

CLAIMS

What is claimed is:

1. A method for processing a substrate in a plasma processing system having at least one plasma processing chamber, said plasma processing chamber employing a plurality of RF power supplies for sustaining a plasma within said plasma processing chamber during said processing, comprising:

pulsing a first RF power supply of said plurality of RF power supplies to deliver a first RF signal between a high power state and a low power state, wherein said pulsing is performed at a first pulsing frequency; and

operating a second RF power supply of said plurality of RF power supplies in a fixed frequency mode wherein said second RF power supply is not permitted to self-tune a frequency of a second RF signal output by said second RF power supply and ~~whereby~~ wherein said second RF signal operates with at least two fixed alternate RF frequency values: a first RF frequency value and a second RF frequency value, ~~whereby~~ wherein said first RF frequency value and said second RF frequency value are learned earlier during a learning phase when said second RF power supply operates in a frequency self-tuning mode to self-tune an RF frequency of said second RF signal in response to said first RF signal pulsing between said high power state and said low power state at a second pulsing frequency lower than said first pulsing frequency.

2. The method of claim 1 further comprising:

operating a third RF power supply of said plurality of RF power supplies in a fixed frequency mode wherein said third RF power supply is not permitted to self-tune a frequency of a third RF signal output by said third RF power supply and ~~whereby~~ wherein said third RF signal operates with at least two fixed alternate RF frequency values: a third RF frequency value and a fourth RF frequency value, wherein said third RF frequency value and said fourth RF frequency value are learned earlier during said learning phase when said third RF power supply operates

in a frequency self-tuning mode to self-tune an RF frequency of said third RF signal in response to said first RF signal pulsing between said high power state and said low power state at a pulsing frequency lower than said first pulsing frequency.

3. The method of claim 1 wherein said first RF power supply represents an independently pulsing RF power supply and said second RF power supply changes an RF frequency of said second RF signal between at least said first RF frequency value and said second RF frequency value responsive to values of a measurable chamber parameter from said plasma processing chamber.

4. The method of claim 3 wherein said measurable chamber parameter represents gamma.

5. The method of claim 3 further including comparing said values of said measurable chamber parameter with pre-defined thresholds.

6. The method of claim 5 ~~whereby~~ wherein said pre-defined thresholds are acquired during said learning phase when said first RF power supply pulses between said high power state and said low power state at said second pulsing frequency lower than said first pulsing frequency.

7. The method of claim 6 ~~whereby~~ wherein said predefined thresholds comprises at least a first predefined threshold and a second predefined threshold, said first predefined threshold acquired when said second RF power supply operates in said fixed frequency mode during said learning phase while said second RF signal operates with said first RF frequency value and said first RF signal transitions from said high power state to said low power state, said second predefined threshold acquired when said second RF power supply operates in said fixed frequency mode during said learning phase while said second RF signal operates with said second RF frequency value and said first RF signal transitions from said low power state to said high power state.

8. The method of claim 7 wherein said first predefined threshold represents a sum of a first value of said measurable chamber parameter and a first threshold adjustment constant, said first value of said measurable chamber parameter acquired when said second RF power supply operates in said fixed frequency mode during said learning phase while said second RF signal operates with said first RF frequency value and said first RF signal transitions from said high power state to said low power state.

9. The method of claim 7 wherein said second predefined threshold represents a sum of a second value of said measurable chamber parameter and a second threshold adjustment constant, said second value of said measurable chamber parameter acquired when said second RF power supply operates in said fixed frequency mode during said learning phase while said second RF signal operates with said second RF frequency value and said first RF signal transitions from said low power state to said high power state.

10. The method of claim 1 wherein said low power state is other than zero watt.

11. A method for processing a substrate in a plasma processing system having at least one plasma processing chamber, said plasma processing chamber employing a plurality of RF power supplies for sustaining a plasma within said plasma processing chamber during said processing, comprising:

executing a learning phase, said learning phase comprising:

a) pulsing a first RF power supply of said plurality of RF power supplies to change a power level of a first RF signal between a low power state to a high power state, wherein said pulsing said first RF power supply in said learning phase is performed at a first pulsing frequency,

b) operating a second RF power supply of said plurality of RF power supplies in a self-tuning mode ~~whereby~~ wherein said second RF power supply is permitted to self-tune a frequency of a second RF signal output by said second RF

power supply and acquiring a first RF frequency value, said first RF frequency value represents an RF frequency that said second RF power supply self-tunes said frequency of said second RF signal to in said self-tuning mode when said first RF signal is in said high power state, and

c) thereafter operating said second RF power supply of said plurality of RF power supplies in said self-tuning mode wherein said second RF power supply is permitted to self-tune a frequency of a second RF signal output by said second RF power supply, and acquiring a second RF frequency value, said second RF frequency value represents an RF frequency that said second RF power supply self-tunes said frequency of said second RF signal to in said self-tuning mode when said first RF signal is in its low power state; and

executing a production phase, said production phase comprising:

d) having said first RF power supply of said plurality of RF power supplies to alternate said power level of said first RF signal between said low power state to said high power state, wherein said pulsing said first RF power supply in said production phase is performed at a second pulsing frequency faster than said first pulsing frequency, and

e) alternating said frequency of said second RF power supply between said first RF frequency value and said second RF frequency value while operating said second RF power supply in a fixed frequency mode ~~whereby~~ wherein said second RF power supply, in said fixed frequency mode, is not permitted to self-tune said frequency of said second RF signal in the manner that said second RF power supply self-tunes said frequency of said second RF signal while in the self-tuning mode.

12. The method of claim 11 wherein said executing said learning phase further comprises:

f) operating said second RF power supply in said fixed frequency mode and pulsing said first RF power supply to change said power level of said first RF signal from said high power state to said low power state, and thereafter acquiring, using sensors associated with said second RF power supply, a first value of a measurable chamber parameter while said second RF power supply operates in said fixed

frequency mode and said second RF signal has said first RF frequency value and said first RF signal has said low power state, ~~whereby~~ wherein step f) is executed between steps b) and c).

13. The method of claim 11 wherein said executing said learning phase further comprises:

g) operating said second RF power supply in said fixed frequency mode and pulsing said first RF power supply to change said power level of said first RF signal from said low power state to said high power state, and thereafter acquiring, using sensors associated with said second RF power supply, a second value of said measurable chamber parameter while said second RF power supply operates in said fixed frequency mode and said second RF signal has said second RF frequency value and said first RF signal has said high power state, ~~whereby~~ wherein step g) is executed after step c).

14. The method of claim 13 wherein said measurable plasma parameter represents gamma.

15. The method of claim 13 wherein said alternating is responsive to comparison of values of said measurable parameters against said first value of said measurable chamber parameters and said second value of said measurable chamber parameters.

16. The method of claim 13 wherein said alternating is responsive to comparison of values of said measurable chamber parameter against a first threshold value that represents said first value of said measurable chamber parameter plus a first threshold adjustment value.

17. The method of claim 16 wherein said alternating is responsive to comparison of values of said measurable chamber parameter against a second threshold value that represents said second value of said measurable chamber

parameter plus a second threshold adjustment value.

18. The method of claim 11 wherein said first RF power supply represents an independently pulsing RF power supply.

19. The method of claim 11 wherein said low power state is zero watt.

20. The method of claim 11 wherein said low power state is other than zero watt.