WHAT IS CLAIMED IS:

1. A plasma processing apparatus comprising:

a chamber;

a substrate support having a bias electrode and provided inside the chamber;

a radio frequency power supply configured to generate source radio frequency power for plasma generation within the chamber; and

a bias power supply configured to periodically supply an electric bias having a waveform cycle to the bias electrode,

wherein the radio frequency power supply is configured to set a source frequency of the source radio frequency power in each of a plurality of phase periods within the waveform cycle to a frequency obtained by adding a shift amount for minimizing a degree of reflection of the source radio frequency power and random noise to the source frequency in a same phase period within a preceding waveform cycle.

2. The plasma processing apparatus of Claim 1, wherein the radio frequency power supply is configured to:

if the degree of reflection in a n^{th} phase period within a $(m\text{-}M_2)^{th}$ waveform cycle among a plurality of waveform cycles that are repetitions of the waveform cycle decreases compared to the degree of reflection in the n^{th} phase period within a $(m\text{-}M_1)^{th}$ waveform cycle among the plurality of waveform cycles, set the shift amount, which is applied to the source frequency in the n^{th} phase period within the $(m\text{-}M_2)^{th}$ waveform cycle in order to set the source frequency in the n^{th} phase period within a m^{th} waveform cycle among the plurality of waveform cycles, to an amount having the same shift direction as that of the source frequency in the n^{th} phase period within the $(m\text{-}M_2)^{th}$ waveform cycle with respect to the source frequency in the n^{th} phase period within the $(m\text{-}M_1)^{th}$ waveform cycle; and

if the degree of reflection in the n^{th} phase period within the $(m\text{-}M_2)^{th}$ waveform cycle among the plurality of waveform cycles increases compared to the degree of reflection in the n^{th}

phase period within the $(m\text{-}M_1)^{th}$ waveform cycle, set the shift amount, which is applied to the source frequency in the n^{th} phase period within the $(m\text{-}M_2)^{th}$ waveform cycle in order to set the source frequency in the n^{th} phase period within the m^{th} waveform cycle, to an amount having a shift direction opposite to that of the source frequency in the n^{th} phase period within the $(m\text{-}M_2)^{th}$ waveform cycle with respect to the source frequency in the n^{th} phase period within the $(m\text{-}M_1)^{th}$ waveform cycle,

wherein M_1 and M_2 are natural numbers that satisfy $M_1>M_2$.

3. The plasma processing apparatus of Claim 2, wherein the shift amount has a fixed absolute value.

4. The plasma processing apparatus of Claim 2, wherein the shift amount, which is applied to the source frequency in the n^{th} phase period within the $(m\text{-}M_2)^{th}$ waveform cycle in order to set the source frequency in the n^{th} phase period within the m^{th} waveform cycle, has an absolute value depending on a magnitude of the degree of reflection in the n^{th} phase period within the $(m\text{-}M_2)^{th}$ waveform cycle.

5. The plasma processing apparatus of Claim 1, wherein the bias power supply is configured to periodically supply the electric bias so as to cause a plurality of waveform cycles that are repetitions of the waveform cycle for each of a plurality of pulse periods, and

wherein the radio frequency power supply is configured to:

if the degree of reflection in a n^{th} phase period within a m^{th} waveform cycle within a $(k\text{-}K_2)^{th}$ overlap period among a plurality of overlap periods overlapping the plurality of pulse periods decreases compared to the degree of reflection in the n^{th} phase period within the m^{th} waveform cycle within a $(k\text{-}K_1)^{th}$ overlap period among the plurality of overlap periods, set the shift amount, which is applied to the source frequency in the n^{th} phase period within the m^{th} waveform cycle within the $(k\text{-}K_2)^{th}$ overlap period in order to set the source frequency in the n^{th}

phase period within the m^{th} waveform cycle within a k^{th} overlap period among the plurality of overlap periods, to an amount having the same shift direction as that of the source frequency in the n^{th} phase period within the m^{th} waveform cycle within the $(k-K_2)^{th}$ overlap period with respect to the source frequency in the n^{th} phase period within the m^{th} waveform cycle within the $(k-K_1)^{th}$ overlap period; and

if the degree of reflection in the n^{th} phase period within the m^{th} waveform cycle within the $(k-K_2)^{th}$ overlap period increases compared to the degree of reflection in the n^{th} phase period within the m^{th} waveform cycle within the $(k-K_1)^{th}$ overlap period, set the shift amount, which is applied to the source frequency in the n^{th} phase period within the m^{th} waveform cycle within the $(k-K_2)^{th}$ overlap period in order to set the source frequency in the n^{th} phase period within the m^{th} waveform cycle within the k^{th} overlap period, to an amount having a shift direction opposite to that of the source frequency in the n^{th} phase period within the m^{th} waveform cycle within the $(k-K_2)^{th}$ overlap period with respect to the source frequency in the n^{th} phase period within the m^{th} waveform cycle within the $(k-K_1)^{th}$ overlap period,

wherein, K_1 and K_2 are natural numbers that satisfy $K_1>K_2$.

6. The plasma processing apparatus of Claim 5, wherein the shift amount has a fixed absolute value.

7. The plasma processing apparatus of Claim 5, wherein the shift amount, which is applied to the source frequency in the n^{th} phase period within the m^{th} waveform cycle within the $(k-K_2)^{th}$ overlap period in order to set the source frequency in the n^{th} phase period within the m^{th} waveform cycle within the k^{th} overlap period, has an absolute value depending on a magnitude of the degree of reflection in the n^{th} phase period within the m^{th} waveform cycle within the $(k-K_2)^{th}$ overlap period.

8. The plasma processing apparatus of any one of Claims 1 to 7, wherein the random noise

is generated according to a normal distribution with a mean value of zero.

9. The plasma processing apparatus of any one of Claims 1 to 7, wherein the random noise is generated according to a uniform distribution.

10. The plasma processing apparatus of any one of Claims 1 to 7, wherein the electric bias is either bias radio frequency power with a bias frequency that is a reciprocal of a time length of the waveform cycle, or a voltage pulse generated periodically at a time interval of the waveform cycle.

11. A plasma processing apparatus comprising:

a chamber;

a substrate support having a bias electrode and provided inside the chamber;

a radio frequency power supply configured to generate source radio frequency power for plasma generation within the chamber; and

a bias power supply configured to periodically supply an electric bias having a waveform cycle to the bias electrode,

wherein the radio frequency power supply is configured to set a source frequency of the source radio frequency power in each of a plurality of phase periods within the waveform cycle to a frequency obtained by adding a shift amount for minimizing a degree of reflection of the source radio frequency power and a disturbance to the source frequency in a same phase period within a preceding waveform cycle.

12. A method of controlling a source frequency of source radio frequency power, comprising:

applying an electric bias to a bias electrode of a substrate support provided inside a chamber of a plasma processing apparatus, the electric bias having a waveform cycle and being

applied periodically to the bias electrode;

supplying the source radio frequency power from a radio frequency power supply for plasma generation within the chamber; and

setting the source frequency of the source radio frequency power in each of a plurality of phase periods within the waveform cycle,

wherein in the setting the source frequency, the source frequency of the source radio frequency power in each of the plurality of phase periods within the waveform cycle is set to a frequency obtained by adding a shift amount for minimizing a degree of reflection of the source radio frequency power and random noise to the source frequency of the source radio frequency power in a same phase period within a preceding waveform cycle.

13. A method of controlling a source frequency of source radio frequency power, comprising:

applying an electric bias to a bias electrode of a substrate support provided inside a chamber of a plasma processing apparatus, the electric bias having a waveform cycle and being applied periodically to the bias electrode;

supplying the source radio frequency power from a radio frequency power supply for plasma generation within the chamber; and

setting the source frequency of the source radio frequency power in each of a plurality of phase periods within the waveform cycle,

wherein in the setting the source frequency, the source frequency of the source radio frequency power in each of the plurality of phase periods within the waveform cycle is set to a frequency obtained by adding a shift amount for minimizing a degree of reflection of the source radio frequency power and a disturbance to the source frequency of the source radio frequency power in a same phase period within a preceding waveform cycle.

14. A computer-readable storage medium storing a program for causing a plasma processing apparatus to execute a method of Claim 12 or 13.