Claims:

1. A plasma processing apparatus for generating a plasma of a gas ~~by applying a high frequency power~~ and performing a plasma processing on a target object to be processed by an action of the plasma, comprising:

a depressurizable processing chamber;

a lower electrode, provided in the processing chamber, serving as a mounting table for mounting thereon the target object;

a facing electrode, serving as an upper electrode or an antenna electrode, provided at the processing chamber so as to be opposite to the lower electrode;

a gas supply source for introducing a gas including a halogen-containing gas and an oxygen gas into the processing chamber; and

~~a high frequency power supply for applying a high frequency power for generating plasma to at least one of the upper electrode, the antenna electrode, or the lower electrode~~ a plasma generation unit for generating a plasma of the gas including the halogen-containing gas and the oxygen gas in the processing chamber,

wherein, among inner surfaces of the processing chamber which are exposed to the plasma of the gas including the halogen-containing gas and the oxygen gas, at least a part of or all of the surfaces between a mounting position of the target object and the facing electrode; ~~upper electrode, the antenna electrode,~~ or at least a part of or all of the surfaces of the facing electrode ~~lower electrode~~ are coated with a fluorinated compound,

wherein the fluorinated compound contains YF_3, and

wherein an outermost layer of the fluorinated compound is transformed into a transformed layer containing Y, O and F or containing Y, O, F and at least one of Cl and Br by the plasma of the gas including the halogen-containing gas and the oxygen gas.

~~2. The plasma processing apparatus of claim 1, wherein a material forming the fluorinated compound contains any one of Y, Ce, Eu, Sm, Yb, Dy, Gd, Ca, and Mg.~~

~~3. The plasma processing apparatus of claim 1, wherein the material forming the fluorinated compound contains YF_3.~~

~~4~~2. The plasma processing apparatus of claim ~~3~~1, wherein ~~an outermost layer of the fluorinated compound is transformed into a Y-O-F~~ the transformed layer has ~~having~~ a thickness of 20 nm or less ~~or a layer containing Cl and Br in addition to the Y-O-F layer by the plasma of the gas including the halogen-containing gas and the oxygen gas~~.

~~5~~3. The plasma processing apparatus of claim 1, wherein the fluorinated compound is formed by a thermal spraying, a physical vapor deposition, or a chemical vapor deposition.

~~6. The plasma processing apparatus of claim 1, wherein the material forming the fluorinated compound contains no Y.~~

~~7~~4. The plasma processing apparatus of claim 1, wherein the material of the fluorinated compound contains Al or Si.

~~8~~5. The plasma processing apparatus of claim 1, wherein the fluorinated compound is directly formed on a metal base, or the fluorinated compound is formed on an outermost layer through one or more insulating films.

~~9~~6. The plasma processing apparatus of claim ~~8~~5, wherein the fluorinated compound is directly formed on any one of an Al base, an Y_2O_3 film, or an Al_2O_3 film.

~~10~~7. The plasma processing apparatus of claim 1, wherein the fluorinated compound has a film thickness smaller than 300 μm.

~~11~~8. The plasma processing apparatus of claim 1, wherein the fluorinated compound has a film thickness smaller than 200 μm.

~~12~~9. The plasma processing apparatus of claim 1, wherein an outermost layer of the fluorinated compound is melted by an irradiation of energy rays and then crystallized.

~~13~~10. The plasma processing apparatus of claim 1, wherein, among the inner surfaces of the processing chamber which are exposed to the plasma, a part of or all of the surfaces located between the ~~upper~~ facing electrode and ~~the~~ a baffle plate are coated with the fluorinated compound.

~~14~~11. The plasma processing apparatus of claim 1, wherein, among the inner surfaces of the processing chamber which are exposed to the plasma, an inner surface to be coated with the fluorinated compound is determined by a gap between the mounting table and a ceiling surface of the processing chamber.

~~15~~12. The plasma processing apparatus of claim 1, wherein a surface of at least one of a deposition shield, a shutter, a baffle plate, or a ring bottom shield provided in the processing chamber, the surface being exposed to the plasma of the gas including the halogen-containing gas and the oxygen gas, is coated with the

fluorinated compound.

~~16~~13. The plasma processing apparatus of claim 1, wherein a side surface of an electrostatic chuck on the mounting table is coated with the fluorinated compound, or the side surface and a top surface of the electrostatic chuck are coated with the fluorinated compound.

~~17~~14. The plasma processing apparatus of claim 1, wherein a top surface of a focus ring provided to surround a peripheral portion of the target object mounted on the mounting table is coated with the fluorinated compound.

~~18~~15. A plasma processing method for use with a plasma processing apparatus which includes a depressurizable processing chamber; a lower electrode~~,~~ provided in the processing chamber~~,~~ and serving as a mounting table for mounting thereon a target object to be processed; a facing electrode, serving as an upper electrode or an antenna electrode, provided ~~at~~ in the processing chamber so as to be opposite to the lower electrode; a gas supply source for introducing a gas including a halogen-containing gas and an oxygen gas into the processing chamber; and ~~a high frequency power supply for applying a high frequency power for generating plasma to at least one of the upper electrode, the antenna electrode, or the lower electrode~~ a plasma generation unit for generating a plasma of the gas including the halogen-containing gas and the oxygen gas in the processing chamber, the plasma processing method comprising:

introducing ~~a~~ the gas including ~~a~~ the halogen-containing gas and ~~an~~ the oxygen gas from the gas supplying source into the processing chamber in which, among inner surfaces of the processing chamber which are exposed to the plasma of the gas including the halogen-containing gas and the oxygen gas, at least a part of or all of the surfaces between a mounting position of the target object and the

facing electrode; ~~upper electrode, the antenna electrode,~~ or at least a part of or all of the surfaces of the facing electrode ~~lower electrode~~ are coated with a fluorinated compound;

~~supplying the high frequency power for generating plasma from the high frequency power supply into the processing chamber~~ generating the plasma of the gas including the halogen-containing gas and the oxygen gas by using the plasma generation unit; and

~~generating a plasma of the gas by applying the high frequency power for generating plasma and~~ performing a plasma processing on the target object mounted on the mounting table by an action of the plasma of the gas including the halogen-containing gas and the oxygen gas,

wherein a material forming the fluorinated compound contains YF_3, and

wherein an outermost layer of the fluorinated compound is transformed into a transformed layer containing Y, O and F or containing Y, O, F and at least one of Cl and Br by the plasma of the gas including the halogen-containing gas and the oxygen gas.

16. The plasma processing apparatus of claim 1, wherein a thermally sprayed film of Y_2O_3 is formed beneath the fluorinated compound, and a thickness of the fluorinated compound is equal to or less than that of the thermally sprayed film of Y_2O_3.

17. The plasma processing apparatus of claim 1, a surface roughness of the fluorinated compound is equal to or less than 7.0 μm.

18. The plasma processing apparatus of claim 1, a porosity of the fluorinated compound is in a range from 3% to 7%.

19. The plasma processing apparatus of claim 15, wherein a thermally sprayed film of Y_2O_3 is formed beneath the fluorinated compound, and a thickness of the fluorinated compound is equal to or less than that of the thermally sprayed film of Y_2O_3.

20. The plasma processing apparatus of claim 15, a surface roughness of the fluorinated compound is equal to or less than 7.0 μm.

21. The plasma processing apparatus of claim 15, a porosity of the fluorinated compound is in a range from 3% to 7%.