

WHAT IS CLAIMED IS:

1. A method of manufacturing a semiconductor device, comprising:
etching back a second metal film by supplying an oxygen-containing gas and a fluorine-containing etching gas to a substrate having a surface at which a first metal film is formed at an opening part in which the second metal film is embedded; and
removing the oxygen-containing gas and the fluorine-containing etching gas,
wherein in the act of etching back, the oxygen-containing gas is continuously supplied to the substrate, and the fluorine-containing etching gas is intermittently supplied to the substrate a plurality of times.
2. A method of manufacturing a semiconductor device, comprising:
etching back a second metal film by supplying an oxygen-containing gas and a fluorine-containing etching gas to a substrate having a surface at which a first metal film is formed at an opening part in which the second metal film is embedded; and
removing the oxygen-containing gas and the fluorine-containing etching gas,
wherein the act of etching back sequentially performs:
supplying the oxygen-containing gas to the substrate;
simultaneously supplying the oxygen-containing gas and the fluorine-containing etching gas to the substrate; and
supplying the oxygen-containing gas to the substrate.
3. The method of Claim 1, wherein the act of etching back sequentially performs:
simultaneously supplying the oxygen-containing gas and the fluorine-containing etching gas to the substrate; and
supplying the oxygen-containing gas to the substrate.
4. A method of manufacturing a semiconductor device, comprising:
etching back a second metal film by supplying an oxygen-containing gas and a

fluorine-containing etching gas to a substrate having a surface at which a first metal film is formed at an opening part in which the second metal film is embedded; and

removing the oxygen-containing gas and the fluorine-containing etching gas,
wherein the act of etching back sequentially and repeatedly performs, a plurality of times:

supplying the oxygen-containing gas to the substrate;

removing the oxygen-containing gas;

supplying the fluorine-containing etching gas to the substrate; and

removing the fluorine-containing etching gas.

5. The method of Claim 1, wherein the act of etching back sequentially performs:
supplying the oxygen-containing gas to the substrate; and
simultaneously supplying the oxygen-containing gas and the fluorine-containing etching gas to the substrate.

6. A method of manufacturing a semiconductor device, comprising:
etching back a second metal film by supplying an oxygen-containing gas and a fluorine-containing etching gas to a substrate having a surface at which a first metal film is formed at an opening part in which the second metal film is embedded; and
removing the oxygen-containing gas and the fluorine-containing etching gas,
wherein the act of etching back sequentially and repeatedly performs, a plurality of times:

supplying the oxygen-containing gas to the substrate;

simultaneously supplying the oxygen-containing gas and the fluorine-containing etching gas to the substrate; and

removing the oxygen-containing gas and the fluorine-containing etching gas.

7. The method of any one of Claims 1 to 6, wherein the substrate is a silicon substrate, and in the act of etching back, the silicon substrate is oxidized to form a silicon oxide film at

a back surface of the substrate at which the first metal film and the second metal film are not formed.

8. The method of any one of Claims 1 to 7, wherein the first metal film is a titanium nitride film, and the second metal film is a tungsten film.

9. The method of any one of Claims 1 to 8, wherein the oxygen-containing gas is an oxygen gas, and the fluorine-containing etching gas is a nitrogen trifluoride gas.

10. A substrate processing apparatus, comprising:
a process chamber configured to accommodate a substrate;
a gas supply system configured to supply an oxygen-containing gas and a fluorine-containing etching gas to the process chamber;
an exhaust system configured to exhaust the process chamber; and
a controller configured to control the gas supply system and the exhaust system so as to perform:

etching back a second metal film by supplying the oxygen-containing gas and the fluorine-containing etching gas to the process chamber that accommodates the substrate having a surface at which a first metal film is formed at an opening part in which the second metal film is embedded; and
removing the oxygen-containing gas and the fluorine-containing etching gas, wherein in the act of etching back, the oxygen-containing gas is continuously supplied to the substrate, and the fluorine-containing etching gas is intermittently supplied to the substrate a plurality of times.

11. A program that causes, by a computer, a substrate processing apparatus to perform a process comprising:

etching back a second metal film by supplying an oxygen-containing gas and a fluorine-containing etching gas to a substrate accommodated in a process chamber of the

substrate processing apparatus, the substrate having a surface at which a first metal film is formed at an opening part in which the second metal film is embedded; and

removing the oxygen-containing gas and the fluorine-containing etching gas,
wherein in the act of etching back, the oxygen-containing gas is continuously supplied to the substrate, and the fluorine-containing etching gas is intermittently supplied to the substrate a plurality of times.

12. A substrate processing apparatus, comprising:

a process chamber configured to accommodate a substrate;
a gas supply system configured to supply an oxygen-containing gas and a fluorine-containing etching gas to the process chamber;
an exhaust system configured to exhaust the process chamber; and
a controller configured to control the gas supply system and the exhaust system so as to perform:

etching back a second metal film by supplying the oxygen-containing gas and the fluorine-containing etching gas to the process chamber that accommodates the substrate having a surface at which a first metal film is formed at an opening part in which the second metal film is embedded; and

removing the oxygen-containing gas and the fluorine-containing etching gas,
wherein the act of etching back sequentially performs:

supplying the oxygen-containing gas to the substrate;
simultaneously supplying the oxygen-containing gas and the fluorine-containing etching gas to the substrate; and
supplying the oxygen-containing gas to the substrate.

13. A substrate processing apparatus, comprising:

a process chamber configured to accommodate a substrate;
a gas supply system configured to supply an oxygen-containing gas and a fluorine-containing etching gas to the process chamber;

an exhaust system configured to exhaust the process chamber; and
a controller configured to control the gas supply system and the exhaust system so as
to perform:

etching back a second metal film by supplying the oxygen-containing gas
and the fluorine-containing etching gas to the process chamber that accommodates
the substrate having a surface at which a first metal film is formed at an opening part
in which the second metal film is embedded; and

removing the oxygen-containing gas and the fluorine-containing etching gas,
wherein the act of etching back sequentially and repeatedly performs, a
plurality of times:

supplying the oxygen-containing gas to the substrate;
removing the oxygen-containing gas;
supplying the fluorine-containing etching gas to the substrate; and
removing the fluorine-containing etching gas.

14. A substrate processing apparatus, comprising:
a process chamber configured to accommodate a substrate;
a gas supply system configured to supply an oxygen-containing gas and a fluorine-
containing etching gas to the process chamber;
an exhaust system configured to exhaust the process chamber; and
a controller configured to control the gas supply system and the exhaust system so as
to perform:

etching back a second metal film by supplying the oxygen-containing gas
and the fluorine-containing etching gas to the process chamber that accommodates
the substrate having a surface at which a first metal film is formed at an opening part
in which the second metal film is embedded; and

removing the oxygen-containing gas and the fluorine-containing etching gas,
wherein the act of etching back sequentially and repeatedly performs, a
plurality of times:

supplying the oxygen-containing gas to the substrate;
simultaneously supplying the oxygen-containing gas and the
fluorine-containing etching gas to the substrate; and
removing the oxygen-containing gas and the fluorine-containing
etching gas.

15. A program that causes, by a computer, a substrate processing apparatus to perform a process comprising:

etching back a second metal film by supplying an oxygen-containing gas and a
fluorine-containing etching gas to a substrate accommodated in a process chamber of the
substrate processing apparatus, the substrate having a surface at which a first metal film is
formed at an opening part in which the second metal film is embedded; and

removing the oxygen-containing gas and the fluorine-containing etching gas,
wherein the act of etching back sequentially performs:

supplying the oxygen-containing gas to the substrate;
simultaneously supplying the oxygen-containing gas and the fluorine-
containing etching gas to the substrate; and
supplying the oxygen-containing gas to the substrate.

16. A program that causes, by a computer, a substrate processing apparatus to perform a process comprising:

etching back a second metal film by supplying an oxygen-containing gas and a
fluorine-containing etching gas to a substrate accommodated in a process chamber of the
substrate processing apparatus, the substrate having a surface at which a first metal film is
formed at an opening part in which the second metal film is embedded; and

removing the oxygen-containing gas and the fluorine-containing etching gas,
wherein the act of etching back sequentially and repeatedly performs, a plurality of
times:

supplying the oxygen-containing gas to the substrate;

removing the oxygen-containing gas;
supplying the fluorine-containing etching gas to the substrate; and
removing the fluorine-containing etching gas.

17. A program that causes, by a computer, a substrate processing apparatus to perform a process comprising:

etching back a second metal film by supplying an oxygen-containing gas and a fluorine-containing etching gas to a substrate accommodated in a process chamber of the substrate processing apparatus, the substrate having a surface at which a first metal film is formed at an opening part in which the second metal film is embedded; and

removing the oxygen-containing gas and the fluorine-containing etching gas,
wherein the act of etching back sequentially and repeatedly performs, a plurality of times:

supplying the oxygen-containing gas to the substrate;
simultaneously supplying the oxygen-containing gas and the fluorine-containing etching gas to the substrate; and
removing the oxygen-containing gas and the fluorine-containing etching gas.