

CLAIMS

What is claimed is:

1. A method comprising:

 exposing a metal surface in a feature to a plasma comprising nitrogen species to
5 inhibit metal nucleation on the metal surface; and

 after exposing the metal surface to the plasma comprising nitrogen species, exposing
the feature to a plasma comprising oxygen species and no nitrogen species to further inhibit
metal nucleation on the metal surface.
- 10 2. The method of claim 1, further comprising, after exposing the metal surface to the
plasma comprising oxygen species, depositing metal in the feature.
3. The method of claim 1, wherein the metal surface is one of a tungsten (W),
molybdenum (Mo), ruthenium (Ru), or cobalt (Co) surface.
- 15 4. The method of claim 1, wherein the nitrogen species are nitrogen radicals.
5. The method of claim 1, wherein the oxygen species are oxygen radicals.
- 20 6. The method of claim 1, wherein the exposing the metal surface to the plasma
comprising nitrogen species forms a metal nitride.
7. The method of claim 1, wherein exposing the feature to the plasma comprising
oxygen forms a metal oxynitride.
- 25 8. The method of any of claims 1, wherein the plasma is remotely generated.
9. The method of any of claims 1, wherein plasma is a radical-based plasma with no
ions.
- 30 10. The method of any of claims 1–9, wherein the metal surface is in a recessed feature to
be filled with metal.

11. A method comprising:
after a treatment process that inhibits metal nucleation on a surface, exposing the treated surface to a plasma comprising oxygen species and nitrogen species to de-inhibit metal nucleation on the surface.
- 5 12. The method of claim 11, further comprising, prior to deposition on the surface and after de-inhibiting the surface, exposing the surface to nitrogen species to inhibit metal nucleation on the surface.
- 10 13. The method of claim 11, wherein the exposing the treated surface is performed in response to a delay.
14. The method of claim 13, further comprising receiving an indication of a delay.
- 15 15. The method of claim 11, further comprising, after de-inhibiting metal nucleation on the surface, exposing the surface to a treatment process that inhibits metal nucleation on the surface.
16. The method of claim 15, further comprising, after exposing the surface to the
20 treatment process, depositing metal in the feature.
17. The method of claim 16, wherein the metal is one of tungsten (W), molybdenum (Mo), ruthenium (Ru), and cobalt (Co).
- 25 18. The method of any of claims 11–17, wherein the nitrogen species are nitrogen radicals.
19. The method of any of claims 11–18, wherein the oxygen species are oxygen radicals.
- 30 20. The method of any of claims 11–18, wherein the O:N ratio is between 10:90–90:10 (atomic).