CLAIMS

1. An ultrafine bubble generating apparatus, comprising:

a dissolving unit configured to dissolve a predetermined gas component into a liquid;

a plurality of heating elements provided in the liquid, wherein the heating elements are arrayed at predetermined intervals and the predetermined intervals are each 5 μm or less; and

a driving unit configured to drive the heating elements, wherein

the film boiling bubbles generated in the adjacent heating elements are connected with each other in a process of expansion to generate ultrafine bubbles smaller than 1.0 μm in diameter containing the predetermined gas component by causing with the driving unit the heating elements provided in the liquid in which the gas component is dissolved by the dissolving unit to generate heat, making film boiling on an interface between the liquid and the heating elements, and generating a film boiling bubble.

2. The ultrafine bubble generating apparatus according to claim 1, further comprising:

a collecting unit configured to collect the liquid containing the generated ultrafine bubbles.

3. The ultrafine bubble generating apparatus according to claim 1 or 2, characterized by

the ultrafine bubbles include at least one of first ultrafine bubbles generated near a surface of the film boiling bubble when the film boiling bubble is expanded, second ultrafine bubbles generated near the surface of the film boiling bubble when the film

boiling bubble shrinks, third ultrafine bubbles generated near a surface of at least one of the heating elements when the film boiling bubble shrinks, and fourth ultrafine bubbles generated in a region in which a shock wave that is made when the film boiling bubble disappears is propagated.

4. The ultrafine bubble generating apparatus according to claim 1 or 2, characterized by the ultrafine bubbles are generated in a case where a gas dissolved in the liquid exceeds a thermal dissolution limit, and undergoes phase transition.

5. The ultrafine bubble generating apparatus according to claim 1 or 2, characterized by the ultrafine bubbles are generated in a case where a gas dissolved in the liquid exceeds a pressure dissolution limit, and undergoes phase transition.

6. The ultrafine bubble generating apparatus according to any one of claims 1 to 5, wherein the heating elements include a plurality of surface reforming regions with a relatively high surface roughness and a non-surface reforming region with a relatively low surface roughness, and the film boiling bubble is generated in each of the plurality of surface reforming regions by heat generation of the heating elements.

7. The ultrafine bubble generating apparatus according to claim 6, wherein the surface roughness of the surface reforming regions is double or more that of the non-surface reforming region.

8. The ultrafine bubble generating apparatus according to any one of claims 1 to 5, wherein the liquid is stored in a flow passage formed by opposing flow passage walls, and the film boiling bubble is expanded and shrinks while being restricted by the flow passage walls.

9. The ultrafine bubble generating apparatus according to claim 8, wherein a shrinking speed of portions of the film boiling bubble close to the flow passage walls is slower than a shrinking speed of a portion away from the flow passage walls.

10. The ultrafine bubble generating apparatus according to claim 8, wherein a fluid resistance element as a fluid resistance is further formed in the flow passage.

11. The ultrafine bubble generating apparatus according to claim 10, wherein a shrinking speed of the film boiling bubble is substantially equal in a direction orthogonal to the flow passage walls.

12. The ultrafine bubble generating apparatus according to claim 10, wherein a shrinking speed of a portion of the film boiling bubble away from the flow passage walls is slower than a shrinking speed of portions close to the flow passage walls.

13. The ultrafine bubble generating apparatus according to any one of the preceding claims, wherein the driving unit is configured to drive at least one of the heating elements by applying a predetermined voltage pulse to the at least one heating element.

14. The ultrafine bubble generating apparatus according to any one of the preceding claims, wherein each heating element is individually driven and controlled by the driving unit.