What is claimed is:

1. An RF bias workpiece support system for use in a plasma reactor chamber, comprising:

a puck having a workpiece support surface for supporting a workpiece;

a workpiece electrode embedded in said puck, said workpiece electrode underlying and generally parallel to said workpiece support surface;

a metal plate underlying said puck;

an annular process kit collar surrounding a peripheral edge of said workpiece support surface;

a process kit electrode element underlying said process kit collar;

an RF plasma bias power supply coupled to said workpiece electrode and to said process kit electrode element;

a variable RF impedance element comprising a reactive element having a variable reactance, said variable RF impedance element being coupled between said RF plasma power supply and one of: (a) said workpiece electrode, (b) said process kit electrode; and

a system controller connected to a control input of said variable RF impedance element whereby to govern said variable reactance of said reactive element of said variable RF impedance element.

2. The system of Claim 1 wherein:

said metal plate comprises a central portion underlying said workpiece support surface and an outer portion underlying said process kit collar;

said process kit electrode element comprises said outer portion of said metal plate, wherein said metal plate comprises an RF-driven cathode.

3. The system of Claim 1 further comprising:

an annular insulator layer surrounding said puck and said metal plate;

an annular process kit conductor in said insulator layer and extending axially through said annular insulator layer, said annular conductor comprising a kit support surface underlying and contacting said process kit collar;

and wherein said process kit electrode element comprises said annular conductor.

4. The system of Claim 1 further comprising an embedded planar process kit electrode in said puck and separate from and generally parallel with said workpiece electrode, said embedded process kit electrode comprising an annular outer portion underlying said process kit collar, and wherein:

said process kit electrode element comprises said annular outer portion of said embedded process kit electrode.

5. The system of Claim 1 wherein said variable RF impedance element is connected between said bias RF power supply and said workpiece electrode.

6. The system of Claim 5 further comprising a second variable RF impedance element connected between said bias RF power supply and said process kit electrode element, said system controller being connected to a control input of said second variable RF impedance element whereby to govern an impedance of said second variable RF impedance element.

7. The system of Claim 1 further comprising a cathode ground variable impedance element comprising an input terminal and a ground terminal, said input terminal being coupled to said workpiece electrode and to said process kit electrode element, said ground terminal being connected to an RF ground potential.

8. The system of Claim 1 further comprising:

a first electrostatic chucking voltage supply coupled to said workpiece electrode; and

a second electrostatic chucking voltage supply coupled to said process kit electrode element, said system controller being coupled to said first and second electrostatic chucking voltage supplies whereby to separately govern clamping forces applied to a workpiece on said workpiece support surface and to said process kit collar.

9. The system of Claim 2 wherein said puck comprises a central puck portion underlying said workpiece support surface and an outer puck portion underlying said process kit collar, said outer puck portion having a collar support surface underlying said collar, said system further comprising:

fluid coolant flow passages in said metal plate;

gas flow channels in said collar support surface.

10. The system of Claim 9 further comprising:

a process kit collar electrostatic chucking electrode underlying said collar;

a first electrostatic chucking voltage supply coupled to said workpiece electrode;

a second electrostatic chucking voltage supply coupled to said process kit collar electrostatic chucking electrode, said system controller being connected to govern separate output voltages of said first and second electrostatic chucking voltage supplies.

11. The system of Claim 3 further comprising:

fluid coolant flow passages in said annular process kit conductor;

gas flow channels in said kit support surface of said annular conductor.

12. The system of Claim 11 further comprising:

a first electrostatic chucking voltage supply coupled to said workpiece electrode;

a second electrostatic chucking voltage supply coupled to said process kit annular conductor; and

wherein said system controller is connected to separately govern output voltages of each of said first and second electrostatic chucking voltage supplies.

13. The system of Claim 4 further comprising:

a first electrostatic chucking voltage supply coupled to said workpiece electrode;

a second electrostatic chucking voltage supply coupled to said embedded process kit electrode; and

wherein said system controller is connected to separately govern output voltages of each of said first and second electrostatic chucking voltage supplies.

14. The system of Claim 1 wherein said puck comprises a bottom surface on a side opposite said workpiece support surface, said system further comprising:

an elongate center insulator extending axially along an axis of symmetry of said puck from said bottom surface of said puck and through said metal plate and terminated at a bottom end thereof;

an annular cathode feed conductor surrounding and extending coaxially with said center insulator from a bottom surface of said metal plate and terminated at a bottom end thereof; and

a workpiece electrode feed conductor extending through said center insulator and through said puck, said workpiece electrode feed conductor having a top end connected to said workpiece electrode and a bottom end extending through the bottom end of said center insulator to provide a current path between said bias RF power supply and said workpiece electrode.

Claims

1. An RF bias workpiece support system for use in a plasma reactor chamber, comprising:

a puck having a workpiece support surface for supporting a workpiece;

a workpiece electrode embedded in said puck, said workpiece electrode underlying and parallel to said workpiece support surface;

a metal plate underlying said puck;

an annular process kit collar surrounding a peripheral edge of said workpiece support surface;

a process kit electrode element underlying said process kit collar;

an RF plasma bias power supply coupled to said workpiece electrode and to said process kit electrode element;

a variable RF impedance element comprising a reactive element having a variable reactance, said variable RF impedance element being coupled between said RF plasma bias power supply and one of: (a) said workpiece electrode or (b) said process kit electrode;

a system controller connected to a control input of said variable RF impedance element whereby to govern said variable reactance of said reactive element of said variable RF impedance element; and

an embedded planar process kit electrode in said puck and separate from and parallel with said workpiece electrode, said embedded planar process kit electrode comprising an annular outer portion underlying said process kit collar,

wherein said process kit electrode element comprises said annular outer portion of said embedded planar process kit electrode.

2. The system of Claim 1 wherein: said metal plate comprises a central portion underlying said workpiece support surface and an outer portion underlying said process kit collar;

said process kit electrode element comprises said outer portion of said metal plate; and

said metal plate comprises an RF-driven cathode.

3. The system of Claim 1 further comprising: an annular insulator layer surrounding said puck and said metal plate; an annular process kit conductor in said annular insulator layer and extending axially through said annular insulator layer, said annular process kit conductor comprising a kit support surface underlying and contacting said process kit collar; and wherein said process kit electrode element comprises said annular process kit conductor.

4. The system of Claim 1 wherein said metal plate is grounded.

5. The system of Claim 1 wherein said variable RF impedance element is connected between said RF plasma bias power supply and said workpiece electrode.

6. The system of Claim 5 further comprising a second variable RF impedance element connected between said RF bias plasma power supply and said process kit electrode element, said system controller being connected to a control input of said second variable RF impedance element whereby to govern an impedance of said second variable RF impedance element .

7. The system of Claim 1 further comprising a cathode ground variable impedance element comprising an input terminal and a ground terminal, said input terminal being coupled to said workpiece electrode and to said process kit electrode element, said ground terminal being connected to an RF ground potential .

8. The system of Claim 1 further comprising:

a first electrostatic chucking voltage supply coupled to said workpiece electrode; and

a second electrostatic chucking voltage supply coupled to said process kit electrode element, said system controller being coupled to said first and second electrostatic chucking voltage supplies whereby to separately govern clamping forces applied to a workpiece on said workpiece support surface and to said process kit collar .

9. The system of Claim 2 wherein said puck comprises a central puck portion underlying said workpiece support surface and an outer puck portion underlying said process kit collar, said outer puck portion having a collar support surface underlying said collar, said system further comprising: fluid coolant flow passages in said metal plate; and gas flow channels in said collar support surface.

10. An RF bias workpiece support system for use in a plasma reactor chamber, comprising:

a puck having a workpiece support surface for supporting a workpiece;

a workpiece electrode embedded in said puck, said workpiece electrode underlying and parallel to said workpiece support surface;

a metal plate underlying said puck;

an annular process kit collar surrounding a peripheral edge of said workpiece support surface;

a process kit electrode element underlying said process kit collar;

an RF plasma bias power supply coupled to said workpiece electrode and to said process kit electrode element;

a variable RF impedance element comprising a reactive element having a variable reactance,

said variable RF impedance element being coupled between said RF plasma bias power supply and one of: (a) said workpiece electrode, or (b) said process kit electrode;

a system controller connected to a control input of said variable RF impedance element whereby to govern said variable reactance of said reactive element of said variable RF impedance element;

a process kit collar electrostatic chucking electrode underlying said collar;

a first electrostatic chucking voltage supply coupled to said workpiece electrode;

a second electrostatic chucking voltage supply coupled to said process kit collar electrostatic chucking electrode;

fluid coolant flow passages in said metal plate; and

gas flow channels in said collar support surface,

wherein: said metal plate comprises a central portion underlying said workpiece support surface and an outer portion underlying said process kit collar;

said process kit electrode element comprises said outer portion of said metal plate,

said metal plate comprises an RF-driven cathode,

said outer puck portion having a collar support surface underlying said collar, and

said system controller is connected to govern separate output voltages of said first and second electrostatic chucking voltage supplies.

11. The system of Claim 3 further comprising: fluid coolant flow passages in said annular process kit conductor; and gas flow channels in said kit support surface of said annular process kit conductor.

12. An RF bias workpiece support system for use in a plasma reactor chamber, comprising:

a puck having a workpiece support surface for supporting a workpiece;

a workpiece electrode embedded in said puck, said workpiece electrode underlying and parallel to said workpiece support surface;

a metal plate underlying said puck;

an annular process kit collar surrounding a peripheral edge of said workpiece support surface;

a process kit electrode element underlying said process kit collar;

an RF plasma bias power supply coupled to said workpiece electrode and to said process kit electrode element;

a variable RF impedance element comprising a reactive element having a variable reactance, said variable RF impedance element being coupled between said RF plasma bias power supply and one of: (a) said workpiece electrode, or (b) said process kit electrode;

a system controller connected to a control input of said variable RF impedance element

whereby to govern said variable reactance of said reactive element of said variable RF impedance element;

an annular insulator layer surrounding said puck and said metal plate;

an annular process kit conductor in said insulator layer and extending axially through said annular insulator layer, said annular process kit conductor comprising a kit support surface underlying and contacting said process kit collar;

fluid coolant flow passages in said annular process kit conductor;

gas flow channels in said kit support surface of said annular process kit conductor;

a first electrostatic chucking voltage supply coupled to said workpiece electrode; and

a second electrostatic chucking voltage supply coupled to said process kit annular conductor;

wherein: said process kit electrode element comprises said annular process kit conductor; and said system controller is connected to separately govern output voltages of each of said first and second electrostatic chucking voltage supplies.

13. The system of Claim 1 further comprising: a first electrostatic chucking voltage supply coupled to said workpiece electrode;

a second electrostatic chucking voltage supply coupled to said embedded planar process kit electrode; and

wherein said system controller is connected to separately govern output voltages of each of said first and second electrostatic chucking voltage supplies.

14. The system of Claim 1 wherein said puck comprises a bottom surface on a side opposite said workpiece support surface, said system further comprising:

an elongate center insulator extending axially along an axis of symmetry of said puck from said bottom surface of said puck and through said metal plate and terminated at a bottom end thereof;

an annular cathode feed conductor surrounding and extending coaxially with said center insulator from a bottom surface of said metal plate and terminated at a bottom end thereof; and

a workpiece electrode feed conductor extending through said center insulator and through said puck, said workpiece electrode feed conductor having a top end connected to said workpiece electrode and a bottom end extending through the bottom end of said center insulator to provide a current path between said RF plasma bias power supply and said workpiece electrode.