CLAIMS:

1. A deposition apparatus for processing semiconductor substrates having an isothermal processing zone, comprising:

a chemical isolation chamber in which semiconductor substrates are processed;

a process gas source in fluid communication with the chemical isolation chamber for supplying a process gas into the chemical isolation chamber;

a showerhead module which delivers process gases from the process gas source to the isothermal processing zone wherein the showerhead module includes a faceplate wherein a lower surface of the faceplate forms an upper wall of a cavity defining the isothermal processing zone; a backing plate; an isolation ring which surrounds the faceplate and the backing plate wherein the isolation ring supports the backing plate; a support element which attaches the faceplate to the backing plate; and at least one compression seal which forms an outer perimeter of a central plenum between the faceplate and the backing plate wherein a contact area between the support element and the faceplate is less than 1% of the total surface area of the faceplate; and

a substrate pedestal module configured to heat and support a semiconductor substrate wherein an upper surface of the pedestal module forms a lower wall of the cavity defining the isothermal processing zone within the chemical isolation chamber

wherein the at least one compression seal comprises first and second compression seals,

wherein the first compression seal is a first annular lever seal which is compressed between the faceplate and the backing plate and forms an inner gas plenum between the faceplate and the backing plate; and

wherein the second compression seal is a second annular lever seal which is compressed between the faceplate and the backing plate wherein the second lever seal surrounds the first lever seal and forms an intermediate gas plenum which surrounds the inner gas plenum, and wherein an outer gas plenum surrounds the intermediate gas plenum.

2. The deposition apparatus of Claim 1, wherein the deposition apparatus includes:

(a) an RF energy source adapted to energize the process gas into a plasma state in the isothermal processing zone;

(b) a control system configured to control processes performed by the deposition apparatus;

(c) a non-transitory computer machine-readable medium comprising program instructions for control of the deposition apparatus; and/or

(d) a vacuum source in fluid communication with the isothermal processing zone for evacuating process gas from the isothermal processing zone.

3. A deposition apparatus for processing semiconductor substrates having an isothermal processing zone, comprising:

a chemical isolation chamber in which semiconductor substrates are processed;

a process gas source in fluid communication with the chemical isolation chamber for supplying a process gas into the chemical isolation chamber;

a showerhead module which delivers process gases from the process gas source to the isothermal processing zone wherein the showerhead module includes a faceplate wherein a lower surface of the faceplate forms an upper wall of a cavity defining the isothermal processing zone; a backing plate; an isolation ring which surrounds the faceplate and the backing plate wherein the isolation ring supports the backing plate; a support element which attaches the faceplate to the backing plate; and at least one compression seal which forms an outer perimeter of a central plenum between the faceplate and the backing plate wherein a contact area between the support element and the faceplate is less than 1% of the total surface area of the faceplate; and

a substrate pedestal module configured to heat and support a semiconductor substrate wherein an upper surface of the pedestal module forms a lower wall of the cavity defining the isothermal processing zone within the chemical isolation chamber,

wherein the faceplate is a ceramic faceplate and the support element comprises:

(a) a plurality of cam lock assemblies wherein each cam lock assembly includes an RF contact electrically connected to an RF electrode embedded in the ceramic faceplate;

(b) an annular RF contact made of a metallic strip having at least one bend wherein the RF contact is electrically connected to an RF electrode embedded in the ceramic faceplate and wherein the annular RF contact forms the outer perimeter of an outer gas plenum between the backing plate and the ceramic faceplate; or

(c) at least one upwardly extending projection which contacts the ceramic faceplate wherein the at least one upwardly extending projection is located on an inner annular flange of the isolation ring wherein the inner annular flange of the isolation ring underlies an outer portion of the ceramic faceplate.

4. The deposition apparatus of Claim 3, wherein the annular RF contact:

(a) comprises tungsten, stainless steel, or an austenitic nickel-chromium based alloy;

(b) comprises a metallic material and has a nickel outer coating;

(c) is brazed to an RF electrode embedded in the faceplate;

(d) has a length between a lower free end in contact with the faceplate and an upper free end in contact with the backing plate of about 0.5 to 1.5 inch, and a thickness of about 0.003 to 0.009 inch;

(e) has an S-shaped, C-shaped, E-shaped, Z-shaped, or V-shaped cross section and/or

(f) forms a friction contact with a metalized surface of the faceplate wherein the metalized surface is in electrical contact with an RF electrode embedded in the faceplate.

5. A deposition apparatus for processing semiconductor substrates having an isothermal processing zone, comprising:

a chemical isolation chamber in which semiconductor substrates are processed;

a process gas source in fluid communication with the chemical isolation chamber for supplying a process gas into the chemical isolation chamber;

a showerhead module which delivers process gases from the process gas source to the isothermal processing zone wherein the showerhead module includes a faceplate wherein a lower surface of the faceplate forms an upper wall of a cavity defining the isothermal processing zone; a backing plate; an isolation ring which surrounds the faceplate and the backing plate wherein the isolation ring supports the backing plate; a support element which attaches the faceplate to the backing plate; and at least one compression seal which forms an outer perimeter of a central plenum between the faceplate and the backing plate wherein a contact area between the support element and the faceplate is less than 1% of the total surface area of the faceplate; and

a substrate pedestal module configured to heat and support a semiconductor substrate wherein an upper surface of the pedestal module forms a lower wall of the cavity defining the isothermal processing zone within the chemical isolation chamber,

wherein the compression seal:

(a) comprises an annular lever seal which is compressed between the faceplate and the backing plate;

(b) comprises tungsten, stainless steel, or an austenitic nickel-chromium base alloy;

(c) comprises a metallic material and has a nickel outer coating;

(d) provides a spring force opposing the backing plate and the faceplate;

(e) comprises a compressible ring of metallic strip material which has at least one bend in a cross section thereof wherein a length between a lower free end in contact with the faceplate and an upper free end in contact with the backing plate is about 0.5 to 1.5 inch, and a thickness of about 0.003 to 0.009 inch; and/or

(f) comprises a compressible ring of metallic strip material which has an S-shaped, C-shaped, E-shaped, Z-shaped, or V-shaped cross section.

6. A deposition apparatus for processing semiconductor substrates having an isothermal processing zone, comprising:

a chemical isolation chamber in which semiconductor substrates are processed;

a process gas source in fluid communication with the chemical isolation chamber for supplying a process gas into the chemical isolation chamber;

a showerhead module which delivers process gases from the process gas source to the isothermal processing zone wherein the showerhead module includes a faceplate wherein a lower surface of the faceplate forms an upper wall of a cavity defining the isothermal processing zone; a backing plate; an isolation ring which surrounds the faceplate and the backing plate wherein the isolation ring supports the backing plate; a support element which attaches the faceplate to the backing plate; and at least one compression seal which forms an outer perimeter of a central plenum between the faceplate and the backing plate; and

wherein the at least one compression seal comprises first and second compression seals,

wherein the first compression seal is a first annular lever seal which is disposed between the faceplate and the backing plate and forms an inner gas plenum between the faceplate and the backing plate; and

wherein the second compression seal is a second annular lever seal which is disposed between the faceplate and the backing plate wherein the second annular lever seal surrounds the first annular lever seal and forms an intermediate gas plenum which surrounds the inner gas plenum, and wherein an outer gas plenum surrounds the intermediate gas plenum.

7. The deposition apparatus of Claim 1, wherein the total contact area is less than

(a) 0.5% of the total surface area of the faceplate;

(b) 0.3% of the total surface area of the faceplate;

(c) 0.2% of the total surface area of the faceplate;

(d) 0.1% of the total surface area of the faceplate; or

(e) 0.05% of the total surface area of the faceplate.

8. The deposition apparatus of Claim 3, wherein the contact area between the faceplate and the at least one upwardly extending projection of the isolation ring has a maximum total contact area of:

(a) less than about 0.05 in^2;

(b) less than about 0.02 in^2; or

(c) less than about 0.01 in^2.

9. A deposition apparatus for processing semiconductor substrates having an isothermal processing zone, comprising:

a chemical isolation chamber in which semiconductor substrates are processed;

a process gas source in fluid communication with the chemical isolation chamber for supplying a process gas into the chemical isolation chamber;

a showerhead module which delivers process gases from the process gas source to the isothermal processing zone wherein the showerhead module includes a faceplate wherein a lower surface of the faceplate forms an upper wall of a cavity defining the isothermal processing zone; a backing plate; an isolation ring which surrounds the faceplate and the backing plate wherein the isolation ring supports the backing plate; a support element which attaches the faceplate to the backing plate; and at least one compression seal which forms an outer perimeter of a central plenum between the faceplate and the backing plate wherein a contact area between the support element and the faceplate is less than 1% of the total surface area of the faceplate; and

a substrate pedestal module configured to heat and support a semiconductor substrate wherein an upper surface of the pedestal module forms a lower wall of the cavity defining the isothermal processing zone within the chemical isolation chamber,

wherein at least one spacer is included between the faceplate and the backing plate, wherein the at least one spacer is configured to maintain the faceplate parallel with respect to the backing plate.

10. A deposition apparatus for processing semiconductor substrates having an isothermal processing zone, comprising:

a chemical isolation chamber in which semiconductor substrates are processed;

a process gas source in fluid communication with the chemical isolation chamber for supplying a process gas into the chemical isolation chamber;

a showerhead module which delivers process gases from the process gas source to the isothermal processing zone wherein the showerhead module includes a faceplate wherein a lower surface of the faceplate forms an upper wall of a cavity defining the isothermal processing zone; a backing plate; an isolation ring which surrounds the faceplate and the backing plate wherein the isolation ring supports the backing plate; a support element which attaches the faceplate to the backing plate; and at least one compression seal which forms an outer perimeter of a central plenum between the faceplate and the backing plate wherein a contact area between the support element and the faceplate is less than 1% of the total surface area of the faceplate; and

a substrate pedestal module configured to heat and support a semiconductor substrate wherein an upper surface of the pedestal module forms a lower wall of the cavity defining the isothermal processing zone within the chemical isolation chamber,

wherein:

(a) the faceplate is formed from aluminum oxide or aluminum nitride and includes an embedded RF electrode therein wherein the embedded RF electrode is electrically connected to an RF contact;

(b) the faceplate is formed from a metallic material and is electrically connected to an RF contact;

(c) the substrate pedestal module includes a bottom RF electrode wherein an outer periphery of the bottom RF electrode extends outward of the outer periphery of the cavity;

(d) the plenum between the faceplate and the backing plate has a height of about 2 to 6 mm;

(e) the lower surface of the faceplate forms the upper wall and a sidewall of the cavity;

(f) the lower surface of the faceplate includes a ring of like material at an outer periphery thereof wherein an inner surface of the ring forms the sidewall of the cavity;

(g) each exposed surface of the cavity is formed from a ceramic material;

(h) the at least one compression seal comprises an annular lever seal positioned in an annular recess in the faceplate;

(i) the at least one compression seal comprises an annular lever seal positioned in an annular recess in the backing plate; and/or

(j) the isolation ring forms an outer perimeter of an outer gas plenum between the faceplate and the backing plate.

11. A method of processing a semiconductor substrate in the deposition apparatus according to Claim 1, comprising:

supplying the process gas from the process gas source into the isothermal processing zone; and

processing a semiconductor substrate in the isothermal processing zone;

wherein the processing is at least one of chemical vapor deposition; plasma-enhanced chemical vapor deposition; atomic layer deposition; plasma-enhanced atomic layer deposition; pulsed deposition layer; and/or plasma enhanced pulsed deposition layer.

12. A showerhead module of a plasma processing apparatus configured to deliver process gases to an isothermal processing zone of the plasma processing apparatus comprising:

a faceplate wherein a lower surface of the faceplate forms an upper wall of a cavity defining the isothermal processing zone;

a backing plate;

an isolation ring which surrounds the faceplate and the backing plate wherein the isolation ring supports the backing plate;

a support element which attaches the faceplate to the backing plate; and

at least one compression seal which forms an outer perimeter of a central gas plenum between the faceplate and the backing plate,

wherein a contact area between the support element and the faceplate is less than 1% of the total surface area of the faceplate,

wherein the at least one compression seal comprises first and second compression seals,

wherein the first compression seal is a first annular lever seal which is compressed between the faceplate and the backing plate and forms an inner gas plenum between the faceplate and the backing plate; and

wherein the second compression seal is a second annular lever seal which is compressed between the faceplate and the backing plate wherein the second lever seal surrounds the first lever seal and forms an intermediate gas plenum which surrounds the inner gas plenum, and wherein an outer gas plenum surrounds the intermediate gas plenum.

13. A showerhead module of a plasma processing apparatus configured to deliver process gases to an isothermal processing zone of the plasma processing apparatus comprising:

a faceplate wherein a lower surface of the faceplate forms an upper wall of a cavity defining the isothermal processing zone;

a backing plate;

an isolation ring which surrounds the faceplate and the backing plate wherein the isolation ring supports the backing plate;

a support element which attaches the faceplate to the backing plate; and

at least one compression seal which forms an outer perimeter of a central gas plenum between the faceplate and the backing plate,

wherein a contact area between the support element and the faceplate is less than 1% of the total surface area of the faceplate,

wherein the faceplate is a ceramic faceplate and the support element comprises:

(a) a plurality of cam lock assemblies wherein each cam lock assembly includes an RF contact electrically connected to an RF electrode embedded in the ceramic faceplate;

(b) an annular RF contact made of a metallic strip having at least one bend in a cross section thereof wherein the RF contact is electrically connected to an RF electrode embedded in the ceramic faceplate and wherein the annular RF contact forms the outer perimeter of an outer gas plenum between the backing plate and the ceramic faceplate; or

(c) at least one upwardly extending projection which contacts the ceramic faceplate wherein the at least one upwardly extending projection is located on an inner annular flange of the isolation ring wherein the inner annular flange of the isolation ring underlies an outer portion of the ceramic faceplate.

14. The showerhead module of Claim 13, wherein the annular RF contact:

(a) comprises tungsten, stainless steel, or an austenitic nickel-chromium based alloy;

(b) comprises a metallic material and has a nickel outer coating;

(c) is brazed to an RF electrode embedded in the faceplate;

(d) has a length between a lower free end in contact with the faceplate and an upper free end in contact with the backing plate of about 0.5 to 1.5 inch, and a thickness of about 0.003 to 0.009 inch;

(e) has an S-shaped, C-shaped, E-shaped, Z-shaped, or V-shaped cross section; and/or

(f) forms a friction contact with a metalized surface of the faceplate wherein the metalized surface is in electrical contact with an RF electrode embedded in the faceplate.

15. A showerhead module of a plasma processing apparatus configured to deliver process gases to an isothermal processing zone of the plasma processing apparatus comprising:

a faceplate wherein a lower surface of the faceplate forms an upper wall of a cavity defining the isothermal processing zone;

a backing plate;

an isolation ring which surrounds the faceplate and the backing plate wherein the isolation ring supports the backing plate;

a support element which attaches the faceplate to the backing plate; and

at least one compression seal which forms an outer perimeter of a central gas plenum between the faceplate and the backing plate

wherein a contact area between the support element and the faceplate is less than 1% of the total surface area of the faceplate,

wherein at least one spacer is included between the faceplate and the backing plate, wherein the spacer is configured to maintain the faceplate parallel with respect to the backing plate.

16. A showerhead module of a plasma processing apparatus configured to deliver process gases to an isothermal processing zone of the plasma processing apparatus comprising:

a faceplate wherein a lower surface of the faceplate forms an upper wall of a cavity defining the isothermal processing zone;

a backing plate;

an isolation ring which surrounds the faceplate and the backing plate wherein the isolation ring supports the backing plate;

a support element which attaches the faceplate to the backing plate; and

at least one compression seal which forms an outer perimeter of a central gas plenum between the faceplate and the backing plate

wherein a contact area between the support element and the faceplate is less than 1% of the total surface area of the faceplate,

wherein the compression seal:

(a) comprises an annular lever seal which is compressed between the faceplate and the backing plate;

(b) comprises tungsten, stainless steel, or an austenitic nickel-chromium base alloy;

(c) comprises a metallic material and has a nickel outer coating;

(d) provides a spring force opposing the backing plate and the faceplate;

(e) comprises a compressible ring of metallic strip material which has at least one bend in a cross section thereof wherein a length between a lower free end in contact with the faceplate and an upper free end in contact with the backing plate is about 0.5 to 1.5 inch, and a thickness of about 0.003 to 0.009 inch; and/or

(f) comprises a compressible ring of metallic strip material which has an S-shaped, C-shaped, E-shaped, Z-shaped, or V-shaped cross section.

17. The showerhead module of Claim 12, wherein the contact area is less than

(a) 0.5% of the total surface area of the faceplate;

(b) 0.3% of the total surface area of the faceplate;

(c) 0.2% of the total surface area of the faceplate;

(d) 0.1% of the total surface area of the faceplate; or

(e) 0.05% of the total surface area of the faceplate.

18. The showerhead module of Claim 13, wherein the contact area between the faceplate and the at least one upwardly extending projection of the isolation ring has a maximum total contact area of:

(a) less than about 0.05 in^2;

(b) less than about 0.02 in^2; or

(c) less than about 0.01 in^2.

19. A showerhead module of a plasma processing apparatus configured to deliver process gases to an isothermal processing zone of the plasma processing apparatus comprising:

a faceplate wherein a lower surface of the faceplate forms an upper wall of a cavity defining the isothermal processing zone;

a backing plate;

an isolation ring which surrounds the faceplate and the backing plate wherein the isolation ring supports the backing plate;

a support element which attaches the faceplate to the backing plate; and

at least one compression seal which forms an outer perimeter of a central gas plenum between the faceplate and the backing plate

wherein a contact area between the support element and the faceplate is less than 1% of the total surface area of the faceplate,

wherein:

(a) the faceplate is formed from aluminum oxide or aluminum nitride and includes an embedded RF electrode therein wherein the embedded RF electrode is electrically connected to an RF contact;

(b) the faceplate is formed from a metallic material and is electrically connected to an RF contact;

(c) the plenum between the faceplate and the backing plate has a height of about 2 to 6 mm;

(d) the lower surface of the faceplate forms the upper wall and a sidewall of the cavity;

(e) the lower surface of the faceplate includes a ring of like material at an outer periphery thereof wherein an inner surface of the ring forms the sidewall of the cavity;

(f) each exposed surface of the cavity is formed from a ceramic material;

(g) the at least one compression seal comprises an annular lever seal positioned in an annular recess in the faceplate;

(h) the at least one compression seal comprises an annular lever seal positioned in an annular recess in the backing plate; and/or

(i) the isolation ring forms an outer perimeter of an outer gas plenum between the faceplate and the backing plate.