

IMPEDANCE MATCHING SYSTEM, IMPEDANCE MATCHING METHOD AND SEMICONDUCTOR PROCESSING APPARATUS

TECHNICAL FIELD

5 The present invention relates to the field of microelectronic processing technology, and particularly, to an impedance matching system, an impedance matching method and a semiconductor processing apparatus.

BACKGROUND

10 In plasma processing systems, RF (radio frequency) energy is transmitted into a reaction chamber by an RF power supply, to excite the reaction gas in the reaction chamber to generate plasma containing a large number of active particles, and then the plasma interacts with a wafer, thereby completing a process such as etching or deposition. In the transmission of the RF energy, the output impedance of the RF
15 power supply is typically 50 ohm, while the input impedance of the reaction chamber is not 50 ohm. For this reason, in a case where the RF energy is directly transmitted into the reaction chamber, the RF energy may be reflected due to the impedance mismatching of the transmission path, causing that the reaction gas in the reaction chamber cannot be excited normally to generate the plasma. As such, a matching
20 device connected between the RF power supply and the reaction chamber is required to ensure the normal transmission of the RF energy.

 Fig. 1 is a functional block diagram of an existing matching device. Referring to Fig. 1, an RF system, which is configured to supply RF energy to a reaction chamber 60, includes an RF power supply 10 and a matching device 30. The RF power supply
25 10 has a pulse function. The matching device 30 is connected between the RF power supply 10 and the reaction chamber 60, and has an auto-matching function and a matching-position holding function. Specifically, the matching device 30 includes a detection unit 1, an impedance adjustment unit 2, a control unit 3, and two control
30 motors 4 and 5. The detection unit 1 is configured to detect a signal on a transmission line at a front end of the impedance adjustment unit 2, and to transmit the signal to the

control unit 3. The impedance adjustment unit 2 has an internal structure as illustrated in Fig. 2, in which two variable capacitors C2 and C3, a fixed capacitor C1, and fixed inductors L1 and L2 are included. The two control motors 4 and 5 are configured to respectively adjust the two variable capacitors C2 and C3 under the control of the control unit 3. At the beginning of a process, the RF power supply 10 is first switched into a continuous wave mode for outputting continuous wave power, and at the same time, the detection unit 1 transmits the input signal and the value of reflected power, which are detected in real time, to the control unit 3. The control unit 3 obtains adjustment amounts of the variable capacitors C2 and C3 based on a preset algorithm, and controls the two control motors 4 and 5 to adjust the two variable capacitors C2 and C3, respectively. In the adjustment process, the control unit 3 determines whether the value of reflected power, which is transmitted from the detection unit 1, is within a small threshold range. In a case where the value of reflected power is within the small threshold range, it is determined that the output impedance of the RF power supply 10 matches the input impedance of the matching device 30, and the impedance adjustment unit 2 is controlled to be in a hold mode in which the capacitance and other parameters of the two variable capacitors C2 and C3 are all kept unchanged, when the plasma remains stable. Meanwhile, the control unit 3 controls the RF power supply 10 to switch into a pulse wave mode for the process. After the process proceeds to a certain stage, the control unit 3 determines whether it is required to switch to a next process. If it is not required, the process continues until its end. If it is required, due to changes of all processing conditions, it is necessary to control the RF power supply 10 to switch into the continuous wave mode again and the matching device 30 performs the matching again. After completion of the matching, the impedance adjustment unit 2 is in the hold mode again, while the RF power supply 10 is switched into the pulse wave mode again for a new process. Rest processes are performed in a similar fashion until completion of all processes.

In actual applications, the above-described matching device 30 inevitably has the following problems.

First, an overshoot phenomenon may occur when the RF power supply 10

outputs the pulse power, causing a sudden change of the impedance of the RF system. Since the impedance adjustment unit 2 is in the hold mode while the RF power supply 10 is in the pulse wave mode, a response to the sudden change of the impedance cannot be made in time, so the impedance matching cannot be achieved continuously, which in turn affects the outcome of the process.

Second, the matching position of the impedance adjustment unit 2 in the continuous wave mode of the RF power supply 10 and that of the impedance adjustment unit 2 in the pulse wave mode of the RF power supply 10 are thought to be identical in default. In actual applications, however, the impedance of the RF system may be varied between these two modes under the same process conditions. As such, in a case where the matching positions are set to be identical in these two modes, the matching precision between the output impedance of the RF power supply 10 and the input impedance of the matching device 30 may be affected and the output impedance of the RF power supply 10 and the input impedance of the matching device 30 may even be mismatched. As a result, problems such as unstable matching and non-repeatable matching may occur, thereby affecting the outcome of the process.

SUMMARY

The present invention aims to address at least one of the technical problems existing in the prior art, and provides an impedance matching system, an impedance matching method and a semiconductor processing apparatus, which can enable a continuous wave radio frequency (RF) power supply to simulate a pulse wave mode, thereby reducing the cost of the system and improving the economic benefit in addition to avoiding the overshoot phenomenon in loading the pulsed RF power signal into the reaction chamber.

To address one of the above problems, the present invention provides an impedance matching system, which includes: an impedance matcher, arranged between a radio frequency (RF) power supply and a reaction chamber and capable of being connected to the RF power supply and the reaction chamber respectively, and configured to automatically perform an impedance matching on an output impedance

of the RF power supply and an input impedance of the impedance matcher; a selector switch and a load circuit, the selector switch being configured to enable the RF power supply to be selectively connected to the reaction chamber or to the load circuit; and a control unit, configured to control the selector switch to connect the RF power supply to the reaction chamber or connect the RF power supply to the load circuit according to a preset timing sequence, so that the impedance matcher converts a continuous wave output of the RF power supply into a pulse output, and provides the pulse output to the reaction chamber.

Optionally, the load circuit is provided with an adjustable load. And, the control unit includes: a switch control module, configured to control, according to a preset time sequence, the selector switch to enable the RF power supply to be connected to the reaction chamber or enable the RF power supply to be connected to the load circuit; and a load control module, configured to adjust an impedance of the adjustable load to be a preset impedance when the selector switch connects the RF power supply to the load circuit, the preset impedance being an input impedance of the reaction chamber at a last moment of a previous connection between the RF power supply and the reaction chamber.

Optionally, the adjustable load is connected in parallel with the reaction chamber and then connected to a rear end of the impedance matcher via the selector switch.

Optionally, the load circuit is only provided with a fixed load therein, and the control unit includes a switch control module configured to control, according to a preset time sequence, the selector switch to enable the RF power supply to be connected to the reaction chamber or enable the RF power supply to be connected to the load circuit.

Optionally, the impedance matcher is connected in series with the reaction chamber, and the impedance matcher and the reaction chamber connected in series are then connected in parallel with the fixed load, and further connected to a rear end of the RF power supply via the selector switch.

Optionally, the control unit is further configured to set an initial matching position of the impedance matcher as a matching position at a last moment of a

previous connection between the RF power supply and the reaction chamber when the selector switch connects the RF power supply to the reaction chamber.

Further optionally, the impedance matching system further includes a detection unit, and the control unit further includes a matching control module and the impedance matcher includes an impedance adjustment unit and an actuator unit. The impedance adjustment unit is provided in a transmission line between the RF power supply and the reaction chamber; the detection unit is configured to detect a signal in the transmission line at a front end of the impedance adjustment unit, and to transmit the signal to the matching control module; the matching control module is configured to obtain a control signal based on the signal transmitted from the detection unit, and to transmit the control signal to the actuator unit; and the actuator unit is configured to adjust an impedance of the impedance adjustment unit based on the control signal to perform the impedance matching.

Optionally, the selector switch has a preset initial state in which the RF power supply is connected to the reaction chamber; the matching control module is further configured to determine in real time, under the initial state of the selector switch, whether current matching is successful based on the signal transmitted from the detection unit, to transmit a start-up instruction to the switch control module if the current matching is successful, and to continue the impedance matching if the current matching is not successful.

Optionally, the impedance adjustment unit includes an adjustable capacitor; and the actuator unit includes a drive motor configured to adjust a value of a capacitance of the adjustable capacitor in a circuit.

Optionally, the selector switch includes: two separate switches, configured to be connected between the reaction chamber and the RF power supply and between the load circuit and the RF power supply, respectively; and the switch control module is configured to selectively control, according to the preset timing sequence, the two separate switches to be turned on or turned off.

Optionally, the separate switch is a relay, a diode or an RF switch.

Optionally, the selector switch includes a change-over switch at least having one

moving contact and two static contacts, the moving contact being connected with the RF power supply, one of the two static contacts being connected with the reaction chamber and the other one of the two static contacts being connected with the load circuit.

5 As another technical solution, the present invention further provides an impedance matching method for performing an impedance matching on an output impedance of a radio frequency (RF) power supply and an input impedance of an impedance matcher. The impedance matching method includes following steps of: providing a load circuit independent of a reaction chamber; enabling the RF power
10 supply to be selectively connected to the reaction chamber or connected to the load circuit according to a preset timing sequence, so as to convert a continuous wave output of the RF power supply to a pulse output and provide the pulse output to the reaction chamber; and automatically performing the impedance matching on the output impedance of the RF power supply and the input impedance of the impedance
15 matcher, when the RF power supply is connected to the reaction chamber.

Optionally, in a case where an adjustable load is provided in the load circuit, an impedance of the adjustable load is adjusted to a preset impedance, which is an input impedance of the reaction chamber at a last moment of a previous connection between the RF power supply and the reaction chamber, when the RF power supply is
20 connected to the load circuit.

Optionally, in a case where only a fixed load is provided in the load circuit, an initial matching position of the impedance matcher is set as a matching position at a last moment of the previous connection between the RF power supply and the reaction chamber when the RF power supply is connected to the reaction chamber.

25 As yet another technical solution, the present invention further provides a semiconductor processing apparatus, including an impedance matching system, a radio frequency (RF) power supply and a reaction chamber, the impedance matching system being arranged between the RF power supply and the reaction chamber, wherein the impedance matching system is the impedance matching system in any
30 one of the above technical solutions of the present invention.

The present invention has the following beneficial effects.

According to the impedance matching system and the impedance matching method provided by the present invention, the RF power supply always operates in the continuous wave mode and switch between the connection of the RF power supply to the reaction chamber and the connection of the RF power supply to the load circuit is controlled according to the preset timing sequence, such that an actual power signal received by the reaction chamber is a pulse modulated RF power signal (i.e., a pulsed RF power signal). That is to say, the impedance matching system and method provided by the present invention can simulate an operating mode of a pulsed RF power supply by using a continuous wave RF power supply, and compared to the prior art, the cost of the system can be reduced and the economic benefits can be increased due to the absence of the pulsed RF power supply, while the overshoot phenomenon can be avoided when a pulsed RF power signal is loaded to the reaction chamber; moreover, since the impedance matcher is capable of automatically performing the impedance matching when the RF power supply is switched to be connected to the reaction chamber, the matching speed, matching precision and matching stability can be improved.

The semiconductor processing apparatus provided by the present invention adopts the impedance matching system provided by any one of the above technical solutions of the present invention, thus can simulate an operating mode of a pulsed RF power supply by using a continuous wave RF power supply, and compared to the prior art, it also has the following benefits: the cost of the system can be reduced due to the absence of the pulsed RF power supply, while the overshoot phenomenon can be avoided when a pulsed RF power signal is loaded to the reaction chamber; moreover, since the impedance matcher is capable of automatically performing the impedance matching when the RF power supply is switched to be connected to the reaction chamber, matching precision and matching stability can be improved.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a functional block diagram of an existing matching device;

Fig. 2 is a schematic diagram illustrating an internal structure of an impedance adjustment unit;

Fig. 3 is a functional block diagram of an impedance matching system according to a second embodiment of the present invention;

5 Fig. 4 is a comparison diagram illustrating timing sequences of an output signal of an RF power supply in Fig. 3, a pulse modulation signal, a preset timing sequence signal and an actual input signal of a reaction chamber in Fig. 3;

Fig. 5 is a flowchart illustrating an operation of an impedance matching system according to an embodiment of the present invention;

10 Fig. 6 is a functional block diagram illustrating an impedance matching system according to a third embodiment of the present invention;

Fig. 7 is a functional block diagram illustrating an impedance matching system according to a fourth embodiment of the present invention;

15 Fig. 8 is a timing diagram illustrating an operation of the impedance matching system according to the fourth embodiment of the present invention;

Fig. 9 is a functional block diagram illustrating an impedance matching system according to a fifth embodiment of the present invention; and

Fig. 10 is a flowchart illustrating an operation of an impedance matching method according to an embodiment of the present invention.

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DETAILED DESCRIPTION

To make those skilled in the art better understand the technical solutions of the present invention, the impedance matching system, the impedance matching method and the semiconductor processing apparatus according to the present invention will be
25 described below in detail in conjunction with the accompanying drawings.

A first embodiment of the present invention provides an impedance matching system, which includes an impedance matcher, a selector switch, a load circuit and a control unit. The impedance matcher is connected with an RF power supply and a reaction chamber, respectively, and configured to automatically perform impedance
30 matching on an output impedance of the RF power supply and an input impedance of

impedance matcher. The load circuit is configured to provide an additional load for the RF power supply in addition to the reaction chamber. The selector switch is configured to enable the RF power supply to be selectively connected to the reaction chamber or to the load circuit. The control unit is configured to control the selector switch to connect the RF power supply to the reaction chamber or to the load circuit based on a preset timing sequence, such that the electric signal in the form of the pulse wave is loaded to the reaction chamber (i.e., the reaction chamber operates under the pulse wave mode). As such, the electric signal loaded to the reaction chamber can be in the form of the pulse wave, even though the RF power supply always operates in the continuous wave mode.

The preset timing sequence may be set in such a manner that a frequency and time of the connection between the RF power supply and the reaction chamber and a frequency and time of the connection between the RF power supply and the load circuit are calculated respectively, according to a pulse frequency and a duty cycle of the pulsed RF signal required by a process. The preset timing sequence is similar to a pulse modulation signal.

According to the impedance matching system in the embodiments of the present invention, the RF power supply always operates in the continuous wave mode and switch between the connection of the RF power supply to the reaction chamber and the connection of the RF power supply to the load circuit is controlled according to the preset timing sequence, such that an actual power signal received by the reaction chamber is a pulse modulated RF power signal (i.e., a pulsed RF power signal). That is to say, the impedance matching system provided by the present embodiment can have an operating mode of a pulse wave RF power supply by means of a continuous wave RF power supply, which has the following advantages over that in the prior art: the cost of the system can be reduced to increase economic benefits due to the absence of the pulsed RF power supply, and it is possible to avoid the overshoot phenomenon caused by the case where the pulsed RF power signal directly from the pulsed RF power supply is loaded to the reaction chamber; moreover, since the impedance matcher is capable of automatically performing the impedance matching when the RF

power supply is switched to be connected to the reaction chamber, the matching speed, matching precision and matching stability can be improved.

Next, an impedance matching system provided by a second embodiment of the present invention will be described in detail with reference to Fig. 3. The impedance matching system provided by the present embodiment is a preferred implementation of the impedance matching system provided by the first embodiment. In the present embodiment, the selector switch is a change-over switch at least having one moving contact and two static contacts, and the control unit is further configured to set the matching position of the impedance matcher at the initial moment of the current connection between the RF power supply and the reaction chamber as the matching position of the impedance matcher at the last moment of the previous connection between the RF power supply and the reaction chamber. As such, every time when the RF power supply and the reaction chamber are connected, the impedance matcher can achieve the matching quickly, thereby improving the impedance matching speed, and the stability and repeatability of the matching in a pulse mode.

Referring to Fig. 3, an impedance matching system 20 includes an impedance matcher 21, a change-over switch 22, a load circuit, and a control unit 24. The impedance matcher 21 is provided between an RF power supply 10 and a reaction chamber 60, and configured to automatically perform the impedance matching. The change-over switch 22 includes a moving contact connected with the RF power supply 10 and two static contacts of which one is connected with a circuit for connecting the reaction chamber 60 and the other is connected with the load circuit, and is configured to enable the RF power supply 10 to be selectively connected to the reaction chamber 60 or to the load circuit.

The load circuit is provided with an adjustable load 23, which is connected in parallel with the reaction chamber 60 and further connected to a rear end of the impedance matcher 21 via the change-over switch 22. The so-called rear end is defined with respect to the transmission direction of the power in the circuit, i.e., the rear end is at the output end of the impedance matcher 21 in the transmission direction of the power. The control unit 24 includes: a switch control module 241 configured to

control, according to a preset timing sequence, the change-over switch 22 to switch between a state in which the RF power supply 10 is connected to the reaction chamber 60 and a state in which the RF power supply 10 is connected to the load circuit; a load control module 242 configured to adjust an impedance of the adjustable load 23 to a preset impedance when the change-over switch 22 is switched to the state in which the RF power supply 10 is connected to the load circuit. The so-called preset impedance is an input impedance of the reaction chamber 60 at the last moment of the previous connection between the RF power supply 10 and the reaction chamber 60.

The preset timing sequence is the same as the pulse modulation signal required by the process, as illustrated in Fig. 4. When the pulse modulation signal is of a high level, the switch control module 241 controls the change-over switch 22 to switch to the state in which the RF power supply 10 is connected to the reaction chamber 60, and at this time, the reaction chamber 60 is capable of receiving an RF power signal. Moreover, when the pulse modulation signal is of a low level, the switch control module 241 controls the change-over switch 22 to switch to the state in which the RF power supply 10 is connected to the adjustable load 23, and at this time, the reaction chamber 60 cannot receive any RF power signal. Thus, an actual input signal of the reaction chamber 60 is illustrated in Fig. 4, that is, the reaction chamber 60 actually receives a pulse modulated RF power signal. Obviously, in actual applications, the switch control module 241 may be configured to control the change-over switch 22 to switch to the state in which the RF power supply 10 is connected to the reaction chamber 60 when the pulse modulation signal is of a low level, and to control the change-over switch 22 to switch to the state in which the RF power supply 10 is connected to the adjustable load 23 when the pulse modulation signal is of a high level.

The impedance matching system 20 includes a detection unit 29, the control unit 24 further includes a matching control module 243, and the impedance matcher 21 includes an impedance adjustment unit and an actuator unit. The impedance adjustment unit is provided in the transmission line between the RF power supply 10 and the reaction chamber 60. The detection unit 29 is configured to detect a signal,

such as a voltage and a current, in the transmission line at a front end of the impedance adjustment unit, and to transmit the detected signal to the matching control module 243. The matching control module 243 is configured to obtain a control signal based on the signal transmitted from the detection unit 29, and to transmit the control
5 signal to the actuator unit. More specifically, the matching control module 243 performs an impedance matching calculation to calculate a current load impedance of the RF power supply 10 based on the voltage signal and current signal transmitted from the detection unit 29, and compares the current load impedance with the characteristic impedance (typically, 50 ohm) of the RF power supply 10 to obtain the
10 control signal. The actuator unit is configured to adjust the impedance of the impedance adjustment unit based on the control signal, thereby achieving the impedance matching.

Preferably, the impedance adjustment unit includes adjustable capacitors C1 and C2; and the actuator unit includes drive motors M1 and M2 for adjusting capacitances
15 of the adjustable capacitors C1 and C2 in the circuit, respectively.

In the present embodiment, the input impedance of the reaction chamber 60 is obtained in a manner as follow: the matching control module 243 performs a calculation based on the obtained load impedance of the RF power supply 10 and the impedance of the impedance adjustment unit to obtain the input impedance of the
20 reaction chamber 60.

Additionally, in the present embodiment, the change-over switch 22 has a preset initial state in which the change-over switch 22 is connected to the reaction chamber 60, and the matching control module 243 is further configured to determine in real time, under the condition that the change-over switch 22 is in the initial state, whether
25 the current matching is successful based on the signal transmitted from the detection unit 211. If the current matching is successful, the matching control module 243 transmits a start-up instruction to the switch control module 241. Upon receipt of the start-up instruction, the switch control module 241 starts to control, according to a preset timing sequence, the change-over switch 22 to switch between the state in
30 which the RF power supply 10 is connected to the reaction chamber 60 and the state

in which the RF power supply 10 is connected to the adjustable load 23. If the current matching is not successful, the impedance matching is performed again.

From the above it can be seen that, in the present embodiment, the impedance matching is achieved in the continuous wave mode and then a pulse mode is entered.

5 In this case, preferably, an initial impedance of the adjustable load 23 is preset to the input impedance of the reaction chamber 60 in a state where the matching is achieved under the condition that the change-over switch 22 is in the initial state. The initial impedance is obtained by performing a calculation based on the current impedance of the impedance adjustment unit and the characteristic impedance of the RF power
10 supply 10 in the state where the matching is achieved; alternatively, by performing a calculation based on the current load impedance of the RF power supply 10 and the current impedance of the impedance adjustment unit in the state where the matching is achieved.

Next, how to achieve the impedance matching quickly in the pulse mode by the
15 impedance matching system provided by the embodiments of the present invention will be described in detail with reference to Fig. 5. In the present embodiment, it is assumed that the change-over switch 22 with a high level connects the impedance matcher 21 to the reaction chamber 60, the change-over switch 22 with a low level connects the impedance matcher 21 to the adjustable load 23, and the preset timing
20 sequence is of a high level at a first moment thereof. Moreover, the impedance of the impedance matcher 21 is defined as MZ , and the impedance of the reaction chamber 60 is defined as CZ_1 .

Referring to Fig. 5, the procedure of the impedance matching in the present embodiment mainly includes the following steps.

25 At step S1, a preset timing sequence is set in advance in the switch control module 241 (i.e., parameters, such as a frequency and a duty cycle of the pulse modulation signal required by a process, are preset in the switch control module 241), and the initial state of the change-over switch 22 is preset as a state where the RF power supply 10 is connected to the reaction chamber 60.

30 At step S2, the RF power supply is turned on, and the impedance matcher 21

starts to automatically perform the impedance matching.

At step S3, the matching control module 243 determines whether the current matching is successful, and if it is successful, a start-up instruction is transmitted to the switch control module 241, the current impedance of the impedance matcher 21 is defined as MZ_1 , the current impedance of the reaction chamber 60 is defined as CZ_1 , and the procedure proceeds to step S4; otherwise, the procedure returns to step S2.

At step S4, the switch control module 241 receives the start-up instruction and then starts its operation to control the operation mode of the change-over switch 22, details of which will be described as follows.

At step S411, in a high level period of a first pulse, the change-over switch 22 connects the impedance matcher 21 to the reaction chamber 60, and starting from MZ_1 , the impedance matcher 21 continues to automatically perform the impedance matching. The impedance of the impedance matcher 21 and the impedance of the reaction chamber 60 at the last moment of the high level period of the first pulse are defined as MZ_2 and CZ_2 , respectively.

At step S411', in a low level period of the first pulse, the change-over switch 22 is controlled to connect the impedance matcher 21 to the adjustable load 23, of which an initial impedance is CZ_1 . The load control module 242 adjusts the impedance of the adjustable load 23 from CZ_1 to CZ_2 ; and the impedance matcher 21 continues to perform the impedance matching from MZ_2 . Since the impedance of the adjustable load 23 is CZ_2 at the last moment of the low level period of the pulse, the impedance of the impedance matcher 21 remains MZ_2 at the last moment of the low level period of the pulse. That is to say, the matching position of the impedance matcher 21 is not changed after going through the low level period of the pulse.

At step S412, in a high level period of a second pulse, the change-over switch 22 is switched to connect the RF power supply 10 to the reaction chamber 60, i.e., the matching target is changed to the reaction chamber 60; the RF power supply 10 continues to output the RF power signal continuously; the impedance matcher 21 continues to automatically perform the impedance matching from MZ_2 , and at the last moment of the high level period of the pulse, the impedance of the impedance

matcher 21 is defined as MZ_3 , and the impedance of the reaction chamber 60 is defined as CZ_3 ; the impedance of the adjustable load 23 is kept unchanged as CZ_2 .

At step S412', in a low level period of the second pulse, the change-over switch 22 is switched to connect the RF power supply 10 to the adjustable load 23, and the RF power supply 10 continues to output the RF power signal continuously; the load control module 242 adjusts the impedance of the adjustable load 23 from CZ_2 to CZ_3 ; and the impedance matcher 21 continues to automatically perform the impedance matching from MZ_3 . Since the impedance of the adjustable load 23 is CZ_3 at the last moment of the low level period of the pulse, the impedance of the impedance matcher 21 remains MZ_3 at the last moment of the low level period of the pulse. That is to say, the matching position of the impedance matcher 21 is not changed after going through the low level period of the pulse.

Similarly, in a high level period of a subsequent N^{th} pulse, the RF power supply 10 continues to output the RF power signal continuously, the change-over switch 22 is switched to connect the RF power supply 10 to the reaction chamber 60; the impedance matcher 21 continues to automatically perform the impedance matching from MZ_N , and at the last moment of the high level period of the pulse, the impedance of the impedance matcher 21 is defined as MZ_{N+1} , and the impedance of the reaction chamber 60 is defined as CZ_{N+1} ; the impedance of the adjustable load 23 is kept unchanged as CZ_N .

In a low level period of the N^{th} pulse, the RF power supply 10 continues to output the RF power signal continuously; the change-over switch 22 is switched to connect the RF power supply 10 to the adjustable load 23, while the load control module 242 adjusts the impedance of the adjustable load 23 from CZ_N to CZ_{N+1} ; and the impedance matcher 21 continues to automatically perform the impedance matching from MZ_{N+1} . Similarly, since the impedance of the adjustable load 23 is CZ_{N+1} at the last moment of the low level period of the pulse, the impedance of the impedance matcher 21 remains MZ_{N+1} at the last moment of the low level period of the pulse. That is to say, the matching position of the impedance matcher 21 is not changed after going through the low level period of the pulse.

At step S5, the control unit 24 determines whether it is required to switch to a next process currently, if it is required, the procedure returns to step S1, and otherwise, the procedure proceeds to step S6.

At step S6, the control unit 24 determines whether the current process is finished,
5 if it is finished, the procedure proceeds to step S7, and otherwise, the procedure returns to step S4.

At step S7, the control unit 24 controls the RF power supply 10 to be off, and the current process ends.

It should be noted that although the above step S4 has been described by taking
10 an example in which it is of a high level in a first time period of the pulse mode, the present invention is not limited thereto. In actual applications, in the above step S4, it is also possible to be of a low level at a first time period of the pulse mode, to which the same procedure and principle can be applied, and details thereof will not be described herein.

15 It should also be noted that, in the present embodiment, the impedance matching is achieved in the continuous wave mode and then the simulated pulse wave mode is entered. In actual applications, as long as the impedance of the reaction chamber 60 in a state where the impedance matching is achieved in the continuous wave mode is not much different from the impedance of the reaction chamber 60 in a state where the
20 impedance matching is achieved in the pulse mode, the initial impedance of the adjustable load 23 can be set to the impedance of the reaction chamber 60 in the state where the impedance matching is achieved in the continuous wave mode as in the present embodiment, thereby the matching can further be quickly achieved in the pulse mode.

25 Moreover, it should be noted that, in the present embodiment, the selector switch is the change-over switch 22 at least having one moving contact and two static contacts, but the present invention is not limited thereto. In actual applications, the selector switch may also include two separate switches to be connected with the circuit between the reaction chamber 60 and the RF power supply 10 and connected
30 with the circuit between the load circuit and the RF power supply 10, respectively.

The switch control module 241 is configured to control the two separate switches to be turned on or turned off according to a preset timing sequence. Preferably, each of the separate switches may be an electronic switch such as a relay, a diode or an RF switch.

5 Referring to Fig. 6, it illustrates a functional block diagram of an impedance matching system provided by a third embodiment of the present invention. The impedance matching system 20, which is provided between an RF power supply 10 and a reaction chamber 60, includes a detection unit 29, an impedance matcher 21, a control unit 24 and a fixed load 28. The detection unit 29 is configured to detect an
10 output signal of the RF power supply 10 and a value of reflected power in real time, and to transmit the same to the control unit 24. The impedance matcher 21 is configured to enable an output impedance of the RF power supply 10 to match an input impedance of the impedance matching system 20. The fixed load 28 has an impedance that is equal to the output impedance of the RF power supply 10, e.g., in a
15 case where the input impedance of the RF power supply 10 is 50 ohm, then the fixed load 28 having the impedance of 50 ohm is employed. The control unit 24 is configured to perform a switch between a matching mode and a hold mode according to a preset timing sequence, i.e., to selectively connect the RF power supply 10 to the reaction chamber 60 or connect the RF power supply 10 to the fixed load 28. In the
20 embodiments of the present invention, the matching mode refers to a mode in which the control unit 24 controls the continuous wave power output from the RF power supply 10 to be loaded to the reaction chamber 60 via the impedance matcher 21; and the hold mode refers to a mode in which the control unit 24 controls the continuous wave power output from the RF power supply 10 to be loaded onto the fixed load 28.

25 During a current process, the RF power supply 10 always outputs the continuous wave power, while the continuous wave output of the RF power supply 10 is converted, according to a preset timing sequence, into a pulse sequence output supplied to the reaction chamber 60 and the fixed load 28, respectively. Further, in a case where the RF power supply 10 is connected to the reaction chamber 60, an initial
30 matching position of the impedance matcher 21 is set as the matching position at the

last moment of the previous connection between the RF power supply 10 and the reaction chamber 60, and the impedance matcher 21 automatically performs the matching; while in a case where the RF power supply is connected to the fixed load 28, the impedance matcher 21 is kept at its current matching position. Alternatively, after the impedance matching is completed in a first-time matching mode, the impedance matcher 21 is always kept at its current matching position without any changes. Accordingly, the impedance matching system provided by the present embodiment can avoid the occurrence of the overshoot phenomenon when the pulsed RF power signal is loaded to the reaction chamber, and can improve the matching speed, matching precision and matching stability while reducing the system costs.

Fig. 7 is a functional block diagram illustrating an impedance matching system provided by a fourth embodiment of the present invention. The structure and functions of the impedance matching system 20 are further refined in the present embodiment on the basis of the above-described third embodiment. Further, the selector switch in the present embodiment includes a first switch 221 and a second switch 222, thereby enabling the RF power supply 10 to be selectively connected to the reaction chamber 60 or to the fixed load 28 by means of the control unit 24, the first switch 221 and the second switch 222. Specifically, the first switch 221 is configured to connect or disconnect the RF power supply 10 and the impedance matcher 21, that is, the first switch 221 is configured to connect or disconnect the RF power supply 10 and the reaction chamber 60; the second switch 222 is configured to connect or disconnect the RF power supply 10 and the fixed load 28. The control unit 24 includes a switch control module (not shown) configured to turn on or turn off the first switch 221 and the second switch 222 according to a preset timing sequence, such that the RF power supply 10 is connected to the reaction chamber 60 or the RF power supply 10 is connected to the fixed load 28. Specifically, the switch control module is configured to turn on the first switch 221 and turn off the second switch 222 when the matching mode is switched on, and at this time, the continuous wave power of the RF power supply 10 is loaded onto the reaction chamber 60 via the impedance matcher 21; and the switch control module is configured to turn on the second switch 222 and turn off

the first switch 221 when the hold mode is switched on, and at this time, the continuous wave power of the RF power supply 10 is loaded onto the fixed load 28 and no RF energy is input to the impedance matcher 21 and the reaction chamber 60. That is to say, the control unit 24 is configured to control the first switch 221 and the second switch 222 to be turned on, alternately, according to the preset timing sequence, thereby enabling the continuous wave output of the RF power supply 10 to be converted into a pulse sequence output supplied to the reaction chamber 60 and the fixed load 28, respectively. As such, instead of the pulse wave power output of an existing RF power supply, only an RF power supply having a continuous wave power output function may be adopted, and the cost of using the RF power supply can be reduced.

Further, the control unit 24 is first switched to the matching mode when a process starts, so that the impedance matcher 21 automatically performs the impedance matching in the first-time matching mode. After the matching is completed, when the RF power supply 10 is connected to the reaction chamber 60 subsequently, an initial matching position of the impedance matcher 21 is set as the matching position at the last moment of the previous connection between the RF power supply 10 and the reaction chamber 60, and the impedance matcher 21 automatically performs the matching; and when the RF power supply 10 is connected to the fixed load 28 subsequently, the impedance matcher is kept at its current matching position. Alternatively, in any subsequent matching mode or hold mode, the matching position of the impedance matcher 21 is kept unchanged until the completion of the whole process. In actual applications, each of the first switch 211 and the second switch 222 may adopt an on-off switch such as a relay, a diode switch or an RF switch.

In the present embodiment, the impedance matcher 21 includes two variable capacitors (C1, C2) and two control motors (M1, M2), and the two control motors (M1, M2) are configured to adjust the capacitances of the two variable capacitors (C1, C2), respectively. In the first-time matching mode, the control unit 24 calculates based on the value of reflected power transmitted from the detection unit 29 and a matching algorithm to obtain target values of the capacitances of the two variable capacitors

(C1, C2), and controls the two control motors (M1, M2) respectively to adjust values of the capacitances of the two variable capacitors (C1, C2) to the target values of the capacitances. The target values of the capacitances are the capacitances of the variable capacitors when the output impedance of the RF power supply 10 matches the input
5 impedance of the impedance matching system 20.

Next, an operation mode of the impedance matching system provided by the present embodiment will be described in detail with reference to an operation timing diagram illustrated in Fig. 8. In this operation mode, when the RF power supply 10 is connected to the reaction chamber 60, the initial matching position of the impedance
10 matcher 21 may be set as the matching position at the last moment of the previous connection between the RF power supply 10 and the reaction chamber 60. As illustrated in Fig. 8, a preset timing sequence of the control unit 24 is required to be set in advance, and the preset timing sequence is set in a manner as follow: a frequency and time of connecting, by the first switch 221, the RF power supply 10
15 and the impedance matcher 21 and a frequency and time of connecting, by the second switch 222, the RF power supply 10 and the fixed load 28 are calculated respectively according to a frequency and a duty cycle of a pulse required by a process, i.e., a frequency and a duty cycle of a pulse wave output by an existing RF power supply. The calculated frequencies and duty cycles are respectively written into the switch
20 control modules of the control unit 24 corresponding to the first switch 221 and the second switch 222, thereby achieving control of on/off states of each of the first switch 221 and the second switch 222 according to the preset timing sequence. For example, in a case where a pulse having a frequency of 1000Hz and a duty cycle of 70% is required to be loaded, a switched-on time of the first switch 221 in the
25 first-time matching mode is 0.7 ms, which is a switched-off time of the second switch 222; the switched-on time of the second switch 222 in the hold mode is 0.3ms, which is the switched-off time of the first switch 221, while the first switch 221 and the second switch 222 each has an on-off frequency of 1000Hz. During a process, the control unit 24 controls on/off states of the first switch 221 and the second switch 222
30 based on the above-described on/off times and frequencies. In actual applications, the

frequency of the pulse required by a process may be set to 400 KHz, 2 MHz, 13 MHz, 27 MHz, 40 MHz, 60 MHz or other frequencies according to specific situations, and the present invention has no particular limitation thereto.

When a process starts, the RF power supply 10 is turned on, and the RF power supply 10 is always maintained to output continuous wave power. At the same time, the control unit 24 is first switched to the matching mode, in which the first switch 221 is switched on and the second switch 222 is switched off, and the detection unit 29 automatically detects the input signal of the RF power supply 10 and the value of reflected power, and transmits the same to the control unit 24. Upon receiving the input signal and the value of reflected power, the control unit 24 performs a calculation based on the value of reflected power and a preset matching algorithm. Specifically, the target values of the capacitances of the two variable capacitors (C1, C2) are calculated and compared with the current values of the capacitances of the two variable capacitors (C1, C2), respectively, and based on the result of the comparison, control signals are transmitted to the two control motors (M1, M2), respectively. Based on the control signals, the two control motors (M1, M2) adjust the values of the capacitances of the two variable capacitors (C1, C2) respectively until these values are equal to the target values of the capacitances, thereby enabling the output impedance of the RF power supply 10 to match the input impedance of the impedance matching system 20, that is, the impedance matcher 21 completes the impedance matching operation.

After the impedance matcher 21 completes the impedance matching operation, the control unit 24 is switched to the hold mode, in which the second switch 222 is switched on and the first switch 221 is switched off, the continuous wave power of the RF power supply 10 is loaded onto the fixed load 28, and there is no RF energy input to the impedance matcher 21 and the reaction chamber 60. In the subsequent procedure, as illustrated in Fig. 8, the RF power supply 10 keeps outputting the continuous wave power, and when the first switch 221 is in an ON state and the second switch 222 is in an OFF state, i.e., when the RF power supply 10 is connected to the reaction chamber 60, the initial matching position of the impedance matcher 21

is the matching position at the last moment of the previous connection between the RF power supply 10 and the reaction chamber 60; when the first switch 221 is in an OFF state and the second switch 222 is in an ON state, the impedance matcher 21 is controlled to keep its current matching position unchanged. The control unit 24
5 controls the first switch 221 and the second switch 222 to be switched on, alternately, according to the preset timing sequence, thereby enabling the continuous wave output of the RF power supply 10 to be converted into a pulse sequence output supplied to the impedance matcher 21 and the reaction chamber 60, respectively, until the end of the process. When the process is required to be switched, the RF power supply 10 is
10 required to be turned off, and then the output of the whole pulse timing sequence restarts and the impedance matcher 21 restarts to perform the impedance matching.

In actual applications, when the first-time matching mode is enabled, in a case where the switch-on time of the first switch 221 is not sufficient for the impedance matcher 21 to complete the impedance matching operation (i.e., the impedance
15 matcher 21 does not achieve a matched state during the switch-on time period of the first switch 221), the switch-on time of the first switch 221 may be appropriately prolonged, and once the impedance matcher 21 completes the impedance matching operation, the first switch 221 is switched off and the second switch 222 is switched on.

It should be noted that, in the present embodiment, the impedance matcher 21
20 adopts an L-shaped matching network structure, in which the two variable capacitors (C1, C2) and the two control motors (M1, M2) are used for achieving the impedance matching. However, the present invention is not limited thereto, and in actual applications, the matcher may adopt a matching network structure having an “inverted
25 L” shape, a “T” shape, a “ π ” shape or any other shape according to specific situations.

Fig. 9 is a functional block diagram of an impedance matching system provided by a fifth embodiment of the present invention. Referring to Fig. 9, the impedance matching system provided by the present embodiment is different from that of the fourth embodiment only in that a change-over switch 22 is employed instead of the
30 first switch 221 and the second switch 222. In the present embodiment, the RF power

supply 10 is enabled to be selectively connected to the reaction chamber 60 and the fixed load 28 by means of the control unit 24 and the change-over switch 22. Specifically, the change-over switch 22 is configured to selectively connect the RF power supply 10 and the impedance matcher 21 or connect the RF power supply 10 and the fixed load 28. The control unit 24 is configured to control the change-over switch 22 to connect the RF power supply 10 and the impedance matcher 21 in the matching mode and to control the change-over switch 2 to connect the RF power supply 10 and the fixed load 28 in the hold mode.

Similar to the settings of the switched-on times and the frequencies of the first switch 221 and the second switch 222 in the fourth embodiment, the preset timing sequence of the control unit 24 is set in a manner as follows: a frequency and time period of connecting the RF power supply 10 and the impedance matcher 21 by the change-over switch 22 and a frequency and time of connecting the RF power supply 10 and the fixed load 28 by the change-over switch 22 are calculated respectively according to a frequency and a duty cycle of a pulse required by a process.

It should be noted that, in the third through fifth embodiments, the load circuit is only provided with the fixed load 28 therein, and the impedance matcher 21 is connected in series with the reaction chamber 60 and then connected in parallel with the fixed load 28, and further connected to the rear end of the RF power supply 10 via the selector switch. The so-called rear end is defined with respect to the transmission direction of the power in the circuit, i.e., the rear end is at the output end of the RF power supply 10 in the transmission direction of the power.

It should also be noted that, in the third through fifth embodiments, the control unit 24 has functions including a writing/reading function for writing in the frequencies and times of the first switch 221 and the second switch 222, a function of controlling the on/off states of the first switch 221 and the second switch 222, and a function of calculating and controlling the matching operation of the impedance matcher 21 or keeping the matching position unchanged. In actual applications, in every matching mode and every hold mode subsequent to the successful first-time matching, the control unit 24 enables the impedance matcher 21 to keep at the

matching position at a time when the first-time matching is successful. Alternatively, when the RF power supply 10 is connected to the reaction chamber 60, the initial matching position of the impedance matcher 21 is set as the matching position at the last moment of the previous connection between the RF power supply 10 and the reaction chamber 60. As such, the matching can be performed in real time during the process, thereby further improving the speed and precision of the matching.

As another technical solution, embodiments of the present invention further provide a semiconductor processing apparatus, which includes an RF power supply, a reaction chamber and an impedance matching system arranged between the RF power supply and the reaction chamber. The impedance matching system may adopt any of the impedance matching systems provided by the above embodiments of the present invention.

In actual applications, the semiconductor processing apparatus may be an inductively coupled plasma processing apparatus or a capacitively coupled plasma processing apparatus.

The semiconductor processing apparatus provided by the embodiment of the present invention adopts the impedance matching system provided by any of the above embodiments of the present invention. As such, the RF power supply always operates in the continuous wave mode, and the power signal actually obtained by the reaction chamber is a pulsed RF power signal by controlling a switch between a connection of the RF power supply with the reaction chamber and a connection of the RF power supply with the load circuit according to preset timing sequence, such that the reaction chamber can obtain a pulsed RF power signal without additional arrangement of the pulsed RF power supply, thereby reducing the costs of the system. Meanwhile, when the pulsed RF power signal is loaded to the reaction chamber, the overshoot phenomenon in the prior art caused by the loading of the pulsed RF power signal directly transmitted from the pulsed RF power supply can be avoided. Moreover, since the impedance matcher can automatically perform the impedance matching when the RF power supply is switched to be connected to the reaction chamber, the matching stability and matching precision can be improved.

As yet another technical solution, embodiments of the present invention further provide an impedance matching method, to which an impedance matching system including an impedance matcher is applied. The impedance matcher is connected to an RF power supply and a reaction chamber, respectively, and configured to perform the impedance matching on the output impedance of the RF power supply and the input impedance of the impedance matcher. The impedance matching method includes the following steps of:

controlling the RF power supply to be selectively connected to the reaction chamber and connected to a load circuit according to a preset timing sequence, such that the impedance matcher converts a continuous wave output of the RF power supply to a pulse output to be loaded to the reaction chamber, wherein the load circuit is an additional load for the RF power supply in addition to the reaction chamber; and automatically performing an impedance matching by the impedance matcher when the RF power supply is connected to the reaction chamber.

In actual applications, preferably, the impedance matching method further includes determining whether it is required to switch a process; if it is required, turning off the RF power supply, restarting output of whole pulse sequence, and restarting the impedance matching by the impedance matcher; and if it is not required, determining whether the process is completed, if it is determined that the process is not completed, continuing to perform the above impedance matching method, and if it is determined that the process is completed, turning off the RF power supply and terminating the process.

In actual applications, in a case where an adjustable load is provided in the load circuit, an impedance of the adjustable load may be adjusted to a preset impedance when the RF power supply is connected to the load circuit, wherein the preset impedance is an input impedance of the reaction chamber at the last moment of the previous connection between the RF power supply and the reaction chamber.

In actual applications, in a case where the load circuit is only provided with a fixed load, when the RF power supply is connected to the reaction chamber, an initial matching position of the impedance matcher may be set as a matching position at the

last moment of the previous connection between the RF power supply and the reaction chamber; alternatively, the impedance matcher is always kept at a matching position at a time when a first-time matching is successful, in every matching mode and every hold mode subsequent to the successful first-time matching.

5 Next, the impedance matching method provided by the embodiments of the present invention will be described in detail by taking the case of using the impedance matching system provided by the fourth embodiment to perform the impedance matching as an example. In the present embodiment, the impedance matching system operates in another operation mode different from that illustrated in Fig. 8: i.e., in
10 every matching mode and every hold mode subsequent to the successful first-time matching, the impedance matcher 21 is always kept at the matching position at a time when the first-time matching is successful. Referring to Fig. 10, before a process starts, a frequency and a time of connecting the RF power supply 10 and the impedance matcher 21 by the first switch 221 are calculated in advance according to a
15 frequency and a duty cycle of a pulse required by a process. Moreover, the RF power supply 10 is in an OFF state, the first switch 221 and the second switch 222 are each in an OFF state, and the impedance matcher 21 is in the auto-matching mode. Then, during the current process, the following operations are performed sequentially.

At a first stage, the RF power supply 10 is turned on, and the RF power supply
20 10 is always maintained to output continuous wave power. The first switch 221 is switched on and the second switch 222 is switched off, and the impedance matcher 21 is in the auto-matching mode, i.e., the impedance matching operation is performed. Then, it is determined whether an output impedance of the RF power supply 10 completely matches an input impedance of the impedance matcher 21, if yes, the
25 method proceeds to a second stage, otherwise, the first stage is repeated.

At the second stage, the control unit 24 performs a switch between the hold mode and the matching mode according to a preset timing sequence, i.e., controls the first switch 221 and the second switch 222 to be switched on alternately according to the preset timing sequence, thereby enabling the continuous wave output of the RF power
30 supply 10 to be converted into a pulse sequence output supplied to the impedance

matcher 21 and the reaction chamber 60, respectively. Meanwhile, the RF power supply 10 is always maintained to output the continuous wave power, and the impedance matcher 21 is controlled to keep its current matching position unchanged until end of the current process.

5 At a third stage, it is determined whether it is required to switch the process, if it is required, the RF power supply 10 is required to be turned off, output of whole pulse sequence restarts, and the impedance matcher 21 restarts the impedance matching, i.e., the operation of the first stage is repeated; and if it is not required, it is determined whether the process is completed, if it is determined that the process is not completed,
10 the operation of the second stage is repeated, and if it is determined that the process is completed, the RF power supply 10 is turned off.

 According to the impedance matching method provided by the embodiments of the present invention, compared to the prior art, the overshoot phenomenon in the prior art caused by the loading of the pulsed RF power signal directly transmitted
15 from the pulsed RF power supply can be avoided when the pulsed RF power signal is loaded to the reaction chamber, because the pulsed RF power signal is not directly transmitted from the RF power supply. Moreover, since the impedance matcher automatically performs the impedance matching when the RF power supply is switched to be connected to the reaction chamber, the phenomenon of unstable
20 matching and unrepeatable matching can be alleviated in the simulated pulse mode, thereby ensuring the matching precision and speed. Further, since the expensive RF power supply with a pulse mode function is not required, the cost can be reduced and the economic benefit can be improved.

 It should be noted that the so-called auto-matching in the present invention
25 should include the following cases: the matching is achieved by keeping the matching position of the adjustable impedance of the impedance matcher unchanged; alternatively, the matching is achieved by changing the matching position of the adjustable impedance of the impedance matcher. That is to say, in the present invention, regardless of whether the matching position of the adjustable impedance of
30 the impedance matcher needs to be adjusted, it is considered as automatically

performing the impedance matching on the output impedance of the RF power supply and the input impedance of the impedance matcher as long as the purpose of matching the output impedance of the RF power supply and the input impedance of the impedance matcher can be achieved.

- 5 It should also be understood that the foregoing implementations are merely exemplary embodiments for illustrating the principle of the present invention, but the present invention is not limited thereto. Various modifications and improvements may be made for those of skilled in the art without departing from the spirit and essence of the present invention. Accordingly, these modifications and improvements are also
- 10 construed as the protection scope of the present invention.

What is claimed is:

1. An impedance matching system, comprising:

an impedance matcher, arranged between a radio frequency (RF) power supply
5 and a reaction chamber and capable of being connected to the RF power supply and
the reaction chamber respectively, and configured to automatically perform an
impedance matching on an output impedance of the RF power supply and an input
impedance of the impedance matcher;

a selector switch and a load circuit, the selector switch being configured to
10 enable the RF power supply to be selectively connected to the reaction chamber or to
the load circuit; and

a control unit, configured to control the selector switch to connect the RF power
supply to the reaction chamber or connect the RF power supply to the load circuit
according to a preset timing sequence, so that the impedance matcher converts a
15 continuous wave output of the RF power supply into a pulse output, and provides the
pulse output to the reaction chamber.

2. The impedance matching system according to claim 1, characterized in that, an
adjustable load is provided in the load circuit; and

20 the control unit comprises:

a switch control module, configured to control, according to a preset time
sequence, the selector switch to enable the RF power supply to be connected to the
reaction chamber or enable the RF power supply to be connected to the load circuit;
and

25 a load control module, configured to adjust an impedance of the adjustable load
to be a preset impedance when the selector switch connects the RF power supply to
the load circuit, the preset impedance being an input impedance of the reaction
chamber at a last moment of a previous connection between the RF power supply and
the reaction chamber.

3. The impedance matching system according to claim 2, characterized in that, the adjustable load is connected in parallel with the reaction chamber and then connected to a rear end of the impedance matcher via the selector switch.

5 4. The impedance matching system according to claim 1, characterized in that, only a fixed load is provided in the load circuit, and

the control unit comprises a switch control module configured to control, according to a preset time sequence, the selector switch to enable the RF power supply to be connected to the reaction chamber or enable the RF power supply to be
10 connected to the load circuit.

5. The impedance matching system according to claim 4, characterized in that, the impedance matcher is connected in series with the reaction chamber, and the impedance matcher and the reaction chamber connected in series are then connected
15 in parallel with the fixed load, and further connected to a rear end of the RF power supply via the selector switch.

6. The impedance matching system according to claim 4, characterized in that, the control unit is further configured to set an initial matching position of the
20 impedance matcher as a matching position at a last moment of a previous connection between the RF power supply and the reaction chamber when the selector switch connects the RF power supply to the reaction chamber.

7. The impedance matching system according to claim 2 or 4, characterized in
25 that, the impedance matching system comprises a detection unit, and the control unit further comprises a matching control module and the impedance matcher comprises an impedance adjustment unit and an actuator unit, wherein

the impedance adjustment unit is provided in a transmission line between the RF power supply and the reaction chamber;

30 the detection unit is configured to detect a signal in the transmission line at a

front end of the impedance adjustment unit, and to transmit the signal to the matching control module;

the matching control module is configured to obtain a control signal based on the signal transmitted from the detection unit, and to transmit the control signal to the actuator unit; and

the actuator unit is configured to adjust an impedance of the impedance adjustment unit based on the control signal to perform the impedance matching.

8. The impedance matching system according to claim 7, characterized in that, the selector switch has a preset initial state in which the RF power supply is connected to the reaction chamber;

the matching control module is further configured to determine in real time, under the initial state of the selector switch, whether current matching is successful based on the signal transmitted from the detection unit, to transmit a start-up instruction to the switch control module if the current matching is successful, and to continue the impedance matching if the current matching is not successful.

9. The impedance matching system according to claim 7, characterized in that, the impedance adjustment unit comprises an adjustable capacitor; and

the actuator unit comprises a drive motor configured to adjust a value of a capacitance of the adjustable capacitor in a circuit.

10. The impedance matching system according to claim 2 or 4, characterized in that, the selector switch comprises:

two separate switches, configured to be connected between the reaction chamber and the RF power supply and between the load circuit and the RF power supply, respectively; and

the switch control module is configured to selectively control, according to the preset timing sequence, the two separate switches to be turned on or turned off.

11. The impedance matching system according to claim 10, characterized in that, the separate switch is a relay, a diode or an RF switch.

12. The impedance matching system according to claim 2 or 4, characterized in that, the selector switch comprises a change-over switch at least having one moving contact and two static contacts, the moving contact being connected with the RF power supply, one of the two static contacts being connected with the reaction chamber and the other one of the two static contacts being connected with the load circuit.

13. An impedance matching method for performing an impedance matching on an output impedance of a radio frequency (RF) power supply and an input impedance of an impedance matcher, characterized in that, the impedance matching method comprises following steps of:

providing a load circuit independent of a reaction chamber;
enabling the RF power supply to be selectively connected to the reaction chamber or connected to the load circuit according to a preset timing sequence, so as to convert a continuous wave output of the RF power supply to a pulse output and provide the pulse output to the reaction chamber; and
automatically performing the impedance matching on the output impedance of the RF power supply and the input impedance of the impedance matcher, when the RF power supply is connected to the reaction chamber.

14. The impedance matching method according to claim 13, characterized in that, in a case where an adjustable load is provided in the load circuit, an impedance of the adjustable load is adjusted to a preset impedance when the RF power supply is connected to the load circuit, the preset impedance being an input impedance of the reaction chamber at a last moment of a previous connection between the RF power supply and the reaction chamber.

15. The impedance matching method according to claim 13, characterized in that, in a case where only a fixed load is provided in the load circuit, an initial matching position of the impedance matcher is set as a matching position at a last moment of a previous connection between the RF power supply and the reaction chamber when the
5 RF power supply is connected to the reaction chamber.

16. A semiconductor processing apparatus, comprising an impedance matching system, a radio frequency (RF) power supply and a reaction chamber, the impedance matching system being arranged between the RF power supply and the reaction
10 chamber, characterized in that, the impedance matching system is the impedance matching system according to any one of claims 1 to 12.

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