

difference between the start time point of the second period and the start time point of the output of the second gas from the gas supply system needs to be decided. Further, it is also required to decide a time difference between the end time point of the second period and the end time point of the output of the second gas from the gas supply system. Moreover, these
5 time differences need to be automatically decided according to a recipe.

SUMMARY

[0008a] According to an aspect of the present invention, there is provided a plasma processing method performed by a plasma processing apparatus,
wherein the plasma processing apparatus comprises:
10 a processing vessel;
a gas supply system configured to supply a gas into the processing vessel;
an electrode disposed within the processing vessel;
a high frequency power supply configured to output a high frequency power; and;
a controller configured to control the gas supply system and the high frequency power
15 supply,
wherein, the plasma processing method comprises a first stage of generating plasma of a first processing gas within the processing vessel and a second stage of generating plasma of a second processing gas within the processing vessel after the first stage,
the first processing gas is supplied into the processing vessel and the first high frequency
20 power is supplied to the electrode over a first period during which the first stage is performed and a second period during which the second stage is performed after the first period,
a power level of the high frequency power in the first period is set to be lower than a power level of the high frequency power in the second period, and
wherein the plasma processing method further comprises:
25 starting an output of the second processing gas from the gas supply system at an output start time point which precedes a start time point of the second period by a first time difference under the control of the controller,

wherein the controller specifies, by using a function or a table which relates a flow rate of the first processing gas and a flow rate of the second processing gas to a delay time from a time point when the gas supply system starts the output of the second processing gas to a time point when the second processing gas is supplied into the processing vessel, a first delay time
5 related to the flow rate of the first processing gas and the flow rate of the second processing gas in the second stage designated in a recipe, and sets the first delay time as the first time difference initially.

[0009] There is provided a plasma processing method performed by a plasma processing apparatus. The plasma processing apparatus includes a processing vessel, a gas
10 supply system, a first electrode, a second electrode, a first high frequency power supply, a second high frequency power supply and a controller. The gas supply system is configured to supply a gas into the processing vessel. The first electrode and the second electrode are arranged with a space within the processing vessel therebetween. The first high frequency power supply is configured to output a first high frequency power for plasma generation which is
15 supplied to either one of the first electrode and the second electrode. The second high frequency power supply is configured to supply a second high frequency power for ion attraction which is supplied to the second electrode. The controller is configured to control the gas supply system, the first high frequency power supply and the second high frequency power supply.

[0010] In the plasma processing method, multiple cycles, each of which includes a first
20 stage and a second stage, are performed. In the first stage, plasma of a first processing gas containing a first gas is generated within the processing vessel. In the second stage which follows the first stage, plasma of a second processing gas containing the first gas and a second gas added to the first gas is generated within the processing vessel. In each cycle, the first gas is

WE CLAIM

1. A plasma processing method performed by a plasma processing apparatus,
wherein the plasma processing apparatus comprises:
a processing vessel;
5 a gas supply system configured to supply a gas into the processing vessel;
an electrode disposed within the processing vessel;
a high frequency power supply configured to output a high frequency power; and;

a controller configured to control the gas supply system and the high frequency power
10 supply,

wherein, the plasma processing method comprises a first stage of generating plasma of a
first processing gas within the processing vessel and a second stage of generating plasma of a
second processing gas within the processing vessel after the first stage,

the first processing gas is supplied into the processing vessel and the first high frequency
15 power is supplied to the electrode over a first period during which the first stage is performed
and a second period during which the second stage is performed after the first period,

a power level of the high frequency power in the first period is set to be lower than a power level of the high frequency power in the second period, and

wherein the plasma processing method further comprises:

starting an output of the second processing gas from the gas supply system at an output

5 start time point which precedes a start time point of the second period by a first time difference under the control of the controller,

wherein the controller specifies, by using a function or a table which relates a flow rate of the first processing gas and a flow rate of the second processing gas to a delay time from a time point when the gas supply system starts the output of the second processing gas to a time
10 point when the second processing gas is supplied into the processing vessel, a first delay time related to the flow rate of the first processing gas and the flow rate of the second processing gas in the second stage designated in a recipe, and sets the first delay time as the first time difference initially.

2. The plasma processing method of Claim 1,

wherein the plasma processing apparatus further comprises:

a power feed line configured to connect the first electrode to the high frequency power supply;

5 a matching device configured to adjust a load impedance of the high frequency power supply; and

an operation unit configured to calculate a parameter which includes at least one of the load impedance, a load resistance and a load reactance of the high frequency power supply and a reflection wave coefficient of the high frequency power,

10 wherein if the parameter exceeding a first threshold value is obtained by the operation unit during a time period between the output start time point immediately before the second period and the start time point of the second period, the controller decreases the first time difference by a time difference between a time point when the parameter exceeding the first threshold value is obtained and the start time point of the second period.

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3. The plasma processing method of Claim 2,

wherein if the parameter exceeding the first threshold value is not obtained by the operation unit during the time period between the output start time point immediately before

the second period and the start time point of the second period, the controller increases the first time difference by a preset time length.

4. The plasma processing method of Claim 1,
5 wherein the plasma processing method further comprises:
stopping the output of the second gas from the gas supply system at an output stop time point, within the second period, which precedes an end time point of the second period by a second time difference under the control of the controller,
wherein the controller specifies, by using a function or a table which relates the flow rate
10 of the first processing gas to a delay time from a time point when the gas supply system stops the output of the second processing gas to a time point when the supply of the second processing gas into the processing vessel is ended, a second delay time related to the flow rate of the first processing gas in the second stage designated in the recipe, and sets the second delay time as the second time difference initially.

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5. The plasma processing method of Claim 4,
wherein the plasma processing apparatus further comprises:
a power feed line configured to connect the first electrode to the high frequency power supply;
20 a matching device configured to adjust a load impedance of the high frequency power supply; and
an operation unit configured to calculate a parameter which includes at least one of the load impedance, a load resistance and a load reactance of the high frequency power supply and a reflection wave coefficient of the high frequency power,

wherein if the parameter exceeding a first threshold value is obtained by the operation unit during a time period between the output start time point immediately before the second period and the start time point of the second period, the controller decreases the first time difference by a time difference between a time point when the parameter exceeding the first
5 threshold value is obtained and the start time point of the second period.

6. The plasma processing method of Claim 5,
wherein if the parameter exceeding a second threshold value is obtained by the operation unit during a time period between the output stop time point of the second period
10 and the end time point of the second period, the controller decreases the second time difference by a time difference between a time point when the parameter exceeding the second threshold value is obtained and the end time point of the second period.

7. The plasma processing method of Claim 6,
15 wherein if the parameter exceeding the second threshold value is not obtained by the operation unit during the time period between the output stop time point of the second period and the end time point of the second period, the controller increases the second time difference by a preset time length.

20 8. The plasma processing method of Claim 1,
wherein, in the plasma processing method, a plurality of cycles, each of which includes the first stage and the second stage are performed.