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SPECIFICATION

(54) [NAME OF INVENTION]

Dry Etching Apparatus

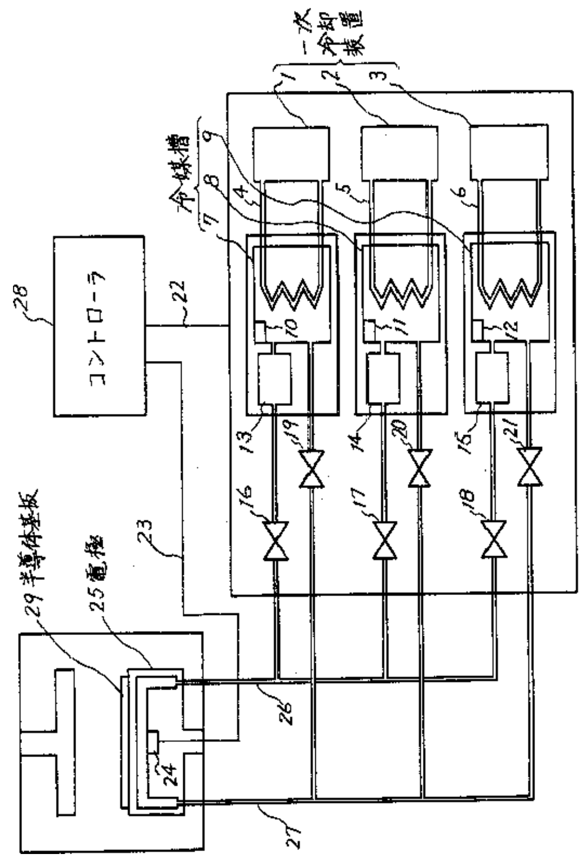
(57) [ABSTRACT]

[OBJECT]

To improve the responsiveness of temperature control of a semiconductor substrate during dry etching.

[STRUCTURE]

Temperature control is carried out individually for a plurality of coolant tanks 7, 8, and 9 for supplying coolant to an electrode 25 on which a semiconductor substrate 29 is placed.



29: Semiconductor Substrate

25: Electrode

28: Controller

7: Coolant Tank

1: Single-Stage Cooling Device

[PATENT CLAIMS]
[CLAIM 1]
A dry etching apparatus for forming, into a plasma, a process gas, introduced into a vacuum process chamber, through application of high-frequency electric power, to etch an etched material on a semiconductor substrate through the use of the plasma, comprising:
a plurality of coolant tanks for supplying coolant to an electrode onto which the semiconductor substrate is placed; and
a temperature controlling device for controlling the temperatures of the individual coolant tanks individually.
[DETAILED EXPLANATION OF THE INVENTION]
[0001]
[FIELD OF APPLICATION IN INDUSTRY]
The present invention relates to a semiconductor controlling device, and, in particular, relates to a temperature controlling system for controlling the temperature of an electrode on which a semiconductor substrate is placed in a dry etching apparatus.
[0002]
[PRIOR ART]
FIG. 3 is a diagram illustrating a temperature controlling system for a conventional dry etching apparatus. As illustrated in FIG. 3, in the single-stage cooling device 1, the temperature of a coolant within a coolant tank 7 is controlled through a pipe 4 by a coolant within a single-stage cooling device 1 in accordance with a setting that is sent from a controller 28 through a signal cable 22.
[0003]
The coolant tank 7 has a temperature monitor 24, where a monitoring temperature is outputted to the controller 28 through a signal cable 23. The coolant within the coolant tank 7 is fed to an electrode 25 by a pump 13 through a pipe 26 and a valve 16, and the temperature is changed so that the monitoring temperature that is outputted to the controller 28 through the signal cable 23 from the temperature monitor 24 will match the temperature setting of the controller 28, and the coolant is returned through a pipe 27 and a valve 19 to the coolant tank 7.
[0004]
In this way, in a conventional temperature controlling system of this type for a dry etching apparatus, there is only a single coolant tank 7, and thus the temperature control of the electrode 25 on which the semiconductor substrate 29 is placed is dependent on temperature control of a single-stage cooling device 1.
[0005]
[PROBLEM SOLVED BY THE PRESENT INVENTION]
In the conventional apparatus, with the temperature controlling system of the single-stage cooling device 1, maintaining a constant temperature is no problem, but responsiveness when changing the temperature is poor, where normally it takes about 10 minutes to go from room temperature to 0°C, and between about 20 and 30 minutes to go from 0°C to -20°C.
[0006]
In a single-wafer dry etching device, the processing time for an individual semiconductor substrate is between about 1 and 5 minutes, and in stepped-etching wherein, for a given semiconductor substrate, etching is performed continuously under differing processing conditions, the time for each individual etching step is even shorter. Because of this, when changing the temperature of the electrode 25 with each individual etching step, the responsiveness when changing temperatures of the single-stage cooling device 1 is poor, and thus this has not been reduced to practice.
[0007]
The object of the present invention is to provide a dry etching apparatus able to provide adequate responsiveness in temperature control of the electrode.
[0008]
[MEANS FOR SOLVING THE PROBLEM]
In order to achieve this object, the dry etching apparatus according to the present invention is a dry etching apparatus for forming, into a plasma, a process gas, introduced into a vacuum process chamber, through application of high-frequency electric power, to etch an etched material on a semiconductor substrate through the use of the plasma, comprising: a plurality of coolant tanks for supplying coolant to an electrode onto which the semiconductor substrate is placed; and a temperature controlling device for controlling the temperatures of the individual coolant tanks individually.
[0009]
[OPERATION]
A plurality of coolant tanks for supplying coolant to the electrode is provided, where the temperature of each individual coolant tank is controlled individually, to improve the responsiveness of temperature control of the electrode, to thereby change the substrate temperature efficiently.
[0010]
[EMBODIMENT]
An embodiment according to the present invention will be explained below using the drawings. FIG. 1 is a structural diagram illustrating one embodiment of the present invention.
[0011]
In FIG. 1, in the present embodiment there is a plurality of coolant tanks 7, 8, and 9 for supplying

coolant to an electrode 25 on which a semiconductor substrate 29 is placed, where the temperatures of the individual coolant tanks 7, 8, and 9 are controlled individually using a plurality of single-stage cooling devices 1, 2, and 3.

[0012]

In the single-stage cooling device 1, the temperature of a coolant in a coolant tank 7 is controlled, through a pipe 4, through coolant within the single-stage cooling device 1, in accordance with a setting that is sent from a controller 28 through a signal cable 22. The coolant tank 7 has a temperature monitor 10, and a monitoring temperature is outputted to the controller 28 through a signal cable 22. The coolant within the coolant tank 7 is fed to an electrode 25 by a pump 13 through a pipe 26 and a valve 16, and the temperature is changed so that the monitoring temperature that is outputted to the controller 28 through the signal cable 23 from the temperature monitor 24 will match the temperature setting of the controller 28, and the coolant is returned through a pipe 27 and a valve 19 to the coolant tank 7.

[0013]

For the other coolant tanks 8 and 9 as well, temperature control is carried out in the same way using the single-stage cooling devices 2 and 3. Here, the pipes 5 and 6, the temperature monitors 11 and 12, the pumps 14 and 15, and the valves 17, 18, 20, and 21 work in the same way as those for the coolant tank 7.

[0014]

The coolants within the coolant tanks 7, 8, and 9 have the temperatures thereof controlled through single-stage cooling devices 1, 2, and 3 so as to go to temperatures A, B, and C that are set in the controller 28.

[0015]

When the electrode 25 needs to be at temperature A, valves 16 and 19 are opened, so that the coolant within the coolant tank 7, which is maintained at temperature A, is fed into the electrode 25 by the pump 13. In this case, valves 17, 18, 20, and 21 are closed, so that the coolants within the coolant tanks 8 and 9 are not fed into the electrode 25.

[0016]

When the electrode 25 needs to be at temperature B, the valves 16 and 19 are closed instantaneously. At the same time, valves 17 and 20 are opened, so that the coolant within the coolant tank 8, which is maintained at temperature B, is fed into the electrode 25 by the pump 14. In this case, valves 18 and 21 are closed, so that the coolant within the coolant tank 9 is not fed into the electrode 25. The time required for the electrode 25 to change from temperature A to B is between 2 and 10 seconds.

[0017]

FIG. 2 is a cross-sectional view illustrating an oxide film on a semiconductor substrate etched using the temperature controlling system according to the present invention.

[0018]

In FIG. 1, the coolants of the coolant tanks 7, 8, and 9 are set to, for example, -50°C, -30°C, and 0°C. In a first etching step, the coolant of the coolant tank 7 is fed into the electrode 25, and etching is carried out with the electrode 25 maintained at -50°C.

[0019]

Similarly, in the second etching step etching is carried out at -30°C, and in the third etching step, etching is carried out at 0°C.

[0020]

The result is the ability to control the angle of etching of the Si oxide film 30, relative to the surface of the semiconductor substrate 31, as illustrated in FIG. 2. The etching angles in the first, second, and third etching steps are, respectively, 60°, 80°, and 90°.

[0021]

[EFFECTS OF THE INVENTION]

As described above, in the present invention there is a plurality of coolant tanks for supplying coolant to the electrode on which the semiconductor substrate is placed, and there are temperature controlling devices for controlling the temperatures of the individual coolant tanks individually, enabling excellent temperature control responsiveness in the electrode, making it possible to change the temperature of the semiconductor substrate efficiently, and thus there is the effect of being able to control arbitrarily the etching angle, in respect to the plane of the semiconductor substrate, of the material being etched on the semiconductor substrate in stepped etching wherein etching is carried out continuously on an individual semiconductor substrate under differing processing conditions.

[0022]

This produces a particularly large effect when forming contact holes at positions wherein there are tight tolerances when forming contact holes for ULSI.

[BRIEF DESCRIPTIONS OF THE DRAWINGS]

FIG. 1 is a structural diagram illustrating one embodiment according to the present invention.

FIG. 2 is a cross-sectional view of the material that is etched on a semiconductor substrate etched using the temperature controlling system according to the present invention.

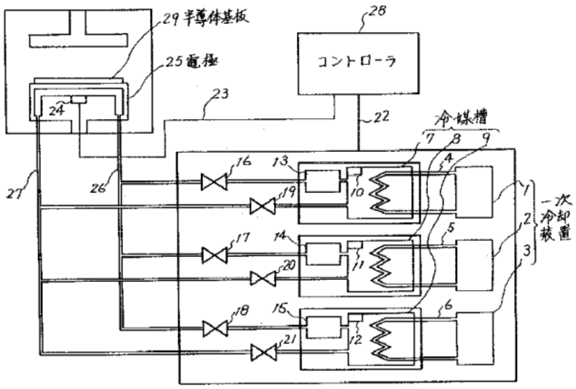
FIG. 3 is a structural diagram of a conventional temperature controlling system.

[EXPLANATIONS OF REFERENCE SYMBOLS]

1, 2, 3: Single-Stage Cooling Devices
4, 5, 6: Pipes
7, 8, 9: Coolant Tanks

10, 11, 12: Temperature Monitors
13, 14, 15: Pumps
16, 17, 18: Valves
19, 20, 21: Valves
22, 23: Signal Cables
24: Temperature Sensor
25: Electrode
26, 27: Pipes
28: Controller
29: Semiconductor Substrate

FIG. 1



29: Semiconductor Substrate
25: Electrode
28: Controller
7: Coolant Tank
1: Single-Stage Cooling Device

FIG. 2

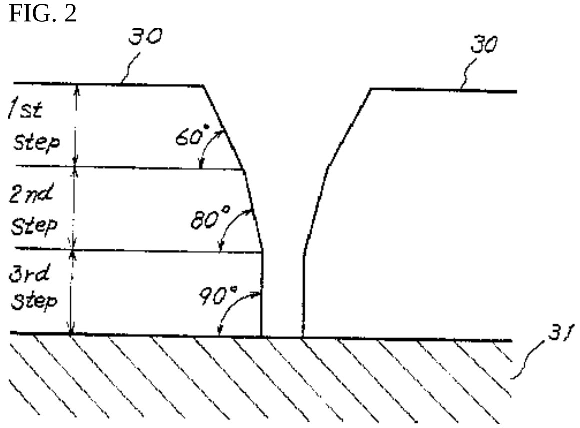
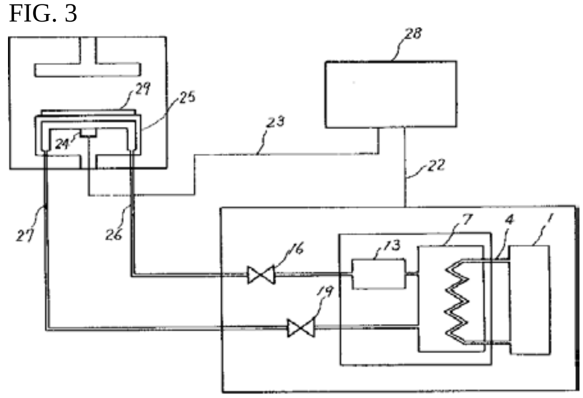


FIG. 3



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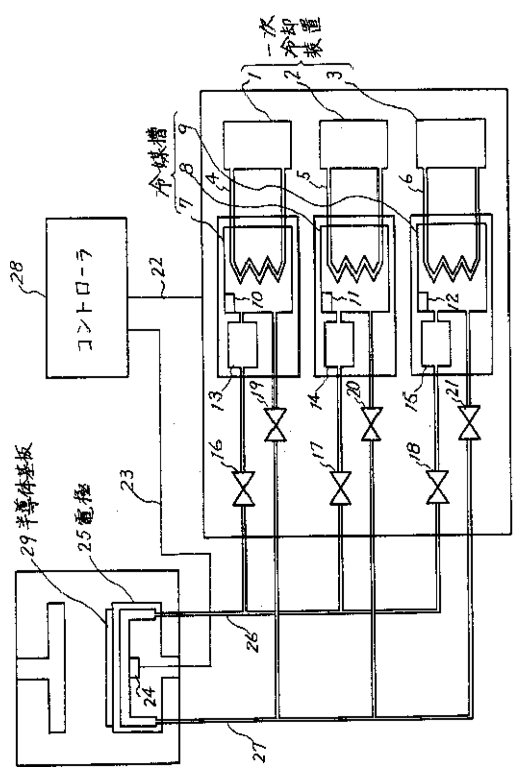
(54)【発明の名称】ドライエッチング装置

(57)【要約】

【目的】　ドライエッチングにおける半導体基板の温度制御の応答性を向上する。

【構成】　半導体基板２９を設置する電極２５への冷媒供給を行う複数の冷媒槽７，８，９の温度制御を個別に行なう。



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