CLAIMS

[Claim 1]

A process for cleaning a wafer having an uneven pattern at its surface, wherein the process comprises at least the steps of:

cleaning the wafer with a cleaning liquid;

substituting the cleaning liquid retained in recessed portions of the wafer with a water-repellent liquid chemical after cleaning; and

drying the wafer,

wherein the cleaning liquid contains 80 mass% or greater of a solvent having a boiling point of 55 to 200 °C, and

wherein the water-repellent liquid chemical supplied in the substitution step has a temperature of not lower than 40 °C and lower than a boiling point of the water-repellent liquid chemical thereby imparting water repellency at least to surfaces of the recessed portions,

the water-repellent liquid chemical comprises an organic solvent selected from the group consisting of hydrocarbons, esters, ethers, ketones, halogen element-containing solvents, sulfoxide-based solvents, lactone-based solvents, carbonate-based solvents, polyalcohol derivatives having no OH group, nitrogen element-containing solvents having no N–H group and a mixture liquid of these,

the wafer is a wafer containing a silicon element at the surfaces of the recessed portions, and

the water-repellent liquid chemical is one containing a silicon compound A represented by the following general formula [1] or one containing the silicon compound A and an acid or a base.

$(R^1)_aSi(H)_bX^1_{4-a-b}$ [1]

[In the formula [1], R^1 mutually independently represents a monovalent organic group having a C_1-C_{18} monovalent hydrocarbon group the hydrogen elements of which may partially or entirely be replaced with a fluorine element(s). Additionally, X^1 mutually independently represents at least one group selected from the group consisting of a monovalent functional group of which element to be bonded to a silicon element is nitrogen, a monovalent functional group of which element to be

bonded to a silicon element is oxygen, a halogen group, a nitrile group and $-CO-NH-Si(CH_3)_3$ group. a is an integer of from 1 to 3. b is an integer of from 0 to 2. The total of a and b is 1 to 3.]

[Claim 2]

A process for cleaning a wafer, as claimed in Claim 1, wherein the cleaning liquid is at least one liquid selected from the group consisting of organic solvents, water, and aqueous solutions obtained by mixing at least one kind of the organic solvents, acids, alkalis and oxidizing agents with water.

[Claim 3]

A process for cleaning a wafer, as claimed in Claim 1, wherein the water-repellent liquid chemical contains acid and that the acid is at least one selected from the group consisting of hydrogen chloride, sulfuric acid, perchloric acid, phosphoric acid, sulfonic acid represented by the following general formula [2] and its anhydride, carboxylic acid represented by the following general formula [3] and its anhydride, alkyl borate ester, aryl borate ester, boron tris(trifluoroacetate), trialkoxyboroxin, boron trifluoride and a silicon compound B represented by the following general formula [4].

$R^2S(O)_2OH$ [2]

[In the formula [2], R^2 represents a C_1-C_{18} monovalent hydrocarbon group the hydrogen elements of which may partially or entirely be replaced with a fluorine element(s).]

R^3COOH [3]

[In the formula [3], R^3 represents a C_1-C_{18} monovalent hydrocarbon group the hydrogen elements of which may partially or entirely be replaced with a fluorine element(s).]

$(R^4)_cSi(H)_dX^2_{4-c-d}$ [4]

[In the formula [4], R^4 mutually independently represents a C_1-C_{18} monovalent hydrocarbon group the hydrogen elements of which may partially or entirely be replaced with a fluorine element(s). Additionally, X^2 mutually

independently represents at least one group selected from the group consisting of chloro group, –OCO–R^5 (R^5 is a C_1-C_{18} monovalent hydrocarbon group the hydrogen elements of which may partially or entirely be replaced with a fluorine element(s).) and –$OS(O)_2$–R^6 (R^6 is a C_1-C_{18} monovalent hydrocarbon group the hydrogen elements of which may partially or entirely be replaced with a fluorine element(s).). *c* is an integer of from 1 to 3. *d* is an integer of from 0 to 2. The total of *c* and *d* is 1 to 3.]

[Claim 4]

A process for cleaning a wafer, as claimed in Claim 1 or 3, wherein the acid is at least one selected from the group consisting of trimethylsilyl trifluoroacetate, trimethylsilyl trifluoromethanesulfonate, dimethylsilyl trifluoroacetate, dimethylsilyl trifluoromethanesulfonate, butyldimethylsilyl trifluoroacetate, butyldimethylsilyl trifluoromethanesulfonate, hexyldimethylsilyl trifluoroacetate, hexyldimethylsilyl trifluoromethanesulfonate, octyldimethylsilyl trifluoroacetate, octyldimethylsilyl trifluoromethanesulfonate, decyldimethylsilyl trifluoroacetate, decyldimethylsilyl trifluoromethanesulfonate, dodecyldimethylsilyl trifluoroacetate and dodecyldimethylsilyl trifluoromethanesulfonate.

[Claim 5]

A process for cleaning a wafer, as claimed in any of Claims 1, 3 and 4, wherein the silicon compound A is at least one selected from the group consisting of hexamethyldisilazane, trimethylsilyl dimethylamine, trimethylsilyl diethylamine, tetramethyldisilazane, dimethylsilyl dimethylamine, dimethylsilyl diethylamine, 1,3–dibutyltetramethyldisilazane, butyldimethylsilyl dimethylamine, butyldimethylsilyl diethylamine, 1,3–dihexyltetramethyldisilazane, hexyldimethylsilyl dimethylamine, hexyldimethylsilyl diethylamine, 1,3–dioctyltetramethyldisilazane, octyldimethylsilyl dimethylamine, octyldimethylsilyl diethylamine, 1,3–didecyltetramethyldisilazane, decyldimethylsilyl dimethylamine, decyldimethylsilyl diethylamine, 1,3–didodecyltetramethyldisilazane, dodecyldimethylsilyl dimethylamine and dodecyldimethylsilyl diethylamine.

[Claim 6]

A process for cleaning a wafer, as claimed in any of Claims 1 and 3 to 5, wherein the water-repellent liquid chemical contains a base and that the base is at least one selected from the group consisting of ammonia, N,N,N',N'-tetramethylethylenediamine, triethylenediamine, dimethylaniline, alkylamine, dialkylamine, trialkylamine, pyridine, piperazine, N-alkylmorpholine and a silicon compound C represented by the following general formula [5].

$(R^7)_eSi(H)_fX^3_{4-e-f}$ [5]

[In the formula [5], R^7 mutually independently represents a C_1-C_{18} monovalent hydrocarbon group the hydrogen elements of which may partially or entirely be replaced with a fluorine element(s). Additionally, X^3 mutually independently represents a monovalent functional group of which element to be bonded to a silicon element is nitrogen, the monovalent functional group possibly containing a fluorine element or a silicon element. e is an integer of from 1 to 3. f is an integer of from 0 to 2. The total of e and f is 1 to 3.]

[Claim 7]

A process for cleaning a wafer, as claimed in any of Claims 1 to 6, wherein the water-repellent liquid chemical supplied in the substitution step has a temperature of not lower than 70 °C and lower than a temperature represented by (the boiling point of the water-repellent liquid chemical − 10 °C).

[Claim 8]

A water-repellent liquid chemical comprising:

a silicon compound A represented by the following general formula [1]; and

an organic solvent selected from the group consisting of hydrocarbons, esters, ethers, ketones, halogen element-containing solvents, sulfoxide-based solvents, lactone-based solvents, carbonate-based solvents, polyalcohol derivatives having no OH group, nitrogen element-containing solvents having no N–H group and a mixture liquid of these,

$(R^1)_aSi(H)_bX^1_{4-a-b}$ [1]

[In the formula [1], R^1 mutually independently represents a monovalent organic group having a C_1-C_{18} monovalent hydrocarbon group the hydrogen elements of which may partially or entirely be replaced with a fluorine element(s). Additionally, X^1 mutually independently represents at least one group selected from the group consisting of a monovalent functional group of which element to be bonded to a silicon element is nitrogen, a monovalent functional group of which element to be bonded to a silicon element is oxygen, a halogen group, a nitrile group and $-CO-NH-Si(CH_3)_3$ group. *a* is an integer of from 1 to 3. *b* is an integer of from 0 to 2. The total of *a* and *b* is 1 to 3.]

the hydrocarbons are selected from the group consisting of toluene, benzene, xylene, hexane, heptane, and octane; the esters are selected from the group consisting of ethyl acetate, propyl acetate, butyl acetate, and ethyl acetoacetate; the ethers are selected from the group consisting of diethyl ether, dipropyl ether, dibutyl ether, tetrahydrofuran, and dioxane; the ketones are selected from the group consisting of acetone, acetylacetone, methyl ethyl ketone, methyl propyl ketone, methyl butyl ketone, cyclohexanone, and isophorone; the halogen element-containing solvents are selected from the group consisting of perfluorocarbons, hydrofluorocarbons, hydrofluoroethers, chlorocarbons, hydrochlorocarbons, chlorofluorocarbons, hydrochlorofluorocarbons, perfluoroethers, and perfluoropolyethers; the sulfoxide-based solvents are dimethyl sulfoxide; the lactone-based solvents are selected from the group consisting of γ-butyrolactone, γ-valerolactone, γ-hexanolactone, γ-heptanolactone, γ-octanolactone, γ-nonanolactone, γ-decanolactone, γ-undecanolactone, γ-dodecanolactone, δ-valerolactone, δ-hexanolactone, δ-octanolactone, δ-nonanolactone, δ-decanolactone, δ-undecanolactone, δ-dodecanolactone, and ε-hexanolactone; the carbonate-based solvents are selected from the group consisting of dimethyl carbonate, ethyl methyl carbonate, diethyl carbonate, and propylene carbonate; the polyalcohol derivatives having no OH group are selected from the group consisting of ethylene glycol dimethyl ether, ethylene glycol diethyl ether, ethylene glycol dibutyl ether, ethylene glycol monomethyl ether acetate, ethylene glycol monoethyl ether acetate, ethylene glycol monobutyl ether acetate, ethylene glycol diacetate, diethylene glycol dimethyl ether, diethylene glycol

ethyl methyl ether, diethylene glycol diethyl ether, diethylene glycol butyl methyl ether, diethylene glycol dibutyl ether, diethylene glycol monomethyl ether acetate, diethylene glycol monoethyl ether acetate, diethylene glycol monobutyl ether acetate, diethylene glycol diacetate, triethylene glycol dimethyl ether, triethylene glycol diethyl ether, triethylene glycol dibutyl ether, triethylene glycol butyl methyl ether, triethylene glycol monomethyl ether acetate, triethylene glycol monoethyl ether acetate, triethylene glycol monobutyl ether acetate, triethylene glycol diacetate, tetraethylene glycol dimethyl ether, tetraethylene glycol diethyl ether, tetraethylene glycol dibutyl ether, tetraethylene glycol monomethyl ether acetate, tetraethylene glycol monoethyl ether acetate, tetraethylene glycol monobutyl ether acetate, tetraethylene glycol diacetate, propylene glycol dimethyl ether, propylene glycol diethyl ether, propylene glycol dibutyl ether, propylene glycol monomethyl ether acetate, propylene glycol monoethyl ether acetate, propylene glycol monobutyl ether acetate, propylene glycol diacetate, dipropylene glycol dimethyl ether, dipropylene glycol methyl propyl ether, dipropylene glycol diethyl ether, dipropylene glycol dibutyl ether, dipropylene glycol monomethyl ether acetate, dipropylene glycol monoethyl ether acetate, dipropylene glycol monobutyl ether acetate, dipropylene glycol diacetate, tripropylene glycol dimethyl ether, tripropylene glycol diethyl ether, tripropylene glycol dibutyl ether, tripropylene glycol monomethyl ether acetate, tripropylene glycol monoethyl ether acetate, tripropylene glycol monobutyl ether acetate, tripropylene glycol diacetate, tetrapropylene glycol dimethyl ether, tetrapropylene glycol monomethyl ether acetate, tetrapropylene glycol diacetate, butylene glycol dimethyl ether, butylene glycol monomethyl ether acetate, butylene glycol diacetate, and glycerine triacetate; and the nitrogen element-containing solvents having no N–H group are selected from the group consisting of *N,N*-dimethylformamide, *N,N*-dimethylacetamide, *N*-methyl-2-pyrrolidone, triethylamine, and pyridine.