Claims

1. A device for treating a surface of an article with a fluid, comprising:

a holder configured to position an article in a predetermined orientation;

a source of ultrasonic or megasonic energy positioned so as to vibrate a fluid medium adjacent the article at a selected wave-length; and

a generator of treatment fluid

characterized in that the generator of treatment fluid is configured to receive a liquid at a first pressure having dissolved gas therein and to discharge adjacent said source of ultrasonic or megasonic energy a treatment fluid at a second pressure lower than said first pressure, such that gas previously dissolved in said liquid comes out of solution in the form of bubbles;

and in that the source of ultrasonic or megasonic energy comprises a resonator positioned adjacent to the space to be occupied by the article so that a gap is formed with a width w of about 0.2 mm to about 3 mm;

wherein the generator of treatment fluid comprises:

a main body housing provided with an inlet opening;

a plurality of injection orifices provided in the main body; and

an external liquid medium supply unit connected to the inlet opening;

wherein the inlet opening has an inner diameter from about 1 mm to about 20 mm, and the injection orifices have a diameter from about 50 μm to about 500 μm.

~~2. The device according to claim 1, wherein the generator of treatment fluid comprises:~~

~~a main body housing provided with an inlet opening;~~

~~a plurality of injection orifices or an injection slit provided in the main body; and~~

~~an external liquid medium supply unit connected to the inlet opening.~~

~~3. The device according to claim 2, wherein the inlet opening has an inner diameter from about 1 mm to about 20 mm, and the injection orifices have a diameter from about 50 μm to about 500 μm.~~

~~4~~2. The device according to claim ~~2~~1, wherein the injection orifices ~~or slit~~ are positioned on an angled surface of the main body.

~~5~~3. The device according to claim ~~2~~1, wherein the main body additionally has outlet orifices with a diameter smaller than the inlet orifices, the outlet orifices having a diameter from about 50 µm to about 2000 µm.

~~6~~4. The device according to claim 1, wherein the holder comprises gripping elements for engaging an edge of the article.

~~7. The device according to claim 1, wherein the source of ultrasonic or megasonic energy comprises a resonator positioned adjacent to the space to be occupied by the article so that a gap is formed with a width w of about 0.2 mm to about 3 mm.~~

~~8~~5. The device according to claim 1, wherein the treatment fluid is a dispersion that comprises more than about 99 vol.-% liquid and more than about 0.001 vol.-% gas, wherein the gas is dispersed in the fluid at a bubble

size with a bubble size distribution where 90% of the bubbles are in a range of a bubble diameter d, wherein d ≤ 1.2*ds and d ≥ 0.8*ds, wherein ds is a selected number in a range of about 0.5 µm to about 50 µm.

~~9~~6. The device according to claim 1, wherein said device is a single wafer wet processing station for treating semiconductor wafers.

~~10~~7. A method for treating a surface of an article with a fluid, comprising:

generating a treatment fluid~~ by reducing a pressure of liquid in which a gas is dissolved until gas bubbles come out of solution to form the treatment fluid as a gas dispersion~~;

supplying the treating fluid to the article; and

supplying ultrasonic or megasonic energy to the treatment fluid adjacent the article at a predetermined wave-length

characterized in that

the treatment fluid is generated by a generator of treatment fluid by reducing a pressure of liquid in which

a gas is dissolved until gas bubbles come out of solution to form the treatment fluid as a gas dispersion;

and in the ultrasonic or megasonic energy is supplied by a resonator positioned adjacent to the space to be occupied by the article so that a gap is formed with a width w of about 0.2 mm to about 3 mm

wherein the generator of treatment fluid comprises:

a main body housing provided with an inlet opening;

a plurality of injection orifices provided in the main body; and

an external liquid medium supply unit connected to the inlet opening;

wherein the inlet opening has an inner diameter from about 1 mm to about 20 mm, and the injection orifices have a diameter from about 50 µm to about 500 µm.

~~11~~8. The method according to claim ~~10~~7, wherein the treatment fluid is a dispersion that comprises more than about 99 vol.-% liquid and more than about 0.001 vol.-% gas, wherein the gas is dispersed in the fluid at a bubble size with a bubble size distribution where 90% of the bubbles are in a range of a bubble diameter d, wherein d ≤

1.2*ds and d ≥ 0.8*ds, wherein ds is a selected number in a range of about 0.5 µm to about 10 µm.

~~12~~9. The method according to claim ~~10~~7, wherein the article is a semiconductor wafer and the treatment is cleaning.

~~13~~10. The method according to claim ~~10~~7, wherein the treatment fluid is generated by a device that comprises:

a main body housing provided with an inlet opening;

a plurality of injection orifices or an injection slit provided in the main body; and

an external liquid medium supply unit connected to the inlet opening.

~~14. A treatment fluid for ultrasonic or megasonic treatment of articles, comprising:~~

~~a dispersion that comprises more than about 99 vol.-% liquid and more than about 0.001 vol.-% gas, wherein the gas is dispersed in the fluid at a bubble size with a bubble size distribution where 90% of the bubbles are in a range of a bubble diameter d, wherein d ≤ 1.2*ds and d ≥~~

~~0.8*ds, wherein ds is a selected number in a range of about 0.5 μm to about 10 μm.~~

~~15. The treatment fluid according to claim 14, wherein the gas is generated by a pressure reduction of the liquid.~~