

CLAIMS

1. A plasma etching method comprising:
a physisorption step for causing an adsorbate that is
5 based on first processing gas to be physisorbed onto a film
to be etched, while cooling an object to be processed on
which the film to be etched is provided to a temperature
equal to or lower than a dew point of the first processing
gas; and
10 an etching step for etching the film to be etched, by
causing the adsorbate to react with the film to be etched,
using plasma of second processing gas.
2. A plasma etching method comprising:
15 a physisorption step for causing a passivation film
that is based on first processing gas to be physisorbed
onto a film to be etched, as an adsorbate, while cooling an
object to be processed on which the film to be etched is
provided to a temperature equal to or lower than a
20 sublimation point of the first processing gas; and
an etching step for etching the film to be etched, by
causing the adsorbate to react with the film to be etched,
using plasma of second processing gas.
- 25 3. A plasma etching method comprising:
a physisorption step for causing an adsorbate that is
based on first processing gas to be physisorbed onto a film
to be etched, while cooling an object to be processed on
which the film to be etched is provided;
30 an adjustment step for adjusting a thickness of the
adsorbate, by evaporating or subliming a part of the
adsorbate having been physisorbed onto the film to be

etched; and

an etching step for etching the film to be etched, by causing the adsorbate to react with the film to be etched, using plasma of second processing gas.

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4. A plasma etching method comprising:

a physisorption step for causing an adsorbate that is based on first processing gas to be physisorbed onto a film to be etched so that the film to be etched has no chemical reactivity with the first processing gas, while cooling an
10 object to be processed on which the film to be etched is provided; and

an etching step for etching the film to be etched, by causing the adsorbate to react with the film to be etched,
15 using plasma of second processing gas.

5. The plasma etching method according to any one of claims 1 to 4, wherein the physisorption step and the etching step are repeated alternately a plurality of
20 times.

6. The plasma etching method according to any one of claims 1 to 5,
wherein

25 the film to be etched is a silicon oxide film, and the first processing gas includes CF gas.

7. The plasma etching method according to claim 6, wherein the CF gas is C₄F₈ or C₅F₈.

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8. The plasma etching method according to any one of claims 1 to 5, wherein the film to be etched is a silicon oxide film, and

the first processing gas includes gas including
5 halogen and oxygen.

9. The plasma etching method according to claim 8, wherein the gas including halogen and oxygen is SiF_4/O_2 or $\text{Si}_2\text{F}_6/\text{O}_2$.

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10. The plasma etching method according to any one of claims 1 to 9, wherein the second processing gas includes noble gas.

15 11. A plasma etching apparatus comprising:

a chamber in which a plasma etching process is performed to an object to be processed;

an exhaust unit that reduces pressure in the chamber;

a gas supplying unit that supplies processing gas into
20 the chamber; and

a control unit that executes a physisorption step for causing an adsorbate that is based on first processing gas to be physisorbed onto a film to be etched, while cooling an object to be processed on which the film to be etched is
25 provided to a temperature equal to or lower than a dew point of the first processing gas, and an etching step for etching the film to be etched, by causing the adsorbate to react with the film to be etched, using plasma of second processing gas.

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12. A plasma etching apparatus comprising:

a chamber in which a plasma etching process is

performed to an object to be processed;

an exhaust unit that reduces pressure in the chamber;

a gas supplying unit that supplies processing gas into the chamber; and

5 a control unit that executes a physisorption step for causing a passivation film that is based on first processing gas to be physisorbed onto a film to be etched, as an adsorbate, while cooling an object to be processed on which the film to be etched is provided to a temperature
10 equal to or lower than a sublimation point of the first processing gas, and an etching step for etching the film to be etched, by causing the adsorbate to react with the film to be etched, using plasma of second processing gas.

15 13. A plasma etching apparatus comprising:

a chamber in which a plasma etching process is performed to an object to be processed;

an exhaust unit that reduces pressure in the chamber;

a gas supplying unit that supplies processing gas into
20 the chamber; and

a control unit that executes a physisorption step for causing an adsorbate that is based on first processing gas to be physisorbed onto a film to be etched, while cooling an object to be processed on which the film to be etched is
25 provided, an adjustment step for adjusting a thickness of the adsorbate, by evaporating or subliming a part of the adsorbate having been physisorbed onto the film to be etched, and an etching step for etching the film to be etched, by causing the adsorbate to react with the film to
30 be etched, using plasma of second processing gas.

14. A plasma etching apparatus comprising:

a chamber in which a plasma etching process is performed to an object to be processed;

an exhaust unit that reduces pressure in the chamber;

a gas supplying unit that supplies processing gas into
5 the chamber; and

a control unit that executes a physisorption step for causing an adsorbate that is based on first processing gas to be physisorbed onto a film to be etched so that the film to be etched has no chemical reactivity with the first
10 processing gas, while cooling an object to be processed on which the film to be etched is provided, and an etching step for etching the film to be etched, by causing the adsorbate to react with the film to be etched, using plasma of second processing gas.

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