CLAIMS:

1. An ultrasonic/megasonic cleaning device, comprising:

a cleaning unit comprising:

an upper casing and an lower casing; the upper casing and the lower casing are connected to form a hollow chamber, the hollow chamber is provided with an opening at a bottom surface of the lower casing;

an ultrasonic/megasonic generator provided in the hollow chamber with a space formed between an upper portion and side portion of the ultrasonic/megasonic generator and an inner wall of the hollow chamber; wherein, the ultrasonic/megasonic generator comprises a piezoelectric material connected to at least one signal source outside the cleaning unit, for receiving an electrical signal output from the at least one signal source and generating an ultrasonic/megasonic wave;

a bottom quartz component provided with a quartz rod array composed of a plurality of vertically arranged quartz rod-like structures; wherein, the quartz rod array extends out from the opening at the bottom surface of the lower casing for conducting the ultrasonic/megasonic wave vertically downward to a cleaning solution on a surface of the wafer;

a spray arm connected to the upper casing; wherein, the spray arm is driven by a rotary motor to enable the cleaning unit to perform an arc reciprocating motion above the surface of the wafer passing through the center of the wafer;

an ultrasonic/megasonic frequency control unit connected between the signal source and the ultrasonic/megasonic generator, for constantly varying a frequency of the electrical signal output from the at least one signal source and introducing the electrical signal into the ultrasonic/megasonic generator, so as to dynamically vary an oscillation frequency of the ultrasonic/megasonic wave generated by the ultrasonic/megasonic generator;

a real-time position feedback unit which obtains positional information of the cleaning unit relative to the wafer surface by collecting a unit rotational angle or a unit rotational time of the rotating motor and outputs the positional information;

an ultrasonic/megasonic energy control unit connected with the ultrasonic/megasonic frequency control unit, the piezoelectric material and the real-time position feedback unit, respectively;

wherein, the ultrasonic/megasonic energy control unit adjusts a duty cycle or power of the electrical signal from the ultrasonic/megasonic frequency control unit in real time according to the positional information of the cleaning unit transmitted from the real-time position feedback unit, so as to obtain a same amount of pulse signal or power of the ultrasonic/megasonic wave at different positions on the wafer surface.

2. The ultrasonic/megasonic cleaning device according to claim 1, wherein the amount of the at least one signal source is more than two; the ultrasonic/megasonic frequency control unit includes a signal selector; the signal selector has one end connected to the piezoelectric material and the other end connected to the signal sources; wherein at least one of the signal sources generates an electrical signal having the same frequency as a natural frequency of the piezoelectric material, and the other signal sources generate electrical signals with frequencies shifted near the natural frequency of the piezoelectric material positively and negatively; the signal selector switches between the signal sources to change the frequency of the electrical signal applied to the piezoelectric material in real time, so as to dynamically change the oscillation frequency of the ultrasonic/megasonic wave generated by the piezoelectric material.

3. The ultrasonic/megasonic cleaning device according to claim 1, wherein the amount of the at least one signal source is one; the ultrasonic/megasonic frequency control unit includes a frequency converter connected between the piezoelectric material and the signal source; the frequency converter constantly changes a frequency of the electrical signal output from the signal source near a natural frequency of the piezoelectric material positively and negatively to output multiple electrical signals with different frequencies; wherein at least one electrical signal has the same frequency as the natural frequency of the piezoelectric material, the other electrical signals have frequencies shifted positively and negatively relative to the natural frequency of the piezoelectric material, so as to dynamically change the oscillation frequency of the ultrasonic/megasonic wave generated by the piezoelectric material.

4. The ultrasonic/megasonic cleaning device according to claim 1, wherein the piezoelectric material comprises multiple sub-materials with different natural frequencies, the amount of the at least one signal source is the same as the amount of the sub-materials; the multiple sub-materials are one-to-one correspondingly connected to the signal sources respectively; the sub-materials are integrated as a whole; the ultrasonic/megasonic frequency control unit includes a signal channel selection switch provided between the signal sources and the piezoelectric material; the signal channel selection switch only switches on one communication channel between one of the signal

sources and its corresponding sub-material at each time, and constantly switches on the communication channels between the signal sources and their corresponding sub-materials randomly, so as to dynamically change the oscillation frequency of the ultrasonic/megasonic wave generated by the ultrasonic/megasonic generator.

5. The ultrasonic/megasonic cleaning device according to claim 1, wherein the amount of the at least one signal sources is one; the piezoelectric material comprises multiple sub-materials with different natural frequencies connected to the signal source; the ultrasonic/megasonic frequency control unit includes a frequency converter and a channel selector provided in sequence between the signal source and the sub-materials; the frequency converter changes a frequency of the electrical signal from the signal source and outputs several electrical signals with different frequencies which are respectively corresponding to the natural frequencies of the sub-materials; the channel selector switches on a communication channel to the sub-material whose natural frequency is the same as the frequency of electrical signal output from the frequency converter, so as to dynamically change the oscillation frequency of the ultrasonic/megasonic wave generated by the ultrasonic/megasonic generator.

6. The ultrasonic/megasonic cleaning device according to claim 1, wherein the ultrasonic/megasonic energy control unit includes a signal duty-cycle adjuster which is connected with the ultrasonic/megasonic frequency control unit, the piezoelectric material and the real-time position feedback unit, respectively; the signal duty-cycle adjuster changes a duty cycle of the electrical signal output from the ultrasonic/megasonic frequency control unit in accordance with the positional information output from the real-time position feedback unit to make the duty cycle of the electrical signal gradually decrease from the wafer center to the wafer edge, so that the ultrasonic/megasonic wave converted by the piezoelectric material has a corresponding changed duty cycle to obtain a same amount of ultrasonic/megasonic pulse signal at different positions on the wafer surface in per unit time.

7. The ultrasonic/megasonic cleaning device according to claim 1, wherein the ultrasonic/megasonic energy control unit includes a power adjuster connected with the ultrasonic/megasonic frequency control unit, the piezoelectric material and the real-time position feedback unit, respectively; the power adjuster changes power of the electrical signal output from the ultrasonic/megasonic frequency control unit according to the positional information output from the real-time position feedback unit to make the power of the electrical signal gradually increase from the wafer center to the wafer edge, so that the power of the ultrasonic/megasonic wave