CLAIMS

1. A microwave system, comprising:

a solid-state generator for generating microwave energy characterized by one or more parameters, the solid-state generator having at least one control input for receiving a control signal to vary electrically the one or more parameters of the microwave energy;

a microwave load for receiving the microwave energy and producing an effect in response to the microwave energy ;

a microwave conducting element for coupling the microwave energy to the microwave load;

an impedance match adjusting device coupled to the microwave conducting element to vary at least one of the one or more parameters of the microwave energy; and

a controller for generating the control signal to vary one or more parameters of the microwave energy; wherein

the solid-state generator comprises: (i) a plurality of microwave amplifiers with independently controllable frequency, phase, and/or amplitude, each of the microwave amplifiers generating one of a respective plurality of amplified microwave signals and (ii) a microwave combiner receiving the plurality of amplified microwave signals and combining the plurality of amplified microwave signals into a single combined microwave signal and applying the single combined microwave signal as the microwave energy to the microwave load, and

the effect produced in response to the microwave energy is altered by both electrical variation of the one or more parameters of the microwave energy via the control signal and adjustment of the impedance match adjusting device to vary the at least one of the one or more parameters of the microwave energy.

2. The microwave system of claim 1, wherein the microwave conducting element comprises a waveguide.

3. The microwave system of claim 2, wherein the impedance match adjusting device comprises a mechanical stub tuner.

4. The microwave system of claim 2, wherein the microwave stub tuner comprises multiple stubs.

5. The microwave system of claim 1, wherein the control input is an electrical control input for receiving the control signal to vary electrically the one or more parameters of the microwave energy.

6. The microwave system of claim 1, wherein the microwave load comprises a chamber.

7. The microwave system of claim 5, wherein the chamber is used in processing a semiconductor substrate.

8. The microwave system of claim 1, wherein the microwave load comprises a chamber in which heat is controlled, the heat in the chamber being the effect produced in response to the microwave energy.

9. The microwave system of claim 7, wherein the chamber is used in processing a semiconductor substrate.

10. The microwave system of claim 1, wherein the microwave load comprises a plasma applicator, such that the microwave energy is used to generate plasma, the plasma being the effect produced in response to the microwave energy.

11. The microwave system of claim 1, further comprising a coax-to-waveguide transition for coupling the solid-state generator to a waveguide.

12. The microwave system of claim 1, further comprising a second solid-state generator for generating microwave energy, the microwave energy of the first solid-state generator having a first frequency and the microwave energy of the second solid-state generator having a second frequency.

13. The microwave system of claim 12, wherein the first and second frequencies of the first and second solid-state generators are different.

14. The microwave system of claim 12, wherein one of the first and second frequencies is approximately 915 MHz, and another of the first and second frequencies is approximately 2,450 MHz.

15. The microwave system of claim 12, further comprising a coax-to-waveguide transition for coupling the first and second solid-state generators to the microwave conducting element.

16. The microwave system of claim 1, further comprising a second solid-state generator for generating microwave energy, the microwave energy of the first solid-state generator having a first phase and the microwave energy of the second solid-state generator having a second phase.

17. The microwave system of claim 16, wherein the first and second phases of the first and second solid-state generators are different.

18. The microwave system of claim 1, wherein the solid-state generator further comprises a plurality of frequency synthesizers, each of the plurality of frequency synthesizes generating a microwave output signal with independently controllable frequency, phase, and/or amplitude, each of the microwave output signals being applied to a respective one of the plurality of microwave amplifiers.

19. The microwave system of claim 1, wherein the solid-state generator further comprises: (i) a frequency synthesizer generating a microwave output signal with independently controllable frequency, phase, and/or amplitude, and (ii) a splitter receiving the microwave output signal from the frequency synthesizer and splitting the microwave output signal from the frequency synthesizer into a plurality of split microwave signals, each of the split microwave signals being applied to a respective one of the plurality of microwave amplifiers.

20. A microwave plasma system, comprising:

a solid-state generator for providing microwave energy characterized by one or more parameters, the solid-state generator having at least one electrical control input for receiving a control signal to vary electrically the one or more parameters of the microwave energy;

a plasma applicator for receiving the microwave energy, the plasma applicator comprising a plasma discharge tube in which a plasma is generated in response to the microwave energy, a central longitudinal axis of the plasma discharge tube extending between opposite ends of the plasma discharge tube, the plasma generated in the plasma discharge tube being characterized by a spatial plasma intensity profile distributed longitudinally along the central longitudinal axis and radially from the central longitudinal axis, perpendicular to the central longitudinal axis, toward a radial wall of the plasma discharge tube;

a detector receiving a first signal from the plasma discharge tube and converting the first signal to an electrical signal indicative of the spatial plasma intensity profile in the plasma discharge tube; and

a controller receiving the electrical signal indicative of the spatial plasma intensity profile in the plasma discharge tube, generating from the electrical signal the control signal to vary electrically the one or more parameters of the microwave energy, and applying the control signal to the control input of the solid-state generator to vary electrically the one or more parameters of the microwave energy to alter the spatial plasma intensity profile in the plasma discharge tube; wherein

the solid-state generator comprises: (i) a plurality of microwave amplifiers with independently controllable frequency, phase, and/or amplitude, each of the microwave amplifiers generating one of a respective plurality of amplified microwave signals and (ii) a microwave combiner receiving the plurality of amplified microwave signals and combining the plurality of amplified microwave signals into a single combined microwave signal and applying the single combined microwave signal as the microwave energy to the plasma applicator.

21. The microwave plasma system of claim 20, wherein the detector is an optical detector, and the first signal is an optical signal.

22. The microwave plasma system of claim 21, wherein the optical detector comprises a camera.

23. The microwave plasma system of claim 20, wherein the detector is a temperature detector, and the first signal is a thermal signal.

24. The microwave plasma system of claim 23, wherein the temperature detector comprises a thermocouple.

25. The microwave plasma system of claim 20, further comprising:

a waveguide for coupling the microwave energy to the plasma discharge tube;

a mechanical tuner coupled to the waveguide to vary mechanically at least one of the one or more parameters of the microwave energy.

26. The microwave plasma system of claim 25, wherein the mechanical tuner comprises a microwave stub tuner.

27. The microwave plasma system of claim 26, wherein the microwave stub tuner comprises multiple stubs.

28. The microwave plasma system of claim 25, wherein the mechanical tuner is a fixed tuner.

29. The microwave plasma system of claim 25, wherein the mechanical tuner is a motorized binary tuner.

30. The microwave plasma system of claim 20, wherein the one or more parameters of the microwave energy comprise frequency of the microwave energy.

31. The microwave plasma system of claim 20, wherein the one or more parameters of the microwave energy comprise phase of the microwave energy.

32. The microwave plasma system of claim 20, wherein the solid-state generator comprises a plurality of frequency synthesizers with independently controllable frequency and/or phase, outputs of the plurality of frequency synthesizers being used to generate the microwave energy.

33. The microwave plasma system of claim 20, wherein the solid-state generator comprises a plurality of amplifiers with independently controllable frequency and/or phase, outputs of the plurality of amplifiers being used to generate the microwave energy.