

WHAT IS CLAIMED IS:

1. An etching method comprising:

(a) forming a protective film on a surface in a chamber;

5 (b) providing substrate on a substrate support in the chamber ,
the substrate having a silicon-containing film and a mask on the
silicon-containing film ; and

(c) etching the silicon-containing film with hydrogen fluoride
within the chamber,

wherein the mask is formed of a metal, and

10 the protective film is formed with a film-forming gas
containing a metal.

2. The etching method according to claim 1, wherein

15 the mask is formed of titanium, titanium nitride, titanium
carbide, titanium oxide, tungsten, tungsten carbide, ruthenium,
ruthenium oxide, molybdenum, or molybdenum carbide.

3. The etching method according to claim 2, wherein

20 the mask is formed with the film-forming gas by a chemical
vapor deposition method, a metalorganic chemical vapor deposition
method, or an atomic layer deposition method.

4. The etching method according to claim 3, wherein

25 the mask is formed of WF_6 , TiCl_4 , $\text{C}_8\text{H}_{24}\text{N}_4\text{Ti}$, RuCl_3 , or
 MoCl_5 .

5. An etching method comprising:

(a) forming a protective film on a surface in a chamber with a film-forming gas containing a metal;

5 (b) providing substrate on a substrate support in the chamber, the substrate having an underlying region, a silicon-containing film that is on the underlying region and in contact with an upper surface of the underlying region, and a mask on the silicon-containing film, the mask being formed of a metal;

10 (c) etching the silicon-containing film with hydrogen fluoride within the chamber to expose an upper surface of the underlying region;

(d) transferring the substrate, which is in a state where the upper surface of the underlying region has been exposed in the (c), out from the chamber; and

15 (e) perform dry cleaning to remove a reaction product deposited on the protective film together with at least a part of the protective film, after the substrate which is in a state where the upper surface of the underlying has been exposed in the (c) is transferred out from the chamber.

20 6. The etching method according to claim 5, wherein

the dry cleaning is performed such that the protective film partially remains in a state where the protective film covers the surface in the chamber, and

after the (e), the (c) is further performed on another substrate.

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7. The etching method according to claim 5, wherein after

said (e), said (a) is further performed, and said (c) is performed on another substrate.

5 8. The etching method according to any one of claims 5 to 7,
wherein
the dry cleaning is performed in a state where a dummy
substrate is placed on the substrate support.

10 9. The etching method according to any one of claims 5 to 7,
wherein
the dry cleaning is performed in a state where a dummy
substrate is not placed on the substrate support.

15 10. The etching method according to any one of claims 5 to 9,
wherein
the dry cleaning is performed with a cleaning gas that contains
NF₃, Cl₂, BCl₃, SiCl₄, O₂, CH₃OH, or C₂H₅OH.

20 11. A plasma processing apparatus comprising:
a chamber;
a substrate support in the chamber;
a gas supply configured to supply a gas into the chamber;
a plasma generator configured to generate plasma from a gas
within the chamber; and
25 a controller configured to control the gas supply and the plasma
generator,

wherein the controller

controls the gas supply to supply a film-forming gas into the chamber to form a protective film on a surface in the chamber, the film-forming gas containing a metal, and

5 controls the gas supply and the plasma generator to generate plasma from an etching gas to etch with hydrogen fluoride a silicon-containing film of a substrate placed on a substrate support, the substrate including the silicon-containing film and the mask on the silicon-containing film, the mask being formed of a metal.

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