Claims

1. A substrate cleaning device comprising a nozzle that comprises:

a first supply port connected to a treatment liquid supplier configured to supply a treatment liquid;

a second supply port connected to a gas supplier configured to supply a gas;

a third supply port connected to a surface tension reducing gas supplier configured to supply a surface tension reducing gas for reducing surface tension of the treatment liquid;

a first discharge port configured to discharge the treatment liquid;

a second discharge port configured to discharge the gas, so as to mix the gas and the treatment liquid discharged from the first discharge port to generate a first mixed fluid at a first mixing position; and

a third discharge port configured to discharge the surface tension reducing gas, so as to mix the first mixed fluid and the surface tension reducing gas to generate a second mixed fluid at a second mixing position, the second mixing position being farther away from the first discharge port than the first mixing position,

wherein the substrate cleaning device is configured to clean a substrate with jets of the second mixed fluid.

2. A substrate cleaning device comprising a nozzle in

which a first flow path, a second flow path and a third flow path are provided,

the first flow path being connected to a treatment liquid supplier configured to supply a treatment liquid;

the second flow path being connected to a gas supplier configured to supply a gas; and

the third flow path being configured to a surface tension reducing gas supplier configured to supply a surface tension reducing gas for reducing surface tension of the treatment liquid,

wherein the first flow path, the second flow path, and the third flow path are configured such that the treatment liquid discharged from the first flow path and the gas discharged from the second flow path are mixed at a first mixing position to generate a first mixed fluid, and the first mixed fluid and the surface tension reducing gas discharged from the third flow path are mixed at a second mixing position to generate a second mixed fluid, the second mixing position being located on a downstream side of the first mixing position in a flow of the first mixed fluid, and

the substrate cleaning device is configured to clean a substrate with jets of the second mixed fluid.

3. A substrate cleaning device comprising a nozzle in which a first flow path, a second flow path, a third flow path and a fourth path are provided,

the first flow path being connected to a treatment

liquid supplier configured to supply a treatment liquid;

the second flow path being connected to a gas supplier configured to supply a gas;

the third flow path being connected to a surface tension reducing gas supplier configured to supply a surface tension reducing gas for reducing surface tension of the treatment liquid; and

the fourth flow path being joined to the first flow path and the second flow path, a first mixed fluid flowing through the fourth flow path, the first mixed fluid being a mixture of the treatment liquid and the gas,

wherein the third flow path and the fourth flow path are configured such that the first mixed fluid discharged from the fourth flow path and the surface tension reducing gas discharged from the third flow path are mixed to generate a second mixed fluid, and

the substrate cleaning device is configured to clean a substrate with jets of the second mixed fluid.

4. A substrate cleaning device comprising a nozzle that comprises in the nozzle in which a first flow path, a second flow path, a third flow path and a fourth path are provided,

the first flow path being connected to a treatment liquid supplier configured to supply a treatment liquid;

the second flow path being connected to a gas supplier configured to supply a gas;

the third flow path being connected to a surface

tension reducing gas supplier configured to supply a surface tension reducing gas for reducing surface tension of the treatment liquid; and

the fourth flow path being joined to the first flow path, the second flow path, and the third flow path,

wherein the first to fourth flow paths are configured such that the treatment liquid discharged from the first flow path and the gas discharged from the second flow path are mixed at a first mixing position to generate a first mixed fluid in the fourth flow path, and the first mixed fluid and the surface tension reducing gas discharged from the third flow path are mixed at a second mixing position to generate a second mixed fluid in the fourth flow path, the second mixing position being located on a downstream side of the first mixing position in a flow of the first mixed fluid, and

the substrate cleaning device is configured to clean a substrate with jets of the second mixed fluid.

5. The substrate cleaning device according to claim 1, further comprising:

a gasifier configured to gasify a surface tension inhibitor in a liquid state, to generate the surface tension reducing gas.

6. The substrate cleaning device according to claim 5, wherein the gasifier is configured to gasify the surface tension inhibitor in a liquid state by an injection technique, to generate the surface tension reducing gas.

7. The substrate cleaning device according to claim 5, wherein the gasifier is of a baking type, of a bubbling type, or a vaporizer.

8. The substrate cleaning device according to claim 1, further comprising:

a filter through which the surface tension reducing gas passes,

wherein the surface tension reducing gas having passed through the filter is mixed with the first mixed fluid.

9. The substrate cleaning device according to claim 1, further comprising:

a cleaning fluid supplier configured to supply the treatment liquid to the nozzle at 200 to 400 ml/min.

10. The substrate cleaning device according to claim 1, further comprising:

a cleaning fluid supplier that supplies the gas to the nozzle at 100 to 200 SLM.

11. The substrate cleaning device according to claim 1, wherein

the treatment liquid is ultrapure water or carbon-dioxide-containing water,

the gas is an inert gas or dry air, and

the surface tension reducing gas is an IPA gas.

12. The substrate cleaning device according to claim 11, wherein the inert gas is a nitrogen gas.

13. The substrate cleaning device according to claim 12,

wherein a concentration of the IPA gas in the second mixed fluid, or a total concentration of the IPA gas and the nitrogen gas in the second mixed fluid is 10 to 30%.

14. A substrate processing apparatus comprising:

a substrate polishing device configured to polish a substrate; and

the substrate cleaning device according to claim 1, configured to clean the polished substrate.

15. A substrate cleaning method comprising:

mixing a treatment liquid and a gas to generate a first mixed fluid;

mixing a surface tension reducing gas for reducing surface tension of the treatment liquid and the first mixed fluid to generate a second mixed fluid, after the first mixed fluid is generated; and

cleaning a substrate by emitting jets of the second mixed fluid onto the substrate.

16. A nozzle used for a substrate cleaning device, a first flow path, a second flow path, a third flow path and a fourth flow path are provided in the nozzle,

the first flow path comprising a first inlet and a first outlet, the first inlet being open toward an outer surface of the nozzle, the first outlet being provided inside the nozzle;

the second flow path that comprising a second inlet and a second outlet, the second inlet being open toward the outer surface of the nozzle, the second outlet being

provided inside the nozzle;

the third flow path that comprising a third inlet and a third outlet, the third inlet being open toward the outer surface of the nozzle, the third outlet being open toward a bottom surface of the nozzle; and

the fourth flow path that comprising a fourth inlet and a fourth outlet, the fourth inlet being joined to the first outlet and the second outlet inside the nozzle, the fourth outlet being open toward the bottom surface of the nozzle,

wherein the fourth flow path is located substantially at a center of the nozzle, and a diameter of the fourth flow path at least in a vicinity of the fourth outlet is larger at a location closer to the bottom surface of the nozzle, and

the third flow path is located radially outside the nozzle with respect to the third flow path, and at least a portion of the third flow path in a vicinity of the third outlet is more inclined to the center of the nozzle at a location closer to the bottom surface of the nozzle such that a mixture fluid formed of a fluid from the third flow path and a fluid from the fourth fluid is formed.