

CLAIMS

What is claimed is:

1. An article coated with a film comprising:

5 a vacuum compatible substrate; and
a protective film disposed on at least a portion of the substrate,
wherein the protective film includes a fluorinated metal oxide containing yttrium,
the protective film is a graded film which contains fluorine at a depth of 0.1 micron or
more and has a fluorine content decreased over a depth of the film decreased over a
10 depth of the film from an outer portion to an inner portion, and
the outer portion contains a fluorine amount of 42 at.% or less on a surface and the inner
portion has a fluorine amount of 15 at.% or less at a depth of 6 microns.

2. An article coated with a film comprising:

15 a vacuum compatible substrate; and
a protective film containing yttrium, oxygen and fluorine,
wherein the protective film has a yttrium content of 20.5 at.% to 38 at.%, a fluorine
content of 4 at.% to 33 at.%, and an oxygen content of 46.5 at.% to 69.5 at.% as
determined by EDS,
20 the protective film is a graded film which contains fluorine at a depth of 0.1 micron or
more and has a fluorine content decreased over a depth of the film from an outer portion
to an inner portion,
the outer portion contains a surface fluorine amount of 42 at.% or less and the inner
portion has a fluorine amount of 15 at.% or less at a depth of 6 microns,

the graded film is stable in 5% aqueous hydrochloric acid after 5 minutes at room temperature, and

the graded film has a rhombohedral or tetragonal yttrium oxyfluoride crystal system as determined by x-ray diffraction.

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3. The article of claim 1 or 2, wherein the protective film contains yttrium oxyfluoride or yttrium aluminum oxyfluoride.

4. The article of claim 1 or 2, wherein the fluorine content of the graded film decreases
10 over a thickness of the graded film from an outer portion that is yttrium oxyfluoride to an inner portion that is yttria.

5. The article of claim 1 or 2, wherein the graded film contains rhombohedral or tetragonal $Y_aO_bF_c$ (wherein $c/(a + b) = 0.04$ to 0.67), and Y_xO_y (wherein $x/y = 0.33$ to
15 0.67).

6. The article of claim 1 or 2, wherein the graded film contains yttrium aluminum oxide which may be converted to yttrium aluminum oxyfluoride, and the fluorine content of the graded film decreases over a thickness of the graded film from an outer portion that
20 is yttrium aluminum oxyfluoride to an inner portion that is yttrium aluminum oxide.

7. The article of claim 1 or 2, wherein the graded film contains yttrium aluminum oxide $Y_oAl_pO_q$ (wherein $o/(p+q) = 0.03$ to 0.18) which may be converted to yttrium aluminum oxyfluoride $Y_eAl_fO_gF_h$ (wherein $h/(e+f+g) = 0.05$ to 0.54).

8. The article of claim 1 or 2, wherein the graded film has a thickness of 1 micron to 15 microns.

5 9. The article of claim 2, wherein the protective film has a yttrium content of 23 at.% to 38 at.%.

10. The article of claim 2, wherein the protective film has an oxygen content of 59 at.% to 69.5 at.%.

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11. A method for coating a film comprising:

providing a vacuum compatible substrate;

depositing yttrium-containing metal oxide on the substrate, forming a film in which the metal oxide is disposed on the substrate; and

15 fluoro-annealing the film to generate a graded film,

wherein the graded film contains fluorine at a depth of 0.1 micron or more and a fluorine content decreases over a depth of the film from an outer portion to an inner portion, and

the outer portion contains a surface fluorine amount of 42 at.% or less and the inner

20 portion has a fluorine amount of 15 at.% or less at a depth of 6 microns.

12. The method of claim 11, wherein the fluoro-annealing is performed at a temperature of 300°C to 650°C.

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