CLAIMS

1. A method of forming features in a porous low-k dielectric layer disposed below a patterned organic resist mask made of a resist material, comprising:

(a) etching features into the porous low-k dielectric layer through the patterned organic resist mask; and

(b) stripping the patterned organic resist mask, comprising:

providing a stripping gas comprising COS;

forming a plasma from the stripping gas; and

stopping the stripping gas,

wherein a flow ratio of COS is about 5 to 15% of the total flow of the stripping gas.

2. The method as recited in claim 1, wherein a cap layer is provided between the porous low-k dielectric layer and the patterned organic resist mask, and wherein the stripping of the patterned organic resist mask leaves the cap layer on the porous low-k dielectric layer.

3. The method as recited in claim 1, further comprising, prior to the etching of features into the porous low-k dielectric layer:

depositing the porous low-k dielectric layer on a substrate;

providing a first patterned photoresist (PR) mask on the porous low-k dielectric layer;

patterning the porous low-k dielectric layer through the first patterned PR mask;

providing an organic planarization layer on the patterned porous low-k dielectric layer; and

etching the organic planarization layer using a second patterned PR mask into the patterned organic resist mask.

4. The method as recited in claim 3, further comprising:

forming a cap layer on the porous low-k dielectric layer before providing the first patterned PR mask, the cap layer being patterned using the first patterned PR mask in the step of patterning the porous low-k dielectric layer,

wherein the stripping of the patterned organic resist mask leaves the cap layer on the porous low-k dielectric layer.

5. The method as recited in claim 3, further comprising, after providing the organic planarization layer:

depositing an oxide layer on the organic planarization layer;

depositing an antireflective coating (ARC) layer on the oxide layer;

providing the second patterned PR mask on the ARC layer; and

opening the ARC layer and the oxide layer through the second patterned PR mask, wherein the organic planarization layer is etched through the second patterned PR mask, the opened ARC layer, and the opened oxide layer.

6. The method as recited in claim 1, wherein the stripping gas further comprises at least one of: O_2, N_2, H_2, CO_2, or N_2O.

7. The method as recited in claim 1, wherein the stripping gas further comprises O_2.

8. The method as recited in claim 7, wherein the stripping gas further comprises CO or N_2.

9. The method as recited in claim 1, wherein the stripping gas consists essentially of O_2 and COS.

10. A method of forming features in a porous low-k dielectric layer disposed below a patterned organic resist mask made of a resist material, comprising:

(a) etching features into the porous low-k dielectric layer through the patterned organic resist mask; and

(b) stripping the patterned organic resist mask, comprising:

providing a stripping gas comprising COS and O_2;

forming a plasma from the stripping gas; and

stopping the stripping gas,

wherein a flow ratio of O_2 and COS is about 5:1 to 15:1.

11. The method as recited in claim 10, wherein a flow ratio of O_2 and COS is about 8:1 to 15:1.

12. The method as recited in claim 11, wherein a flow ratio of O_2 and COS is about 13:1.

13. The method as recited in claim 1, wherein the stripping gas removes the organic resist mask while reducing damages to the low-k dielectric layer having the etched features.

14. The method as recited in claim 7, wherein a flow ratio of O_2 and COS is about 5:1 to 15:1.

15. The method as recited in claim 14, wherein a flow ratio of O_2 and COS is about 8:1 to 15:1.

16. The method as recited in claim 15, wherein a ratio flow ratio of O_2 and COS is about 13:1.

17. The method as recited in claim 1, wherein the stripping gas comprising COS improves reduction of damages to the low-k dielectric layer having the etched features, compared with reduction of damages using a stripping gas lacking COS and comprising CO, CO_2, N_2, or N_2O in place of COS.

18. The method as recited in claim 10, wherein the stripping gas comprising COS improves reduction of damages to the low-k dielectric layer having the etched features, compared with reduction of damages using a stripping gas lacking COS and comprising CO, CO_2, N_2, or N_2O in place of COS.

19. The method as recited in claim 1, wherein the stripping is performed with a chamber pressure between 5 and 20 mTorr.

20. The method as recited in claim 10, wherein the stripping is performed with a chamber pressure of between 5 and 20 mTorr.

CLAIMS

What is claimed is:

1. A method of forming features in a porous low-k dielectric layer disposed below a patterned organic mask, comprising:

(a) etching features into the porous low-k dielectric layer through the patterned organic mask; and

(b) stripping the patterned organic mask, comprising:

providing a stripping gas comprising COS;

forming a plasma from the stripping gas; and

stopping the stripping gas.

2. The method as recited in claim 1, wherein a cap layer is provided between the porous low-k dielectric layer and the patterned organic mask, and wherein the stripping of the patterned organic mask leaves the cap layer on the porous low-k dielectric layer.

3. The method as recited in claim 1 or 2, further comprising, prior to the etching of features into the porous low-k dielectric layer:

depositing the porous low-k dielectric layer on a substrate;

providing a first patterned photoresist (PR) mask on the porous low-k dielectric layer;

patterning the porous low-k dielectric layer through the first patterned PR mask;

providing an organic planarization layer on the patterned porous low-k dielectric layer; and

etching the organic planarization layer using a second patterned PR mask into the patterned organic mask.

4. The method as recited in claim 3, further comprising:

forming a cap layer on the porous low-k dielectric layer before providing the first patterned PR mask, the cap layer being patterned using the first patterned PR mask in the step of patterning the porous low-k dielectric layer,

wherein the stripping of the patterned organic mask leaves the cap layer on the porous low-k dielectric layer.

5. The method as recited in claim 3, further comprising, after providing the organic planarization layer:

depositing an oxide layer on the organic planarization layer;

depositing an antireflective coating (ARC) layer on the oxide layer;

providing the second patterned PR mask on the ARC layer; and

opening the ARC layer and the oxide layer through the second patterned PR mask, wherein the organic planarization layer is etched through the second patterned PR mask, the opened ARC layer, and the opened oxide layer.

6. The method as recited in claim 1 or 2, wherein the stripping gas further comprises at least one of: O_2, N_2, H_2, CO_2, or N_2O.

7. The method as recited in claim 1 or 2, wherein the stripping gas further comprises O_2.

8. The method as recited in claim 7, wherein the stripping gas further comprises CO or N_2.

9. The method as recited in claim 1 or 2, wherein the stripping gas consists essentially of O_2 and COS.

10. The method as recited in claim 1 or 2, wherein a flow ratio of COS is about 1 to 50 % of the total flow of the stripping gas.

11. The method as recited in claim 10, wherein a flow ratio of COS is about 2 to 25 % of the total flow of the stripping gas.

12. The method as recited in claim 11, wherein a flow ratio of COS is about 5 to 15 % of the total flow of the stripping gas.

13. The method as recited in claim 7, wherein a ratio of O_2 and COS is about 5 : 1 to 20 : 1.

14. The method as recited in claim 13, wherein a ratio of O_2 and COS is about 8 : 1 to 15 : 1.

15. The method as recited in claim 14, wherein a ratio of O_2 and COS is about 13 : 1.

16. An apparatus for forming features in a porous low-k dielectric layer disposed below a patterned organic mask, comprising:

a plasma processing chamber, comprising:

a chamber wall forming a plasma processing chamber enclosure;

a substrate support for supporting a substrate within the plasma processing chamber enclosure;

a pressure regulator for regulating the pressure in the plasma processing chamber enclosure;

at least one electrode for providing power to the plasma processing chamber enclosure for sustaining a plasma;

at least one RF power source electrically connected to the at least one electrode;

a gas inlet for providing gas into the plasma processing chamber enclosure; and

a gas outlet for exhausting gas from the plasma processing chamber enclosure;

a gas source in fluid connection with the gas inlet, the gas source comprising:

a porous low-k dielectric etch gas source; and

a stripping gas source, including a COS source, and at least one another gas source;

a controller controllably connected to the gas source and the at least one RF power source, comprising:

at least one processor; and

computer readable media, comprising:

(a) computer readable code for etching features into the porous low-k dielectric layer through the patterned organic mask; and

(b) computer readable code for stripping the patterned organic mask, comprising:

computer readable code for providing a stripping gas comprising COS;

computer readable code for forming a plasma from the stripping gas; and

computer readable code for stopping the stripping gas.

17. The method as recited in claim 3 or 4, further comprising, after providing the organic planarization layer:

depositing an oxide layer on the organic planarization layer;

depositing an antireflective coating (ARC) layer on the oxide layer;

providing the second patterned PR mask on the ARC layer; and

opening the ARC layer and the oxide layer through the second patterned PR mask, wherein the organic planarization layer is etched through the second patterned PR mask, the opened ARC layer, and the opened oxide layer.

18. The method as recited in any one of claims 1-4 and 17, wherein the stripping gas further comprises at least one of: O_2, N_2, H_2, CO_2, or N_2O.

19. The method as recited in any one of claims 1-4 and 17, wherein the stripping gas further comprises O_2.

20. The method as recited in claim 19, wherein the stripping gas further comprises CO or N_2.

21. The method as recited in any one of claims 1-4 and 17, wherein the stripping gas consists essentially of O_2 and COS.

22. The method as recited in any one of claims 1-4 and 17-21, wherein a flow ratio of COS is about 1 to 50 % of the total flow of the stripping gas.

23. The method as recited in claim 22, wherein a flow ratio of COS is about 2 to 25 % of the total flow of the stripping gas.

24. The method as recited in claim 23, wherein a flow ratio of COS is about 5 to 15 % of the total flow of the stripping gas.

25. The method as recited in any one of claims 19-21, wherein a ratio of O_2 and COS is about 5 : 1 to 20 : 1.

26. The method as recited in claim 25, wherein a ratio of O_2 and COS is about 8 : 1 to 15 : 1.

27. The method as recited in claim 26, wherein a ratio of O_2 and COS is about 13 : 1.