

WHAT IS CLAIMED IS:

1. An etching method comprising:

placing a substrate on a substrate support provided in a chamber of a plasma processing apparatus, the substrate having a film and a mask provided on the film; and

etching the film of the substrate placed on the substrate support, said etching the film including

(a) generating plasma of a processing gas in the chamber, and

(b) etching the film by supplying ions from the plasma to the substrate by periodically applying a pulse of a voltage to a lower electrode in the substrate support without changing a frequency of application of the pulse of the voltage to the lower electrode,

wherein in said (b), a level of a voltage of the pulse is changed at least once such that an absolute value of a negative potential of the substrate has a tendency to increase according to progress of etching of the film.

2. An etching method comprising:

placing a substrate on a substrate support provided in a chamber of a plasma processing apparatus, the substrate having a film and a mask provided on the film; and

etching the film of the substrate placed on the substrate support, said etching the film including

(a) generating plasma of a processing gas in the chamber, and

(b) etching the film by supplying ions from the plasma to the substrate by periodically applying a pulse of a voltage to a lower electrode in the substrate support,

wherein in said (b), a level of a voltage of the pulse is changed at least once such that an absolute value of a negative potential of the substrate has a tendency to increase according to progress of etching of the film, and

wherein in said (b), a duty ratio of the pulse is set to 20% or less.

3. An etching method comprising:

placing a substrate on a substrate support provided in a chamber of a plasma processing apparatus, the substrate having a film and a mask provided on the film; and

etching the film of the substrate placed on the substrate support, said etching the film including

(a) generating plasma of a processing gas in the chamber, and

(b) etching the film by supplying ions from the plasma to the substrate by periodically applying a pulse of a voltage to a lower electrode in the substrate support,

wherein in said (b), a level of a voltage of the pulse is changed at least once such that an absolute value of a negative potential of the substrate has a tendency to increase according to progress of etching of the film, and

wherein in said (b), a duty ratio of the pulse is decreased at

least once to have a tendency to decrease according to the progress of the etching of the film.

4. The etching method according to claim 3, wherein in said (b), a duty ratio of the pulse is set to 20% or less.

5. The etching method according to claim 3 or 4, wherein in said (b), the duty ratio of the pulse is decreased to have a ratio of 15% or more and 20% or less.

6. The etching method according to any one of claims 3 to 5, wherein in said (b), the duty ratio of the pulse is stepwise or gradually reduced.

7. The etching method according to any one of claims 1 to 6, wherein in said (b), the level of the voltage of the pulse is stepwise or gradually changed.

8. The etching method according to claim 1, wherein the pulse is a pulse of a negative voltage or a pulse of a negative direct-current voltage, and

in said (b), an absolute value of the voltage of the pulse is increased at least once such that the absolute value of the voltage of the pulse has a tendency to increase according to the progress of the etching of the film.

9. The etching method according to any one of claims 1 to 8,
wherein the film includes a silicon-containing film.

10. The etching method according to any one of claims 1 to 8,
5 wherein the film includes a silicon-containing dielectric film.

11. The etching method according to any one of claims 1 to 8,
wherein the film includes a silicon oxide film.

10 12. The etching method according to claim 11, wherein the
film further includes a silicon nitride film.

13. The etching method according to claim 11 or 12, wherein
the mask is formed of polycrystalline silicon,

15

14. A plasma processing apparatus comprising:

a chamber;

a substrate support having a lower electrode and provided in
the chamber;

20 a gas supply configured to supply a processing gas into the
chamber;

a plasma generator configured to generate plasma from a gas in
the chamber;

25 a bias power source electrically connected to the lower
electrode and configured to periodically generate a pulse of a voltage;
and

a controller configured to control the gas supply, the plasma generator, and the bias power source,

wherein the controller is configured to

(a) control the gas supply and the plasma generator to generate plasma of the processing gas in the chamber, and

(b) control the bias power source to periodically apply the pulse to the lower electrode to supply ions from the plasma to a substrate on the substrate support without changing a frequency of application of the pulse of the voltage to the lower electrode, thereby etching a film of the substrate, and

wherein the controller is configured to in said (b), control the bias power source to change a level of a voltage of the pulse at least once such that an absolute value of a negative potential of the substrate has a tendency to increase according to progress of etching of the film.

15. The plasma processing apparatus according to claim 14, wherein the bias power source is configured to generate, as the pulse, a pulse of a negative voltage or a pulse of a negative direct-current voltage.