CLAIMS

1. An ultrafine bubble generating apparatus comprising:

(a) a thermal ultrafine bubble generating unit that generates ultrafine bubbles smaller than 1.0 μm in diameter by causing a heating element to generate film boiling in a liquid, the thermal ultrafine bubble generating unit comprising:

an element substrate including a heating part provided with a plurality of the heating elements; and

a unit for making energy constant that makes an energy applied to each of the plurality of the heating elements or each of a predetermined number of the heating elements constant, in the heating part, wherein

the element substrate is configured to suppress variation of energies inputted to the heating elements in the heating part, and

the unit for making energy constant maintains a voltage or a current constant in two ends of each of the heating elements;

(b) a post-processing unit configured to remove impurities in the liquid containing the ultrafine bubbles; and

(c) a collecting unit configured to collect and preserve the liquid containing the ultrafine bubbles from which the impurities are removed.

2. The ultrafine bubble generating apparatus according to claim 1, wherein

the heating part includes an aggregate of the heating elements to which energies from an electrode pad are inputted.

3. The ultrafine bubble generating apparatus according to claim 2, wherein

at least two or more of the heating elements are connected to the electrode pad through the same common wiring in the heating part, and

the plurality of the heating elements are driven in a time division manner.

4. The ultrafine bubble generating apparatus according to claim 3, wherein

the element substrate includes a plurality of the heating parts, and

in each of the plurality of the heating parts, the plurality of the heating elements are driven in the time division manner.

5. The ultrafine bubble generating apparatus according to claim 3, wherein

shapes of the heating elements in the heating part are different depending on a positional relationship of the heating elements connected to each other through the common wiring.

6. The ultrafine bubble generating apparatus according to any one of claims 3 to 5, wherein

a voltage applied to each of the heating elements in the time division manner or a time length in which the heating elements are driven is changed depending on a difference between resistances in the common wiring.

7. The ultrafine bubble generating apparatus according to claim 1 or 2, wherein

in the heating part, the heating elements are each connected to an individual wiring.

8. The ultrafine bubble generating apparatus according to claim 7, wherein

the individual wirings are laid out such that a resistance value of each individual wiring falls within a predetermined range.

9. The ultrafine bubble generating apparatus according to claim 3, wherein

a width or a film thickness of the common wiring is set so that a value of a resistance in the common wiring is at a predetermined ratio or less to the sum of a resistance of the heating element and a resistance of a wiring individually connected to the heating element.

10. The ultrafine bubble generating apparatus according to claim 9, wherein

the width or the film thickness of the common wiring is set so that, in a case where an energy for generating the film boiling by the heating element is set to a first value, energies respectively inputted to the plurality of the heating elements connected to the common wiring are set to 1.1 times or more and 3 times or less the first value.

11. The ultrafine bubble generating apparatus according to claim 9 or 10, wherein

the common wiring is formed on a layer different from a layer on which the heating element is formed in the element substrate.

12. The ultrafine bubble generating apparatus according to claim 9, wherein

the common wiring is formed on a back surface of the element substrate opposite to a surface on which the heating element is formed.

13. The ultrafine bubble generating apparatus according to claim 12, wherein

the electrode pad is formed on the back surface.

14. The ultrafine bubble generating apparatus according to any one of claims 9 to 11, further comprising:

a generating unit in which a plurality of the element substrates are formed on a wafer.

15. The ultrafine bubble generating apparatus according to claim 7, wherein

a plurality of groups, which include a group provided with at least two or more heating elements that are each connected to the individual wiring and are driven simultaneously, are driven in different timings in a time division manner.

16. The ultrafine bubble generating apparatus according to claim 15, wherein

in the heating part, each of the groups includes the same number of the heating elements driven simultaneously.

17. The ultrafine bubble generating apparatus according to claim 15, wherein

the groups each provided with at least two or more heating elements driven simultaneously in the heating part are driven in timings in different time-divisions, and a voltage applied to each of the heating elements or a time length in which the heating elements are driven is changed depending on the number of the heating elements driven simultaneously in each timing.

18. The ultrafine bubble generating apparatus according to claim 6 or 17, further comprising:

a monitoring unit that monitors a resistance of the heating elements in the heating part, wherein

a voltage applied to each of the heating elements in the time division manner or a time length in which the heating elements are driven is changed depending on a result of the monitoring by the monitoring unit.

19. The ultrafine bubble generating apparatus according to claim 15, wherein

in the heating part, a plurality of the heating elements driven simultaneously on the same wiring are connected in series.

20. The ultrafine bubble generating apparatus according to claim 19, wherein

in each of the heating elements connected in series, a length of a resistance pattern in a current flow direction is smaller than a width of the resistance pattern.