[0007]

According to one aspect of the technique of the present disclosure, there is provided a substrate processing apparatus including: a process chamber in which a substrate is processed; a pressure sensor that detects a pressure in the process chamber within a range from a near-atmospheric pressure level to a predetermined vacuum level; a first pipe configured to discharge a gas from the process chamber; a first exhaust line comprising a first opening degree adjustment valve; a second pipe connected to the first exhaust line; a second exhaust line comprising a second opening degree adjustment valve; and a control unit configured to be capable of adjusting an opening degree of the first opening degree adjustment valve or the second opening degree adjustment valve to bring the process chamber to a processing pressure, wherein the control unit adjusts the opening degree of the second opening degree adjustment valve to bring the pressure in the process chamber to the processing pressure when the processing pressure is higher than the predetermined vacuum level, and the control unit adjusts the opening degree of the first opening degree adjustment valve to bring the pressure in the process chamber to the processing pressure when the processing pressure is lower than the predetermined vacuum level.

[Advantageous Effects]

[0008]

According to some embodiments in the present disclosure, it is possible to adjust the inner pressure of the process chamber into a high vacuum state in a short time without diffusing

[CLAIMS]

[Claim 1]

A substrate processing apparatus comprising:

a process chamber in which a substrate is processed;

a pressure sensor that detects a pressure in the process chamber within a range from a near-atmospheric pressure level to a predetermined vacuum level;

a first pipe configured to discharge a gas from the process chamber;

a first exhaust line comprising a first opening degree adjustment valve;

a second pipe connected to the first exhaust line;

a second exhaust line comprising a second opening degree adjustment valve; and

a control unit configured to be capable of adjusting an opening degree of the first opening degree adjustment valve or the second opening degree adjustment valve to bring the process chamber to a processing pressure,

wherein the control unit adjusts the opening degree of the second opening degree adjustment valve to bring the pressure in the process chamber to the processing pressure when the processing pressure is higher than the predetermined vacuum level, and

the control unit adjusts the opening degree of the first opening degree adjustment valve to bring the pressure in the process chamber to the processing pressure when the processing pressure is lower than the predetermined vacuum level.

[Claim 2]

The substrate processing apparatus of claim 1, wherein the control unit is configured to be capable of depressurizing the process chamber through the second exhaust line until the pressure in the process chamber reaches a first pressure between the near-atmospheric pressure level and the predetermined vacuum level by adjusting the opening degree of the second opening degree adjustment valve based on information from the pressure sensor.

[Claim 3]

The substrate processing apparatus of claim 2, wherein the control unit is configured to be capable of depressurizing the process chamber through the first exhaust line until the pressure in the process chamber reaches a second pressure lower than the first pressure by closing the second opening degree adjustment valve and operating the first opening degree adjustment valve when the first pressure is reached.

[Claim 4]

The substrate processing apparatus of claim 1, further comprising:

a second vacuum sensor configured to be capable of performing a pressure detection when a second pressure is reached,

wherein the control unit is configured to adjust the pressure in the process chamber from the second pressure to the processing pressure based on information from the second vacuum sensor.

[Claim 5]

The substrate processing apparatus of claim 2, wherein the control unit is configured to close the first opening degree adjustment valve until the first pressure is reached.

[Claim 6]

The substrate processing apparatus of claim 5, wherein the control unit is configured to maintain the opening degree of the first opening degree adjustment valve at 0 %.

[Claim 7]

The substrate processing apparatus of claim 3, wherein the control unit is configured to maintain the opening degree of the first opening degree adjustment valve at 100 %.

[Claim 8]

The substrate processing apparatus of claim 1, wherein a diameter of the second pipe is less than that of the first pipe.

[Claim 9]

The substrate processing apparatus of claim 8, wherein a ratio of a diameter of the first pipe to a diameter of the second pipe is 1.0 : 0.2 or more and 1.0 : 0.8 or less.

[Claim 10]

The substrate processing apparatus of claim 9, wherein a diameter of the second pipe is 80 mm or more and 100 mm or less.

[Claim 11]

The substrate processing apparatus of claim 1, wherein the control unit is configured to be capable of adjusting the pressure in the process chamber to reach a predetermined high-vacuum pressure lower than the second pressure by opening the first opening degree adjustment valve.

[Claim 12]

The substrate processing apparatus of claim 11, wherein the processing pressure is higher than the predetermined vacuum pressure.

[Claim 13]

The substrate processing apparatus of claim 11, wherein the predetermined vacuum pressure is an ultimate vacuum pressure.

[Claim 14]

The substrate processing apparatus of claim 1, wherein the control unit is configured to be capable of performing a slow exhaust from an atmospheric pressure for a number of seconds.

[Claim 15]

The substrate processing apparatus of claim 1, wherein the control unit is configured to be capable of allowing a supply of a purge gas during a transition between the near-atmospheric pressure level to the predetermined vacuum level.

[Claim 16]

A method of manufacturing a semiconductor device, comprising:

(a) preparing a substrate processing apparatus comprising: a process chamber in which a substrate is processed; a pressure sensor that detects a pressure in the process chamber within a range from a near-atmospheric pressure level to a predetermined vacuum level; a first pipe configured to discharge a gas from the process chamber; a first exhaust line comprising a first opening degree adjustment valve; a second pipe connected to the first exhaust line; a second exhaust line comprising a second opening degree adjustment valve; and a control unit configured to be capable of adjusting an opening degree of the first opening degree adjustment valve or the second opening degree adjustment valve to bring the process chamber to a processing pressure;

(b) adjusting the opening degree of the second opening degree adjustment valve to bring the pressure in the process chamber to the processing pressure when the processing pressure is higher than the predetermined vacuum level; and

(c) adjusting the opening degree of the first opening degree adjustment valve to bring the pressure in the process chamber to the processing pressure when the processing pressure is lower than the predetermined vacuum level.

[Claim 17]

A program that causes, by a computer, a substrate processing apparatus, which comprises a process chamber in which a substrate is processed; a pressure sensor that detects a pressure in the process chamber within a range from a near-atmospheric pressure level to a predetermined vacuum level; a first pipe configured to discharge a gas from the process chamber; a first exhaust line comprising a first opening degree adjustment valve; a second pipe connected to the first exhaust line; a second exhaust line comprising a second opening degree adjustment valve; and a control unit configured to be capable of adjusting an opening degree of the first opening degree adjustment valve or the second opening degree adjustment valve to bring the process chamber to a processing pressure, to perform:

(b) adjusting the opening degree of the second opening degree adjustment valve to bring the pressure in the process chamber to the processing pressure when the processing pressure is higher than the predetermined vacuum level; and

(c) adjusting the opening degree of the first opening degree adjustment valve to bring the pressure in the process chamber to the processing pressure when the processing pressure is lower than the predetermined vacuum level.