WHAT IS CLAIMED IS:

1. A bonded component assembly for use in a plasma processing apparatus for processing of semiconductor substrates, the component assembly comprising:

a support member having at least one load bearing surface to support a component;

the component supported on the at least one load bearing surface having at least one surface exposed to a plasma; and

an elastomeric sheet adhesive joint between mating surfaces of the at least one load bearing surface and the component to allow movement in a lateral direction of the component relative to the support member during temperature cycling due to mismatch of thermal expansion of the support member and the component.

2. The bonded component assembly of Claim 1, wherein

the support member comprises a lower electrode, a mechanical clamp, an electrostatic chucking device, an optics tube, and/or a chamber sidewall bounding a plasma processing chamber interior space; and

the component comprises a substrate support on which the substrate is processed within the interior space, a gas injector, a gas ring, a gas nozzle, a gas distribution plate, a temperature controlled gas distribution plate, a ring surrounding the substrate, a plasma confining screen, a liner to protect the chamber sidewall from the process gas, and/or an optics tube window.

3. The bonded component assembly of Claim 1, wherein the mating surface of the support member is parallel to the mating surface of the component.

4. The bonded component assembly of Claim 1, wherein the elastomeric sheet adhesive joint comprises a thermally conductive and/or electrically conductive silicone adhesive sheet.

5. The bonded component assembly of Claim 4, wherein the elastomeric sheet adhesive joint is elastically deformable in the lateral direction to at least 500% shear strain by a shear stress of about 50 to 300 psi in a temperature range of room temperature to 300°C.

6. The bonded component assembly of Claim 5, wherein the elastomeric sheet adhesive joint is elastically deformable in the lateral direction to at least 800% shear strain by a shear stress of about 50 to 300 psi in a temperature range of room temperature to 300°C.

7. The bonded component assembly of Claim 5, wherein the elastomeric sheet adhesive joint is elastically deformable in the lateral direction to at least 500% shear strain by a shear stress of about 100 to 200 psi in a temperature range of room temperature to 180°C.

8. The bonded component assembly of Claim 5, wherein the elastomeric sheet adhesive joint is elastically deformable in the lateral direction to at least 500% shear strain from a shear stress of about 50 to 300 psi in a temperature range of room temperature to 300°C after 5000 temperature cycles of heating the bonded component assembly from room temperature to 250°C.

9. The bonded component assembly of Claim 4, wherein (a) the thermally and/or electrically conductive silicone adhesive sheet comprises two or more laminated layers having different physical properties and/or (b) the thermally

and/or electrically conductive silicone adhesive sheet comprises two or more co-planar portions having different physical properties.

10. The bonded component assembly of Claim 4, wherein at least one portion of the conductive silicone adhesive sheet has a thermal conductivity of about 0.2 to 1.0 W/mK and/or at least one portion of the conductive silicone adhesive sheet has a thermal conductivity of over 1.0 W/mK.

11. The bonded component assembly of Claim 4, wherein (a) the elastomeric sheet adhesive joint further comprises a primer on one or more of the mating surfaces of the support member and/or the component; and/or (b) the conductive silicone adhesive sheet comprises a uniform distribution of conductive filler.

12. The bonded component assembly of Claim 11, wherein (a) the thermally conductive filler is of boron nitride (BN), aluminum oxide (Al_2O_3), silicon, silicon carbide, or combination thereof and/or (b) the thermally conductive silicone adhesive sheet is of (i) high molecular weight dimethyl silicone and the thermally conductive filler, (ii) high molecular weight dimethyl silicone and the thermally conductive filler matrixed around fiberglass screen (scrim), (iii) high molecular weight dimethyl silicone and the thermally conductive filler matrixed around metallic screen or (iv) high molecular weight dimethyl silicone and the thermally conductive filler mixed with glass microbeads and/or nanobeads.

13. The bonded component assembly of Claim 1, wherein a gap distance between the mating surfaces varies by less than +/- 25 μm (0.001 in

14. The bonded component assembly of Claim 1, wherein (a) the elastomeric sheet adhesive joint comprises an elastomeric sheet adhesive cast or rolled into a pre-form shape; (b) the elastomeric sheet adhesive joint comprises an elastomeric sheet adhesive of die cut pre-form shape; (c) the elastomeric sheet adhesive joint comprises an elastomeric sheet adhesive laser cut, plotter cut and/or

water jet cut pre-form shape; and/or (d) one of the mating surfaces comprises a cavity.

15. The bonded component assembly of Claim 14, wherein (a) the cavity depth is in a range of 100 to 200 μm; (b) the cavity depth is in a range of 200 to 500 μm; (c) the cavity comprises an elevation jog sized to match a dimension of the sheet adhesive; (d) the sheet adhesive bonds the mating surface of the component to the at least one load bearing surface of the support member spaced apart by 50 to 400 μm; (e) the sheet adhesive joint comprises a silicone adhesive sheet in a form of a single sheet; (f) the sheet adhesive joint comprises a silicone adhesive sheet in a form of one or more flat rings, flat rings with elevation jogs, cylinders, flat or columnar polygons, blocks or combination thereof; and/or (g) the elastomeric sheet adhesive joint comprises a heat cured adhesive.

16. A method of joining an assembly for use in a plasma processing apparatus for processing a semiconductor substrate, comprising:

applying a first surface of a sheet of uncured elastomeric adhesive in a predetermined pattern to at least one load bearing surface of a support member in a predetermined pattern of regions to be bonded which exclude regions to remain unbonded;

applying at least one bonding surface of a component to a second surface of the sheet of uncured elastomeric adhesive in a predetermined pattern of regions to be bonded, the component having at least one other surface to be exposed to a plasma; and

bonding the at least one bonding surface of the component to the at least one load bearing surface of the support member with the sheet of elastomeric adhesive therebetween to form the assembly.

17. The method of joining an assembly for use in a plasma processing apparatus of Claim 16, further comprising:

applying a primer to the at least one load bearing surface of the support member in a predetermined pattern; and

applying a primer to the at least one bonding surface of the component in a predetermined pattern.

18. The method of joining an assembly for use in a plasma processing apparatus of Claim 17, wherein

applying primer to the at least one bonding surface of the component comprises covering the at least one bonding surface with a mask having openings in a predetermined pattern and coating the primer on unmasked regions of the at least one bonding surface, and/or

applying primer to the at least one load bearing surface of the support member comprises covering the at least one load bearing surface with a mask having openings in a predetermined pattern and coating the primer on unmasked regions of the at least one load bearing surface.

19. The method of joining an assembly for use in a plasma processing apparatus of Claim 18, wherein the predetermined pattern in the mask is a plurality of semi-annular zones.

20. The method of joining an assembly for use in a plasma processing apparatus of Claim 16, wherein

(a) applying the first surface of the sheet of uncured elastomeric adhesive comprises precutting the sheet of uncured elastomeric adhesive bonding material to the predetermined pattern using one of mechanical cutting, die-cutting, laser cutting, water jet cutting, plasma cutting, plotter cutting and combinations thereof;

(b) the at least one bonding surface of the component and/or the at least one load bearing surface of the support member comprise channels over at least a portion of the predetermined pattern;

(c) the sheet of uncured elastomeric adhesive is a filled, uncured elastomeric silicone sheet; and/or

(d) the sheet of uncured elastomeric adhesive is a filled, uncured elastomeric silicone sheet filled with conductive particles of one of aluminum, aluminum oxide, silicon, silicon carbide, boron nitride, or alloys thereof.

21. The method of joining an assembly for use in a plasma processing apparatus of Claim 16, wherein

(a) bonding further comprises seating the sheet adhesive by pressing the at least one bonding surface of the component and the at least one load bearing surface of the support member together under a static weight or optionally by atmospheric pressure within a vacuum bag, wherein the sheet of uncured elastomeric adhesive is heat curable;

(b) heating the assembly to cure the uncured elastomeric adhesive after seating when the static weight or the vacuum is removed;

(c) the component is of single crystal silicon, polycrystalline silicon, graphite, quartz, ceramic, silicon carbide, yttria-containing ceramic, BN, B_4C or combination thereof; and the support member is composed of aluminum, graphite, copper, alumina, quartz, zirconia, silicon nitride, aluminum nitride, silicon carbide or combination thereof;

(d) applying the first surface of the sheet of uncured elastomeric adhesive comprises removing a transfer sheet from the first surface before applying the first surface to the at least one load bearing surface of the support member;

(e) applying the at least one bonding surface of the component comprises removing a transfer sheet from the second surface of the sheet of elastomeric adhesive before applying the at least one bonding surface of the component to the second surface of the sheet of uncured elastomeric adhesive;

(f) applying the first surface of the sheet of uncured elastomeric adhesive comprises applying a vacuum to the sheet of uncured elastomeric adhesive and the support member after applying the first surface to the at least one load bearing surface of the support member to remove gaps therebetween;

(g) applying the at least one bonding surface of the component comprises applying a vacuum to the sheet of uncured elastomeric adhesive, the component and the support member after applying the at least one bonding surface of the component to the second surface of the sheet of uncured elastomeric adhesive to remove gaps therebetween; and/or

(h) the component comprises a substrate support, a ring surrounding the substrate, a plasma confining screen, an optics tube window, a chamber sidewall liner, a gas injector, a gas ring, a gas nozzle, a gas distribution plate, and/or a temperature controlled gas distribution plate and the support member comprises a lower electrode, a mechanical clamp, an electrostatic chucking device, an optics tube, and/or a chamber sidewall bounding the plasma processing chamber.

22. A method of processing a semiconductor substrate with reduced particle contamination in a plasma processing apparatus comprising the bonded component assembly of Claim 1, the method comprising:

placing a substrate on a substrate support in an interior space of the plasma processing chamber;

introducing the process gas into the interior space of the plasma processing chamber with a composite showerhead electrode assembly, a gas ring, or a gas injector;

generating a plasma from the process gas in the interior space of the plasma processing chamber above the substrate;

processing the substrate with the plasma.

23. The method of Claim 22, wherein processing comprises etching the substrate.

24. A component assembly for reducing particle contamination during plasma processing of semiconductor substrates, the component assembly comprising:

a support member of a plasma processing chamber having at least one load bearing surface to support a component;

the component supported on the at least one load bearing surface having at least one surface to be exposed to a plasma; and

an uncured elastomeric sheet adhesive to be cured in a joint between mating surfaces of the at least one load bearing surface and the component to allow

movement of the component relative to the support member due to mismatch of thermal expansion of the support member and the component after curing,

wherein the sheet of elastomeric adhesive is a filled, heat-curable, unvulcanized elastomeric silicone sheet.

25. The component assembly of Claim 24, wherein the uncured elastomeric sheet adhesive is formulated with a peroxide as a heat activated component to perform a cross-linking reaction, the elastomeric sheet adhesive volume shrinkage is 3-5% during curing, or less than 3%.

26. The bonded component assembly of Claim 1, wherein the mating surface of the support member is non-parallel to the mating surface of the component.

27. The bonded component assembly of Claim 1, wherein the component is of single crystal silicon, polycrystalline silicon, graphite, quartz, sapphire, ceramic, silicon carbide, silicon nitride, yttria-containing ceramic, BN, B_4C or a combination thereof; and the support member is composed of aluminum, graphite, copper, alumina, quartz, zirconia, silicon nitride, aluminum nitride, silicon carbide, steel, molybdenum, tungsten or a combination thereof.

What is claimed is:

1. A bonded component assembly for use in a plasma processing apparatus for processing of semiconductor substrates, the component assembly comprising:

a support member having at least one load bearing surface to support a component;

the component supported on the at least one load bearing surface having at least one surface exposed to a plasma; and

an elastomeric sheet adhesive joint between mating surfaces of the at least one load bearing surface and the component to allow movement in a lateral direction of the component relative to the support member during temperature cycling due to mismatch of thermal expansion of the support member and the component;

wherein (a) the elastomeric sheet adhesive joint comprises an elastomeric sheet adhesive cast or rolled into a preform shape; (b) the elastomeric sheet adhesive joint comprises an elastomeric sheet adhesive of die cut preform shape; (c) the elastomeric sheet adhesive joint comprises an elastomeric sheet adhesive laser cut, plotter cut or water jet cut pre-form shape; or (d) one of the mating surfaces comprises a cavity.

2. The bonded component assembly of claim **1**, wherein

the support member comprises a lower electrode, a mechanical clamp, an electrostatic chucking device, an optics tube, or a chamber sidewall bounding a plasma processing chamber interior space; and

the component comprises a substrate support on which the substrate is processed within the interior space, a gas injector, a gas ring, a gas nozzle, a gas distribution plate, a temperature controlled gas distribution plate, a ring surrounding the substrate, a plasma confining screen, a liner to protect the chamber sidewall from a process gas, or an optics tube window.

3. The bonded component assembly of claim **1**, wherein (a) the mating surface of the support member is parallel to the mating surface of the component, (b) the mating surface of the support member is non-parallel to the mating surface of the component or (c) the component is of single crystal silicon, polycrystalline silicon, graphite, quartz, sapphire, ceramic, silicon carbide, silicon nitride, yttria-containing ceramic, BN, B_4C and a combination thereof; and the support member is composed of aluminum, graphite, copper, alumina, quartz, zirconia, silicon nitride, aluminum nitride, silicon carbide, steel, molybdenum, tungsten or combination thereof.

4. The bonded component assembly of claim **1**, wherein the elastomeric sheet adhesive joint comprises a thermally conductive and/or electrically conductive silicone adhesive sheet.

5. The bonded component assembly of claim **4**, wherein the elastomeric sheet adhesive joint is elastically deformable in the lateral direction to at least 500% shear strain by a shear stress of about 50 to 300 psi in a temperature range of room temperature to 300° C.

6. The bonded component assembly of claim **5**, wherein the elastomeric sheet adhesive joint is elastically deformable in the lateral direction to at least 800% shear strain by a shear stress of about 50 to 300 psi in a temperature range of room temperature to 300° C.

7. The bonded component assembly of claim **5**, wherein the elastomeric sheet adhesive joint is elastically deformable in the lateral direction to at least 500% shear strain by a shear stress of about 100 to 200 psi in a temperature range of room temperature to 180° C.

8. The bonded component assembly of claim **5**, wherein the elastomeric sheet adhesive joint is elastically deformable in the lateral direction to at least 500% shear strain from a shear stress of about 50 to 300 psi in a temperature range of room temperature to 300° C. after 5000 temperature cycles of heating the bonded component assembly from room temperature to 250° C.

9. The bonded component assembly of claim **4**, wherein (a) the thermally and/or electrically conductive silicone adhesive sheet comprises two or more laminated layers having different physical properties and/or (b) the thermally and/or electrically conductive silicone adhesive sheet comprises two or more co-planar portions having different physical properties.

10. The bonded component assembly of claim **4**, wherein at least one portion of the conductive silicone adhesive sheet has a thermal conductivity of about 0.2 to 1.0 W/mK and/or at least one portion of the conductive silicone adhesive sheet has a thermal conductivity of over 1.0 W/mK.

11. The bonded component assembly of claim **4**, wherein (a) the elastomeric sheet adhesive joint further comprises a primer on one or more of the mating surfaces of the support member and/or the component; and/or (b) the conductive silicone adhesive sheet comprises a uniform distribution of conductive filler.

12. The bonded component assembly of claim **11**, wherein (a) the thermally conductive filler is of boron nitride (BN), aluminum oxide (Al_2O_3), silicon, silicon carbide, or combination thereof and/or (b) the thermally conductive silicone adhesive sheet is of (i) high molecular weight dimethyl silicone and the thermally conductive filler, (ii) high molecular weight dimethyl silicone and the thermally conductive filler matrixed around fiberglass screen (scrim), (iii) high molecular weight dimethyl silicone and the thermally conductive filler matrixed around metallic screen or (iv) high molecular weight dimethyl silicone and the thermally conductive filler mixed with glass microbeads and/or nanobeads.

13. The bonded component assembly of claim **1**, wherein a gap distance between the mating surfaces varies by less than +/−25 μm (0.001 in).

14. The bonded component assembly of claim **1**, wherein (a) the cavity depth is in a range of 100 to 200 μm; (b) the cavity depth is in a range of 200 to 500 μm; (c) the cavity comprises an elevation jog sized to match a dimension of the sheet adhesive; (d) the sheet adhesive bonds the mating surface of the component to the at least one load bearing surface of the support member spaced apart by 50 to 400 μm; (e) the sheet adhesive joint comprises a silicone adhesive sheet in a form of a single sheet; (f) the sheet adhesive joint comprises a silicone adhesive sheet in a form of one or more flat rings, flat rings with elevation jogs, cylinders, flat or columnar polygons, blocks or combination thereof; and/or (g) the elastomeric sheet adhesive joint comprises a heat cured adhesive.

15. A method of processing a semiconductor substrate with reduced particle contamination in a plasma processing apparatus comprising the bonded component assembly of claim **1**, the method comprising:

placing a substrate on a substrate support in an interior space of a plasma processing chamber;

introducing a process gas into the interior space of the plasma processing chamber with a composite showerhead electrode assembly, a gas ring, or a gas injector;

generating a plasma from the process gas in the interior space of the plasma processing chamber above the substrate;

processing the substrate with the plasma.

16. The method of claim **15**, wherein processing comprises etching the substrate.