CLAIMS

1. An apparatus comprising:

a process chamber, wherein the process chamber is exposed to atmospheric conditions;

a substrate support for holding a semiconductor substrate in the process chamber;

a heating assembly that faces the semiconductor substrate on the substrate support, wherein the heating assembly includes a plurality of heating elements; and

an etch gas delivery nozzle positioned over the substrate support, wherein the etch gas delivery nozzle is movable to position delivery of etch gas to a location over the semiconductor substrate.

2. The apparatus of claim 1, wherein the semiconductor substrate includes a metal-containing EUV resist, wherein one or more portions of the metal-containing EUV resist is removable by the etch gas.

3. The apparatus of claim 1, wherein the process chamber exposed to atmospheric conditions is exposed to atmospheric pressure between about 50 Torr and about 765 Torr.

4. The apparatus of claim 1, wherein the process chamber exposed to atmospheric conditions is exposed to a controlled atmosphere, wherein exposure to the controlled atmosphere includes exposure to a chamber pressure greater than about 760 Torr and/or exposure to nitrogen, water vapor, carbon dioxide, argon, helium, or combinations thereof.

5. The apparatus of claim 1, wherein the plurality of heating elements include a plurality of LEDs, the plurality of LEDs being arranged in a plurality of independently controllable heating zones.

6. The apparatus of claim 1, wherein the etch gas delivery nozzle is coupled to a movable swing arm, the movable swing arm configured to position the etch gas delivery nozzle from center to edge of the semiconductor substrate.

7. The apparatus of claim 1, wherein the substrate support is configured to rotate the semiconductor substrate.

8. The apparatus of claim 1, further comprising:

a controller configured with instructions for processing the semiconductor substrate, the instructions comprising code for:

providing in the process chamber a metal-containing EUV resist on the semiconductor substrate; and

delivering the etch gas to the semiconductor substrate via the etch gas delivery nozzle to dry etch one or more portions of the metal-containing EUV resist from the semiconductor substrate under atmospheric conditions.

9. The apparatus of claim 8, wherein dry etching the one or more portions of the metal-containing EUV resist under atmospheric conditions includes dry developing the metal-containing EUV resist by selectively removing unexposed portions of the metal-containing EUV resist relative to exposed portions of the metal-containing EUV resist.

10. The apparatus of claim 8, wherein dry etching the one or more portions of the metal-containing EUV resist under atmospheric conditions includes dry cleaning the metal-containing EUV resist from a bevel edge of the semiconductor substrate.

11. The apparatus of any one of claims 1-10, further comprising:

an exhaust fan configured to remove etch byproducts and other residual gases in the process chamber.

12. The apparatus of any one of claims 1-10, further comprising:

a gas source coupled to the process chamber for delivering inert gas and/or diluent gas to the process chamber.

13. The apparatus of any one of claims 1-10, wherein the process chamber is a plasma-free thermal process chamber.

14. An apparatus comprising:

a process chamber for performing dry development, wherein the process chamber is exposed to a controlled environment, wherein the controlled environment comprises a pressure above atmospheric pressure;

a substrate support for supporting a semiconductor substrate; and

an etch gas distributor positioned over the bake plate, wherein the etch gas distributor is configured to deliver etch gas to the semiconductor substrate, wherein the semiconductor substrate includes a photoresist, wherein one or more portions of the photoresist is removable by the etch gas.

15. The apparatus of claim 14, wherein the photoresist includes a metal-containing EUV resist.

16. The apparatus of claim 14, wherein the etch gas comprises a halogen-containing gas.

17. The apparatus of claim 14, wherein the process chamber exposed to a controlled environment comprises exposure to a chamber pressure greater than about 760 Torr and exposure to nitrogen, water vapor, carbon dioxide, argon, helium, or combinations thereof.

18. The apparatus of claim 14, wherein the substrate support includes an upper surface and a plurality of minimum contact area (MCA) supports for supporting the semiconductor substrate at a height above the upper surface of the substrate support.

19. The apparatus of any one of claims 14-18, wherein the etch gas distributor includes a showerhead having a faceplate that faces the semiconductor substrate, wherein the faceplate includes a plurality of through-holes for delivery of the etch gas to the semiconductor substrate.

20. The apparatus of any one of claims 14-18, wherein the process chamber is a plasma-free thermal process chamber.

21. The apparatus of any one of claims 14-18, further comprising:

a controller configured with instructions for processing the semiconductor substrate, the instructions comprising code for:

providing in the process chamber a metal-containing EUV resist on the semiconductor substrate; and

delivering the etch gas to the semiconductor substrate via the etch gas distributor to dry etch one or more portions of the metal-containing EUV resist from the semiconductor substrate under the controlled environment.

22. An apparatus comprising:

a furnace reactor with a substrate support for holding a plurality of semiconductor substrates, wherein the furnace reactor is exposed to a controlled environment, wherein the controlled environment comprises a pressure above atmospheric pressure;

a plurality of heating elements for heating the plurality of semiconductor substrates to an elevated temperature; and

one or more etch gas inlets for delivering etch gas into the furnace reactor, wherein the one or more etch gas inlets are configured to deliver etch gas to the plurality of semiconductor substrates.

23. The apparatus of claim 22, wherein the one or more etch gas inlets are further configured to deliver nitrogen, water vapor, carbon dioxide, argon, helium, or combinations thereof to provide the controlled environment.

24. The apparatus of claim 22, further comprising:

one or more gas outlets for removal of etch byproducts and other residual gases from the furnace reactor; and

a motor for rotating the substrate support.

25. The apparatus of any one of claims 22-24, wherein chamber walls of the furnace reactor includes a quartz, a ceramic material, or a low-temperature polymer material.

26. The apparatus of any one of claims 22-24, wherein each of the plurality of semiconductor substrates includes a metal-containing EUV resist, wherein one or more portions of the metal-containing EUV resist is removable by the etch gas.

27. A track lithography system comprising:

a cassette mounting section, wherein the cassette mounting section includes one or more pods for receiving and returning a semiconductor substrate;

a processing section, wherein the processing section includes a plurality of processing stations for photoresist processing of the semiconductor substrate, wherein the plurality of processing stations includes:

a deposition chamber for depositing metal-containing EUV resist on the semiconductor substrate; and

a dry development chamber, wherein one or both of the deposition chamber and the dry development chamber are exposed to a controlled environment, wherein the controlled environment comprises a pressure above atmospheric pressure, wherein the dry development chamber is configured to perform dry removal of one or more portions of the metal-containing EUV resist from the semiconductor substrate; and

an interface section for transferring the semiconductor substrate between the processing section and a scanner.

28. The track lithography system of claim 27, wherein the plurality of processing stations further comprises:

a hexamethyldisilazane (HMDS) treatment chamber for treating a surface of the semiconductor substrate.

29. The track lithography system of claim 27, wherein the dry development chamber includes a substrate support for holding the semiconductor substrate and a gas distributor for delivery of etch gas to the semiconductor substrate, wherein the one or more portions of the metal-containing EUV resist is removable by the etch gas.