generation. However despite being chemically inert with respect to F, the YOF coating as well can undergo degradation due to the deposition of fluorocarbon polymer layers

by the adsorption of fluorocarbon radicals on the YOF surface. Among other drawbacks these layers influence the etching processes and can produce large and uncontrolled shifts.

Thus, there is a need for an improved coating having superior plasma etch-resistance and offering high-level of process stability and reproducibility for the production of integrated circuits. In many cases seasoning and conditioning is used to improve such stability and reproducibility. However, this can be time consuming and can heavily increase the cost of production.

The present disclosure has the objective to solve the problem as described above and to provide an improved coating for process chamber parts, having a superior plasma etch-resistance and offering high-level of process stability and reproducibility for fluorine plasma based etch processes for the production of semiconductor devices. The present disclosure has as well the objective to provide a method for producing such an improved coating.

According to the present disclosure the problem is solved by an article article comprising a substrate, and a protective film overlaying at least part of the substrate, the film comprising a fluorinated metal oxide, containing one or more elements of the Group III and/or Group IV elements of the periodical system of elements, characterized in that the protective film comprises the fluorinated metal oxide with a carbon doping with a carbon concentration not lower than 0.1at% and not higher than 10at%, preferably not lower than 0.5at% and more preferably not higher than 2.5at%, wherein the article is a plasma etch chamber component and/or part and preferably an article of the group formed by electrostatic chuck, a ring, a process kit ring, a single ring, a chamber wall, a shower head, a nozzle, a lid, a liner, a window, a baffle or a fastener. The article may preferably be formed as a vacuum compatible plasma etch chamber article, comprising a vacuum compatible substrate. The dependent claims describe further and preferred examples of the present disclosure.

According to the present disclosure, the article comprises an improved coating, wherein the improved coating may be formed as a thin film comprising fluorinated metal oxide, wherein the thin film in addition comprises carbon with a concentration being in the range from 0.1 at% to 10 at%, preferably between 0.5at% and 2.5at%. The metal of the fluorinated metal oxide may be one or more element of the group III and or group IV elements of the periodical system. More preferably the metal may contain Yttrium or may be Yttrium.

According to another example, the protective film may comprise a gradient layer with increasing fluorine concentration measured from a deeper part of the protective film to a less deep part of the protective film and/or the protective film may be a multilayer

system comprising at least two layers with different fluorine concentrations with the fluorine concentration in the layer more distant to the substrate being higher than the fluorine concentration in the layer closer to the substrate.

According to a preferred example of the present disclosure the thin film is a MaObFcCd film with $0.25 < a < 0.4$, $0.2 < b < 0.6$, $0.1 < c < 0.6$ and $0.01 < d < 0.1$ with $a+b+c+d = 1$ if only these materials in the film are taken into account. This means that additional materials may be as well present in the film. However it is preferred that the concentration of each of the additional materials does not exceed 5 at%. Most preferably no additional materials apart from difficult to avoid pollutions are present in the film.

According to another aspect of the present disclosure a method for producing an article according to the disclosure is disclosed, wherein the protective film overlaying at least a part of the substrate is applied by Physical Vapor Deposition (PVD) and/or Chemical Vapor Deposition (CVD). The inventive film hereby is to be applied on chamber parts/components for use in semiconductor production equipment by Physical Vapor Deposition (PVD) and/or Chemical Vapor Deposition (CVD) such as for example Plasma Enhanced CVD. The inventive film is most suited for being applied on Aluminum and/or oxidized Aluminum and/or anodized Aluminum and/or precoated Aluminum and/or precoated anodized aluminium parts. One example would be the deposition of a thermal spray Y_2O_3 precoat layer onto anodized aluminum. Other substrates, such as for example quartz are possible as well.

The inventive film can comprise or be a graded layer, starting from pure Metaloxide (Me-0) on the substrate to Me-0-F-C as top layer. The film can as well be a two or multilayer system, preferably with increasing F and/or C concentration in direction to the surface.

The inventive film can comprise one or more metal and/or metal oxide layer(s) as an adhesion-promoting means to the substrate.
Preferably the inventive film has a hardness of at least 10 GPa as determined by nanoindentation.

Preferably the inventive film has a thickness between 0.1 µm and 30 µm.

According to one example, the inventive film has an amorphous phase, however according to a preferred example the inventive film has crystalline phase such as

for example trigonal and/or orthorhombic and/or preferably a rhombohedral crystalline phase as determined by x-ray diffraction.

According to a preferred example the inventive film has a roughness of Ra < 1 µm, preferably Ra < 0.25 µm, most preferably Ra < 0.025 µm.

According to a preferred example the inventive film has a reduced peak height of Rpk < 0.25 µm, preferably Rpk < 0.10 µm, most preferably Rpk < 0.025 µm.

The inventive film can for example be produced by plasma vapor deposition (PVD) process, preferably a reactive sputter process for example pulsed DC and/or HiPIMS and or bipolar HiPIMS and/or modulated pulsed power magnetron sputtering (MPPS). If a reactive process is used the reactive gas can be for example a mixture of CF-containing gases (such as CF4, C2F6, C3F8, etc …) with oxygen-containing gases (such as O2). The target can be a pure metallic target. It can be however as well for example a ceramic target, such as for example oxide, preferably Y2O3 and/or fluoride, preferably YF3 or a mixture thereof. A PVD process is particularly suitable, since the inherent density and lack of porosity of PVD films compared to existing art (thermal spray, aerosol deposition) particularly contributes positively to the reduction of particulate formation.

It can be advantageous to use a substrate bias which is floating and/or DC and or pulsed DC and/or bipolar and/or RF.
It can well be advantageous to use a Y-containing thermally sprayed precoat such as but not limited to Y2O3 and/or YOF layer.

Application examples are chamber components including but not limited to an electrostatic chuck (ESC), a ring (e.g. a process kit ring or single ring), a chamber wall, a showerhead, a nozzle, a lid, a liner, a window, baffle, fastener.

Preferably during the coating the substrate temperature is kept below 180 °C, and most preferably below 150°C. It should be noted that with higher temperature a higher deposition rate can be realized, however sometimes the substrates have temperature restrictions.

The invention is now described in detail on the basis of an example and with the help of the figures.

The figures show the following:

Claims

1. An article comprising

- a substrate

- a protective film overlaying at least part of the substrate, the film comprising a fluorinated metal oxide, containing one or more elements of the Group III and/or Group IV elements of the periodical system of elements, characterized in that the protective film comprises the fluorinated metal oxide with a carbon doping with a carbon concentration not lower than 0.1at% and not higher than 10at%, preferably not lower than 0.5at% and more preferably not higher than 2.5at%, wherein the article is a plasma etch chamber component and/or part and preferably an article of the group formed by electrostatic chuck, a ring, a process kit ring, a single ring, a chamber wall, a shower head, a nozzle, a lid, a liner, a window, a baffle or a fastener.

2. Article according to claim 1, characterized in that the metal of the protective film contains Yttrium and preferably is Yttrium.

3. Article according to one of the claims 1 or 2, characterized in that the protective film has a coating thickness not less than 0.1 µm and not more than 30 µm.

4. Article according to one of the preceding claims, characterized in that the protective film has a roughness of Ra < 1 µm, preferably, Ra < 0.25 µm, most preferably Ra < 0.025 µm.

5. Article according to one of the preceding claims, characterized in that the protective film has a reduced peak height of Rpk < 0.25 µm, preferably Rpk < 0.10 µm, most preferably Rpk < 0.025 µm.

6. Article according to one of the preceding claims, characterized in that the protective film has a hardness of at least 10 GPa as determined by nanoindentation with a fixed load of 5mN, while the indentation depth is maintained below 10% of the coating thickness.

7. Article according to one of the preceding claims, characterized in that between the protective film and the substrate is an adhesion-promoting layer being a second metal or second metal oxide, where the metal of the film and second metal are preferably identical.

8. Article according to one of the preceding claims, characterized in that the protective film comprises a gradient layer with increasing fluorine concentration measured from a deeper part of the protective film to a less deep part of the protective film and/or the protective film is a multilayer system comprising at least two layers with different fluorine concentrations with the fluorine concentration in the layer more distant to the substrate being higher than the fluorine concentration in the layer closer to the substrate.

9. Article according to one of the preceding claims, characterized in that the protective film comprises a gradient layer starting close to the substrate from pure M203 to (MaObFcCd), in which the concentration of MaObFcCd are preferably chosen as follows: $0.25 < a < 0.4$, $0.2 < b < 0.6$, $0.1 < c < 0.6$ and $0.01 < d < 0.1$ with $a+b+c+d = 1$.

10. Article according to one of the preceding claims, characterized in that between the protective film or if given the adhesion promoting layer and the substrate foreseen is a Y-containing thermally sprayed precoat, preferably comprising Y_2O_3 and/or YOF.

11. Method for producing an article according to one of the preceding claims, characterized in that the protective film overlaying at least a part of the substrate is applied by Physical Vapor Deposition (PVD) and/or Chemical Vapor Deposition (CVD).