrate cleaning device and a view where an inner cylinder is positioned at a cleaning position;

Fig. 3 is a front view schematically illustrating the substrate cleaning device and a view where the inner cylinder is positioned at a conveyance position;

Fig. 4 is a front view schematically illustrating a substrate rotation device including a motor rotor having a length identical to that of a motor stator and a substrate cleaning device including this substrate rotation device and a view where the inner cylinder is positioned at the cleaning position;

Fig. 5 is a front view schematically illustrating the substrate rotation device including the motor rotor having the length identical to that of the motor stator and the substrate cleaning device including this substrate rotation device and a view where the inner cylinder is positioned at the conveyance position;

Fig. 6 is a front view schematically illustrating a substrate rotation device, where a height at which a magnetic bearing stator is positioned is identical to a height at which the motor stator is positioned and a height at which a magnetic bearing rotor is positioned is identical to a height at which the motor rotor is positioned, and a substrate cleaning device including this substrate rotation device; and

Fig. 7 is a cross-sectional view of the substrate rotation device in Fig. 6.

DESCRIPTION OF EMBODIMENTS

[0007] The following describes a substrate rotation device and a device including this substrate rotation device according to an embodiment by referring to the drawings. In the

WHAT IS CLAIMED IS:

1. A substrate rotation device comprising:

an outer cylinder;

an inner cylinder positioned inside the outer cylinder;

a motor for rotating the inner cylinder;

a magnetic bearing for magnetically levitating the inner cylinder; and

a substrate holder disposed on the inner cylinder, wherein

the motor is a radial motor includes:

a motor stator mounted on the outer cylinder; and

a motor rotor mounted on the inner cylinder,

the magnetic bearing is a radial magnetic bearing includes:

a magnetic bearing stator mounted on the outer cylinder; and

a magnetic bearing rotor mounted on the inner cylinder, and

the magnetic bearing is configured to magnetically levitate the inner cylinder with an attractive force between the magnetic bearing stator and the magnetic bearing rotor,

the inner cylinder is positioned movable up and down inside the outer cylinder,

the substrate rotation device includes a control unit, and

the control unit is configured to control a bias current of the magnetic bearing to move the inner cylinder in an up-down direction between:

a first position; and

a second position that is a position higher than the first position.

2. The substrate rotation device according to claim 1, wherein

the motor rotor has a length longer than a length of the motor stator.

3. The substrate rotation device according to claim 2, wherein

the length of the motor rotor and the length of the motor stator have a difference that is larger than a distance between the first position and the second position.

4. The substrate rotation device according to claim 1, wherein

the substrate rotation device is configured such that:

the motor stator is opposed to the motor rotor when the inner cylinder is at the first position; and

the magnetic bearing stator is opposed to the magnetic bearing rotor when the inner cylinder is at the second position.

5. A substrate rotation device comprising:

an outer cylinder;

an inner cylinder positioned inside the outer cylinder;

a motor for rotating the inner cylinder;

a magnetic bearing for magnetically levitating the inner cylinder; and

a substrate holder disposed on the inner cylinder, wherein

the motor is a radial motor includes:

a motor stator mounted on the outer cylinder; and

a motor rotor mounted on the inner cylinder,

the magnetic bearing is a radial magnetic bearing includes:

a magnetic bearing stator mounted on the outer cylinder; and

a magnetic bearing rotor mounted on the inner cylinder, and

the magnetic bearing is configured to magnetically levitate the inner cylinder with an attractive force between the magnetic bearing stator and the magnetic bearing rotor,

a height at which the magnetic bearing stator is positioned is identical to a height at which the motor stator is positioned, and a height at which the magnetic bearing rotor is positioned is identical to a height at which the motor rotor is positioned.

6. The substrate rotation device according to claim 1, wherein

the magnetic bearing includes an axial sensor, and

the control unit performs a feedback control on the magnetic bearing based on a signal from the axial sensor.

7. A substrate cleaning device comprising:

the substrate rotation device according to claim 1; and

a cleaning arm for cleaning a substrate held by the substrate holder of the substrate rotation device.

8. A substrate cleaning device comprising:

the substrate rotation device according to claim 1;

a cleaning arm for cleaning a substrate held by the substrate holder of the substrate rotation device; and

a splash guard for receiving a liquid scattered from a substrate, wherein

the substrate cleaning device is configured such that:

the substrate holder is positioned at a height identical to an upper end of the splash guard or lower than the upper end of the splash guard when the inner cylinder is at the first position; and

the substrate holder is positioned higher than the upper end of the splash guard when the inner cylinder is at the second position.

9. A substrate processing device comprising:

a substrate polishing unit for polishing a substrate; and

a substrate cleaning unit for cleaning a substrate polished at the substrate polishing unit, wherein

the substrate cleaning unit includes:

the substrate cleaning device according to claim 7; and

a cleaning-unit conveyance robot for receiving a substrate from the substrate holder of the substrate cleaning device and delivers a substrate to the substrate holder.

10. A control method for a substrate rotation device, wherein

the substrate rotation device includes:

an outer cylinder;

an inner cylinder positioned inside the outer cylinder;

a motor for rotating the inner cylinder;

a magnetic bearing for magnetically levitating the inner cylinder; and

a substrate holder disposed on the inner cylinder, wherein

the motor is a radial motor includes:

a motor stator mounted on the outer cylinder; and

a motor rotor mounted on the inner cylinder, and

the magnetic bearing is a radial magnetic bearing includes:

a magnetic bearing stator mounted on the outer cylinder; and

a magnetic bearing rotor mounted on the inner cylinder, and wherein

the method comprises magnetically levitating the inner cylinder with an attractive force between the magnetic bearing stator and the magnetic bearing rotor,

the inner cylinder is positioned movable up and down inside the outer cylinder, and

the method comprises controlling a bias current of the magnetic bearing to move the inner cylinder in an up-down direction between:

a first position; and

a second position that is a position higher than the first position.