CLAIMS

~~*What is claimed is*~~*:*

1. A method of removing material from a low-k dielectric layer on a work piece as part of a partially fabricated integrated circuit after an etch process, the method comprising:

forming a first plasma from a gas comprising hydrogen and a fluorine-containing compound; exposing the work piece to the first plasma; forming a second plasma from a gas comprising hydrogen; and exposing the work piece to the second plasma, wherein exposure to the first and second plasma removes material from the low-k dielectric layer; and

wherein the work piece temperature is maintained at a temperature below about 1~~0~~60°C.

~~2. The method of claim 1, wherein the work piece temperature is maintained at a temperature below about 100°C.~~

2~~3~~. The method of claim 1, wherein the work piece temperature is maintained at a temperature below about 90°C.

3~~4~~. The method of any of claims 1-2~~3~~, wherein the gas from which the first plasma is formed further comprises a weak oxidizing agent.

4~~5~~. The method of claim 3~~4~~, wherein the weak oxidizing agent comprises at least one of carbon dioxide, carbon monoxide, nitrous oxide, nitric oxide, nitrogen dioxide and water.

5~~6~~. The method of claim 3~~4~~, wherein the weak oxidizing agent is carbon dioxide.

6~~7~~. The method of any of claims 1-5~~6~~, wherein the fluorine-containing compound is comprises at least one of nitrogen trifluoride (NF_3), sulfur hexafluoride (SF_6), hexafluoroethane (C_2F_6), tetrafluoromethane (CF_4), trifluoromethane (CHF_3), difluoromethane (CH_2F_2), octofluoropropane (C_3F_8), octofluorocyclobutane (C_4F_8), octofluoro[1-]butane (C_4F_8), octofluoro[2-]butane (C_4F_8), octofluoroisobutylene (C_4F_8), and fluorine (F_2).

7~~8~~. The method of claim 6~~7~~, wherein the fluorine-containing compound is nitrogen trifluoride.

8~~9~~. The method of any of claims 1-7~~8~~, wherein the second plasma is substantially fluorine-free.

9~~10~~. The method of any of claims 1-8~~9~~ wherein the work piece has not undergone a previous oxygen-based plasma photoresist stripping operation.

10~~1~~. The method of any of claims 1-9~~10~~, wherein the material being removed from the dielectric layer comprises photoresist and/or residues from the etch process.

11~~2~~. A method of removing material from a low-k dielectric layer on a work piece as part of a partially fabricated integrated circuit after an etch process, the method comprising:

forming a first plasma from a gas comprising hydrogen, a weak oxidizing agent and a fluorine-containing compound;

exposing the work piece to the first plasma to thereby remove etch-related residue from the low-k dielectric layer, wherein the work piece temperature is maintained at a temperature below about 10~~6~~0^{o}C during the exposure to the first plasma.

~~13. The method of claim 12 wherein work piece temperature is maintained at a temperature below about 100^{o}C during the exposure to the first plasma.~~

12~~4~~. The method of claim 11~~2~~ wherein work piece temperature is maintained at a temperature below about 90^{o}C during the exposure to the first plasma.

13~~5~~. The method of any of claims 11~~2~~-12~~4~~ further comprising forming a second plasma from a gas comprising hydrogen and a weak oxidizing agent; and exposing the work piece to the second plasma.

14~~6~~. The method of claim 13~~5~~ wherein work piece temperature is maintained at a temperature below about 160^{o}C during the exposure to the second plasma.

15~~7~~. The method of claim 13~~5~~ wherein work piece temperature is maintained at a temperature below about 90^{o}C during the exposure to the second plasma.

16~~8~~. The method of any of claims 13~~5~~-15~~7~~, wherein the second plasma is substantially fluorine-free.

17~~9~~. The method of any of claims 13~~5~~-16~~8~~ wherein the work piece temperature is higher during exposure to the second plasma than during exposure to the first plasma.

18~~20~~. The method of any of claims 11~~2~~-17~~9~~ wherein the volume percentage of the fluorine-containing compound in the gas is no more than 1%.

~~21. A method of removing material from a low-k dielectric layer on a work piece as part of a partially fabricated integrated circuit after an etch process, the method comprising forming a first plasma from a gas comprising hydrogen, wherein the work piece temperature is maintained at a temperature below about 160^{o}C and wherein the gas further comprises fluorine-containing compound.~~

~~22. The method of claim 21 wherein the gas further comprises a weak oxidizing agent.~~

19~~23~~. An apparatus for removing material from a low-k dielectric work piece surface as part of a partially fabricated integrated circuit after an etch process, the apparatus comprising:

a reaction chamber comprising:

a plasma source,

a showerhead positioned downstream of the plasma source, and

a work piece support downstream of the showerhead, said work piece support comprising a pedestal and temperature-controlling mechanism to control a temperature of a work piece supported on the work piece support; and

a controller for executing a set of instructions, said set of instruction comprising instructions for receiving in the reaction chamber the substrate having a low-k dielectric work piece surface, forming a first plasma from a gas comprising hydrogen, a weak oxidizing agent and a fluorine-containing compound; exposing the work piece to the first plasma to thereby remove the material from the low-k dielectric; forming a second plasma from a gas comprising hydrogen and a weak oxidizing agent; exposing the work piece to the second plasma to thereby remove the material from the low-k dielectric, and maintaining the work piece at a temperature below about 1060°C during the exposure operations.

204. The method of claim 1, wherein the dielectric layer is an ultra-low k dielectric layer.

215. The method of claim 1, wherein the material removed comprises bulk photoresist and the work piece temperature is maintained at a temperature below about 160°C throughout removal of the bulk photoresist.