CLAIMS

~~What is claimed is:~~

1. A method of etching or removing an organic hardmask comprising:

providing a semiconductor wafer substrate comprising an exposed low-k dielectric, wherein the substrate comprises a bulk low-k dielectric underlying a capping dielectric, the capping dielectric having a higher k value than the bulk low-k dielectric, and the substrate having thereover an organic hardmask to be removed;

introducing over the substrate and organic hardmask an ionizable gas comprising a mixture of hydrogen and an oxidizing gas;

applying energy to the mixture to create a plasma of the mixture; and

contacting the organic hardmask with the plasma, wherein the substrate and organic hardmask are at a temperature in excess of 200ºC, to remove at least a portion of the organic hardmask without damaging the underlying substrate surface or the exposed low-k dielectric.

2. The method of claim 1, wherein the organic hardmask comprises chemical vapor deposited amorphous carbon.

3. The method of claim 1, wherein the organic hardmask comprises a spin-on carbon film.

4. The method of claim 1, wherein both the bulk low-k dielectric and the capping dielectric are low-k dielectrics.

5. The method of claim 1, wherein the bulk low-k dielectric is a low-k dielectric and the capping dielectric is not a low-k dielectric.

6. The method of claim 1, wherein the low-k dielectric has a dielectric constant no greater than about 3.

7. The method of claim 1, wherein the low-k dielectric has a dielectric constant no greater than about 2.8.

8. The method of claim 1, wherein the low-k dielectric has a dielectric constant no greater than about 2.2.

9. The method of claim 1, wherein the bulk low-k dielectric is an ultra-low-k (ULK) dielectric having a k of about 2.2 and the capping dielectric is a carbon-doped oxide (CDO) having a k of about 2.9.

10. The method of claim 1, wherein the bulk low-k dielectric is a carbon-doped oxide (CDO) having a k of about 2.9 and the capping dielectric is tetraethylorthosilicate (TEOS) having a k of about 4.0.

11. The method of claim 1, wherein the substrate comprises discrete bulk low-k dielectric and capping dielectric layers.

12. The method of claim 1, wherein the substrate comprises a graded transition between the bulk low-k dielectric and the capping dielectric.

13. The method of claim 1, wherein the gas mixture is nitrogen-free.

14. The method of claim 1, wherein the organic hardmask is completely removed from the underlying substrate.

15. The method of claim 1, further comprising:

applying photoresist to the substrate;

exposing the photoresist to light;

patterning the resist and transferring the pattern to the substrate; and,

selectively removing the photoresist from the substrate.

16. An apparatus for etching or removing an organic hardmask overlying a dielectric, the apparatus comprising:

(a) a plasma reaction chamber apparatus; and

(b) a controller comprising program instructions for conducting a process comprising the steps of:

providing a semiconductor wafer substrate comprising an exposed low-k dielectric, wherein the substrate comprises a bulk low-k dielectric underlying a capping dielectric, the capping dielectric having a higher k value than the bulk low-k dielectric, and the substrate having thereover an organic hardmask to be removed;

introducing over the substrate and organic hardmask an ionizable gas comprising a mixture of hydrogen and an oxidizing gas;

applying energy to the mixture to create a plasma of the mixture; and

contacting the organic hardmask with the plasma, wherein the substrate and organic hardmask are at a temperature in excess of 200ºC, to remove at least a portion of the organic hardmask without damaging the underlying substrate surface or the exposed low-k dielectric.

17. A semiconductor wafer processing system, the system comprising:

the apparatus of claim 16, and a stepper.

18. A non-transitory computer machine-readable medium comprising program instructions for control of a plasma reaction chamber apparatus~~, the program instructions comprising~~ to carry out the method of etching or removing an organic hardmask in accordance with any one of claims 1 to 15.~~,~~

~~code for providing a semiconductor wafer substrate comprising an exposed low-k dielectric, wherein the substrate comprises a bulk low-k dielectric underlying a capping~~

~~dielectric, the capping dielectric having a higher k-value than the bulk low-k dielectric, and the substrate having thereover an organic hardmask to be removed;~~

~~code for introducing over the substrate and organic hardmask an ionizable gas comprising a mixture of hydrogen and an oxidizing gas;~~

~~code for applying energy to the mixture to create a plasma of the mixture; and~~

~~code for contacting the organic hardmask with the plasma to remove at least a portion of the organic hardmask without damaging the underlying substrate surface or the exposed low-k dielectric.~~