CLAIMS

[Claim 1]

An etching method comprising:

(a) providing a substrate on a substrate support in a chamber, the substrate including a first region and a second region, the first region including a first material including at least one selected from the group consisting of silicon oxide and carbon, and the second region including a second material different from the first material, the second material including at least one selected from the group consisting of silicon oxide, silicon nitride, silicon oxynitride, polysilicon, a metal, and carbon;

(b) etching the substrate by first plasma generated from a first process gas without supplying electric bias to the substrate support, the first process gas consisting only of hydrogen fluoride, or consisting only of hydrogen fluoride and at least one inert gas selected from the group consisting of a noble gas and nitrogen gas; and

(c) exposing the substrate to second plasma generated from a second process gas different from the first process gas while supplying the electric bias to the substrate support.

[Claim 2]

The etching method according to Claim 1,

wherein the first region is a region on the second region and has at least one opening.

[Claim 3]

The etching method according to Claim 1 or 2,

wherein, in the (b), a temperature of the substrate support is

10°C to 150°C.

[Claim 4]

The etching method according to Claim 1 or 2, wherein the second region is etched by repeating the (b) and the (c).

[Claim 5]

The etching method according to Claim 1 or 2,

wherein a duration of the (b) is shorter than a duration of the (c).

[Claim 6]

The etching method according to Claim 1 or 2,

wherein a duration of the (b) is 0.1 to 100 seconds.

[Claim 7]

The etching method according to Claim 1 or 2,

wherein a duration of the (c) is 0.1 to 100 seconds.

[Claim 8]

The etching method according to Claim 1 or 2,

wherein in the (b), radio frequency power is not supplied to the substrate support.

[Claim 9]

The etching method according to Claim 1 or 2,

wherein the second process gas includes a fluorocarbon gas.

[Claim 10]

The etching method according to Claim 1 or 2,

wherein the first process gas consisting only of hydrogen fluoride and at least one inert gas selected from the group consisting of a noble gas and nitrogen gas.

[Claim 11]

The etching method according to Claim 1 or 2,

wherein the second material includes at least one selected from the group consisting of silicon nitride, silicon oxynitride, polysilicon, and a metal.

[Claim 12]

The etching method according to Claim 1 or 2,

wherein the second material includes at least one metal selected from the group consisting of tungsten, molybdenum, and titanium.

[Claim 13]

The etching method according to Claim 1,

wherein the substrate further includes an underlying region,

the first region and the second region are regions on the underlying region,

at least a top of each of the first region and the second region is exposed, and

the second region is adjacent to the first region.

[Claim 14]

The etching method according to Claim 13,

wherein the (a) includes

(a1) providing the substrate including the underlying region, an etching target film on the underlying region, and a mask on the etching target film, the etching target film including the second material and the mask including at least one opening,

(a2) forming the second region by etching the etching target film through the at least one opening, and

(a3) forming the first region by depositing the first

material on a side wall of the second region.

[Claim 15]

The etching method according to Claim 13 or 14,

wherein, in the (b), the second region is selectively etched with respect to the first region.

[Claim 16]

An etching method comprising:

(a) providing a substrate on a substrate support in a chamber, the substrate including a first region and a second region, the first region including a first material including at least one selected from the group consisting of silicon oxide and carbon, and the second region including a second material different from the first material, the second material including at least one selected from the group consisting of silicon oxide, silicon nitride, silicon oxynitride, polysilicon, a metal, and carbon;

(b) etching the substrate by first plasma generated from a first process gas without supplying electric bias to the substrate support or while supplying electric bias at a first level to the substrate support, the first process gas consisting only of hydrogen fluoride, or consisting only of hydrogen fluoride and at least one inert gas selected from the group consisting of a noble gas and nitrogen gas; and

(c) exposing the substrate to second plasma generated from a second process gas identical to or different from the first process gas while supplying electric bias at a second level that is higher than the first level to the substrate support.

[Claim 17]

The etching method according to Claim 16,

wherein the first region is a region on the second region and has at least one opening, and

the second region is etched by repeating the (b) and the (c).

[Claim 18]

The etching method according to Claim 16,

wherein the substrate further includes an underlying region,

the first region and the second region are regions on the underlying region,

at least a top of each of the first region and the second region is exposed, and

the second region is adjacent to the first region,

in the (b), the second region is selectively etched with respect to the first region, and

in the (c), the underlying region is etched.

[Claim 19]

A plasma processing apparatus comprising:

a chamber;

a substrate support for supporting a substrate in the chamber, the substrate including a first region and a second region, the first region including a first material including at least one selected from the group consisting of silicon oxide and carbon, and the second region including a second material different from the first material, the second material including at least one selected from the group consisting of silicon oxide, silicon nitride, silicon oxynitride, polysilicon, a metal, and carbon;

a gas supply configured to supply a first process gas and a second process gas different from the first process gas to the chamber, the first process gas consisting only of hydrogen fluoride, or consisting only of hydrogen fluoride and at least one inert gas selected from the group consisting of a noble gas and nitrogen gas;

a plasma generator configured to generate first plasma from the first process gas and to generate second plasma from the second process gas in the chamber; and

a controller configured to control the gas supply and the plasma generator to execute

(b) etching the substrate by the first plasma without supplying electric bias to the substrate support; and

(c) exposing the substrate to second plasma while supplying the electric bias to the substrate support.