

DESCRIPTION

TITLE OF INVENTION

5 METHOD FOR PRODUCING QUARTZ GLASS

TECHNICAL FIELD

[0001]

10 The present invention relates to a method for producing quartz glass in which irregularities having a desired surface roughness (Ra) are formed on a surface of quartz glass, and particularly relates to a method for producing a quartz glass jig such as a quartz capillary used in a film forming process such as a CVD process in semiconductor element manufacturing.

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BACKGROUND ART

[0002]

Quartz glass has a high purity and is excellent in chemical resistance, and therefore has been conventionally used as a material for semiconductor processing, optical use, physicochemical use, decoration, and the like. The surface of these quartz glass processed products may be subjected to various types of irregularities processing depending on the purpose of use. In particular, by providing irregularities on an inner surface of a furnace core tube used in a semiconductor process, peeling of a polysilicon film or the like in low pressure chemical vapor deposition (LPCVD) treatment is prevented, and particles generated during heat treatment of a wafer are prevented.

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[0003]

As a method for subjecting the quartz glass surface to irregularities processing, sandblasting or surface treatment with a mixed solution of HF/CH₃COOH/NH₄F (surface treatment liquid) is known. The sandblasting treatment is a processing method involving mechanical destruction of the surface, and therefore microcracks exist on the quartz glass surface. The existence of microcracks may cause generation of particles and the like, and thus it cannot be said that the sandblasting treatment is necessarily effective. In addition,

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in the surface irregularities processing by surface treatment with a surface treatment liquid, the microcracks described above do not exist, and thus it is suitable for use in the semiconductor process and has been employed for a long time. Further, in order to prevent peeling of the polysilicon film (hereinafter, it is also referred to as “film peeling prevention”.)
5 from the quartz glass surface in the semiconductor process, it is generally known that film peeling is less likely to occur when surface roughness is higher.

[0004]

However, in the surface treatment method using the surface treatment liquid for quartz glass, there is a problem that variations in surface roughness and control are difficult
10 as compared with a processing method involving mechanical destruction such as sandblasting. In particular, when a quartz capillary used in a film forming process in semiconductor manufacturing is subjected to surface treatment with a surface treatment liquid, the surface roughness of irregularities on the surface is a value in which Ra is around 1 μm . In addition, in the case of a surface having a large curvature like a quartz capillary used in a CVD process
15 in semiconductor element manufacturing, it is considered that a large number of microcrystals serving as nuclei for irregularities formation are generated, or gaps between microcrystals tend to be small. For this reason, from the viewpoint of irregularities as film peeling prevention in the semiconductor process, irregularities having a surface roughness (Ra) of 1 μm or less cannot be said to have sufficient function as compared with the thickness of
20 the film, and the effect is insufficient. Therefore, as the numerical value setting of the irregularities for preventing film peeling, the surface roughness (Ra) is desirably about 1.5 to 3.5 μm .

[0005]

Further, as proposed in Patent Document 1 (JP 4455018), it is possible to control
25 the surface roughness (Ra) of the surface of quartz glass by changing the concentration of the surface treatment liquid. However, in this method, it is necessary to change the concentration of the surface treatment liquid each time, and there have been problems that running cost increases and lead time also increases. That is, the surface treatment liquid needs to be replaced for concentration change each time the surface treatment with the
30 surface treatment liquid is performed, which is complicated and expensive.

[0006]

In addition, as techniques related to the surface roughness (Ra) of the surface of quartz glass, Patent Documents 2 to 3 below and the like can be cited.

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PRIOR ART DOCUMENTS

PATENT DOCUMENTS

[0007]

Patent Document 1: JP 4455018

Patent Document 2: JP 4437365

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Patent Document 3: JP-A H10-36140

SUMMARY OF INVENTION

TECHNICAL PROBLEM

[0008]

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The present invention has been made in view of the above circumstances, and it is an object of the present invention to provide a method for producing quartz glass capable of controlling the surface roughness (Ra) of irregularities on a quartz glass surface by a relatively simple method when irregularities are formed on the quartz glass surface using a surface treatment liquid for surface-treating the quartz glass.

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SOLUTION TO PROBLEM

[0009]

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As a result of intensive studies to achieve the above object, the present inventors have found that, as a treatment means for realizing the surface roughness (Ra) of surface irregularities of a quartz capillary to be used particularly for a semiconductor process in the range of 1.5 to 3.5 μm , in formation of irregularities without microcracks by surface treatment with a surface treatment liquid, irregularities having a relatively coarse surface roughness can be formed on a quartz glass surface by bringing a solvent component not involved in liquid treatment, such as pure water, into contact with the quartz glass surface before subjecting the quartz glass to surface treatment with a surface treatment liquid, and performing the surface treatment with the surface treatment liquid before the solvent is dried, and have completed the present invention.

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[0010]

In the production method of the present invention, a solvent component not involved in liquid treatment such as pure water is brought into contact with the quartz glass surface before subjecting the quartz glass to surface treatment with a surface treatment liquid, and
5 then the surface treatment is performed with the surface treatment liquid. The action or mechanism on the surface of quartz glass at that time is not clear, but the following is generally presumed.

[0011]

For example, when a mixed liquid containing HF and NH_4F is used as a surface
10 treatment liquid, normally, when quartz glass is etched, ammonium silicofluoride $(\text{NH}_4)_2\text{SiF}_6$ (microcrystal) is generated by a reaction between the quartz glass and the mixed liquid. It is said that the ammonium silicofluoride precipitates and grows microcrystals on the surface of quartz glass. It is presumed that etching by hydrofluoric acid is hindered at a site where the microcrystals are precipitated on the surface of quartz glass, so that progress
15 of etching is delayed on a part of the surface of quartz glass, and etching progresses unevenly, so that irregularities are generated on the surface of quartz glass. In addition, once the microcrystals are precipitated, some microcrystals are newly precipitated thereafter, but it is presumed that already precipitated microcrystals grow. When the microcrystals grow into crystals and cover the glass surface, etching is similarly disturbed on the entire glass surface,
20 so that no difference in etching occurs thereafter. On the other hand, in the production method of the present invention, moisture (fine water droplets) is present on a part of the surface of quartz glass, and the surface treatment liquid does not come into direct contact with the glass surface at the part, and therefore microcrystals are not precipitated at this stage. In addition, since the moisture present on the surface of quartz glass is sufficiently small
25 compared to the amount of the surface treatment liquid, the moisture is mixed with the surface treatment liquid, and the glass surface on which the moisture has been present eventually comes into contact with the surface treatment liquid. However, there is a site where the microcrystals have already precipitated on the glass surface without moisture. Since recrystallization proceeds to the site where the microcrystals have already precipitated,
30 it is presumed that microcrystals are hardly newly precipitated on the glass surface where the moisture has been present, and only etching with HF proceeds. Therefore, in the present invention, it is considered that the time until moisture is mixed with the surface treatment

liquid inhibits the irregularities formation by the surface treatment liquid due to the presence of the moisture, and as a result, irregularities having a relatively coarse surface roughness can be formed on the quartz glass surface.

[0012]

5 Therefore, the present invention provides the following method for producing quartz glass.

1. A method for producing quartz glass with irregularities on a glass surface by performing surface treatment of quartz glass using a surface treatment liquid, the method including: bringing a solvent component not involved in the surface treatment with the
10 surface treatment liquid into contact with the surface of quartz glass in advance; and then performing the surface treatment with the surface treatment liquid before the solvent component is dried to form irregularities having a surface roughness (Ra) of 1.5 to 3.5 μm on the glass surface.
2. The method for producing quartz glass according to 1 above, wherein the solvent
15 component not involved in the surface treatment is water or pure water.
3. The method for producing quartz glass according to 1 or 2 above, wherein the method of bringing a solvent component not involved in the surface treatment into contact with the surface of quartz glass is a method in which the solvent component over the quartz glass surface is flown, a method in which the solvent component is sprayed with an atomizer,
20 and a method in which a mist of the solvent component is generated or the solvent component is brought into contact with the quartz glass surface in a state that humidity caused by the solvent component is 70% or more.
4. The method for producing quartz glass according to any one of 1 to 3 above, wherein a component of the surface treatment liquid of quartz glass is a mixed acid
25 containing HF, NH_4F , and acetic acid.
5. The method for producing quartz glass according to any one of 1 to 4 above, wherein the quartz glass produced by the production method is a quartz glass jig used in a film forming process in semiconductor manufacturing.
6. The method for producing quartz glass according to 5 above, wherein the quartz
30 glass jig is a quartz capillary with an inner diameter of 4.0 to 100.0 mm and an outer diameter of 8.0 to 106.0 mm.

ADVANTAGEOUS EFFECTS OF INVENTION

[0013]

According to the method for producing a glass surface of the present invention, it is possible to produce quartz glass with irregularities having a surface roughness (Ra) in a range of 1.5 to 3.5 μm in a step of forming irregularities without microcracks by surface treatment with a surface treatment liquid, and it is not necessary to change the concentration of the surface treatment liquid, which is a relatively simple and economical production method.

BRIEF DESCRIPTION OF DRAWINGS

10 [0014]

[FIG. 1] FIG. 1 is a graph showing surface roughness (average Ra) of a glass surface of each example in quartz capillaries surface-treated in Examples 1 to 7 and Comparative Examples 1 to 7.

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DESCRIPTION OF EMBODIMENTS

[0015]

Hereinafter, the present invention is described in more detail.

The present invention is a method for producing quartz glass with irregularities having a desired surface roughness (Ra) on a surface thereof, and performs the surface treatment of the quartz glass using a surface treatment liquid.

[0016]

Examples of the quartz glass not subjected to a treatment for forming irregularities on the surface include natural quartz and synthetic quartz, and commercially available products can be appropriately used according to the purpose of use and the like, and in particular, natural quartz glass for a semiconductor manufacturing process is suitably adopted. For example, "HERALUX-LA" (trade name, manufactured by Shin-Etsu Quartz Products Co., Ltd.) and "HERALUX-E-LA" (trade name, manufactured by Shin-Etsu Quartz Products Co., Ltd.) can be adopted.

[0017]

30 The present invention includes a step of bringing a solvent component not involved in surface treatment with a surface treatment liquid into contact with a surface of quartz glass in advance.

[0018]

The solvent component not involved in the surface treatment with a surface treatment liquid is a solvent component that does not chemically react with each component of the surface treatment liquid described later to generate crystals, and is not particularly limited, and examples thereof include water, pure water, ethanol, and the like, and in particular, it is preferable to adopt water or pure water.

[0019]

Examples of the method of bringing the solvent component into contact with the surface of quartz glass include a method in which the solvent component over the quartz glass surface is flown, a method in which the solvent component is sprayed with an atomizer, and a method in which a mist of the solvent component is generated or the solvent component is brought into contact with the quartz glass surface in a state that humidity caused by the solvent component is 70% or more, and the like.

[0020]

It is sufficient that the solvent component is present on the surface of the target quartz glass by the above method, or the surface of quartz glass is wetted with the solvent component. In addition, environmental conditions such as temperature and humidity can be appropriately selected according to the type and characteristics of the solvent component to be used so that the solvent component is not dried, but usually, the temperature is normal temperature (15 to 25°C), and the humidity is not particularly limited. It is preferable to perform the method of bringing the solvent component into contact with the quartz glass surface in a high humidity state, after the solvent component is held for 30 minutes or more in an environment of a humidity of 75% or more and a normal temperature (15°C to 25°C).

[0021]

Next, the surface of the target quartz glass is subjected to surface treatment with a surface treatment liquid before the solvent component is dried.

[0022]

As the surface treatment liquid, those conventionally used can be used, and specifically, a surface treatment liquid (chemical liquid) containing hydrogen fluoride (HF) and ammonium fluoride (NH₄F) can be suitably used. In particular, an aqueous solution containing 10 to 50 wt% of hydrogen fluoride, 6 to 30 wt% of ammonium fluoride and 30 to 60 wt% of organic acid is suitably used. The organic acid is not particularly limited,

but for example, acetic acid, formic acid, propionic acid and the like are preferable. Further, the liquid temperature at the time of using the surface treatment liquid is preferably 15 to 25°C.

[0023]

5 The means using a surface treatment liquid is conventionally known by processing a surface of quartz glass into a surface having fine and smooth irregularities, that is, a surface on which fine irregularities without microcracks are formed, by a chemical treatment method called a frost method.

[0024]

10 In the present invention, by having the above-described series of steps, it is possible to obtain quartz glass in which irregularities having a surface roughness (Ra) of 1.5 to 3.5 μm are formed on the glass surface. A preferred value of the surface roughness (Ra) of the glass surface is appropriately selected according to the purpose of use, and for example, in a quartz capillary used in a film forming process in semiconductor manufacturing, the
15 glass surface roughness (Ra) is preferably 1.5 to 3.0 μm . The surface roughness (Ra) is an arithmetic mean height (Ra) defined in JIS B0601 (2001), and can be measured by a commercially available measuring instrument such as a surface roughness measuring instrument.

[0025]

20 The quartz glass on which irregularities having a specific surface roughness (Ra) obtained by the above production method are formed is useful, for example, for a quartz glass jig (tube, furnace core tube, boat, or the like) used in a film forming process in semiconductor manufacturing, particularly for a quartz capillary with an inner diameter of 4.0 to 100.0 mm and an outer diameter of 8.0 to 106.0 mm.

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EXAMPLES

[0026]

Hereinafter, the present invention is described specifically with reference to Examples and Comparative Examples, but the present invention is not limited to the
30 following Examples.

[0027]

[Example 1]

The inner surface and outer surface of a quartz capillary with an outer diameter of 8 mm and an inner diameter of 4 mm (commercially available product name “quartz gas supply tube”) (the same applies hereinafter) used in a film forming process in semiconductor manufacturing were rinsed with pure water, pure water was sprayed with an atomizer until immediately before entering a surface treatment liquid (chemical solution) tank, and surface treatment with the surface treatment liquid was performed immediately thereafter. At this time, the surface treatment liquid has a HF concentration of 14.9 wt% and an acetic acid concentration of 48.3 wt%, and the liquid temperature is 22.8°C. Surface treatment with a surface treatment liquid was performed under these conditions. The surface roughness (Ra) of the surface-treated quartz capillary was measured using a portable surface roughness tester “Surftest SJ-310” (the same applies hereinafter) manufactured by Mitutoyo Corporation. As a result, the maximum Ra was 1.92 μm , the minimum Ra was 1.56 μm , and the average Ra was 1.78 μm , and it was possible to increase the average value of Ra by about 3.3 times as compared with that in the state of Comparative Example 1.

[0028]

[Example 2]

A quartz capillary with an outer diameter of 12.7 mm and an inner diameter of 8.7 mm used in a film forming process in semiconductor manufacturing was immersed in a pure water tank, pure water was sprayed with an atomizer until immediately before entering a surface treatment liquid tank, and surface treatment with a surface treatment liquid was performed immediately thereafter. At this time, the surface treatment liquid has a HF concentration of 14.8 wt% and an acetic acid concentration of 49.1 wt%, and the liquid temperature is 24.4°C. When the surface treatment with the surface treatment liquid was performed under these conditions, the maximum Ra was 2.13 μm , the minimum Ra was 1.69 μm , and the average Ra was 2.01 μm , and it was possible to increase the average value of Ra by 3.2 times as compared with that in the state of Comparative Example 2.

[0029]

[Example 3]

A quartz capillary with an outer diameter of 24.0 mm and an inner diameter of 20.0 mm used in a film forming process in semiconductor manufacturing was immersed in

an ultrasonic cleaner storing pure water, pure water was sprayed with an atomizer until immediately before entering a surface treatment liquid tank, and surface treatment with a surface treatment liquid was performed immediately thereafter. At this time, the surface treatment liquid has a HF concentration of 14.8 wt% and an acetic acid concentration of 48.4 wt%, and the liquid temperature is 21.3°C. When the surface treatment with the surface treatment liquid was performed under these conditions, the maximum Ra was 2.29 μm, the minimum Ra was 1.62 μm, and the average Ra was 1.94 μm, and it was possible to increase the average value of Ra by about 3.5 times as compared with that in the state of Comparative Example 3.

[0030]

[Example 4]

A quartz capillary with an outer diameter of 106.0 mm and an inner diameter of 100.0 mm used in a film forming process in semiconductor manufacturing was immersed in a pure water tank storing pure water, pure water was sprayed with an atomizer until immediately before entering a surface treatment liquid tank, and surface treatment with a surface treatment liquid was performed immediately thereafter. At this time, the surface treatment liquid has a HF concentration of 14.9 wt% and an acetic acid concentration of 48.3 wt%, and the liquid temperature is 23.8°C. When the surface treatment with the surface treatment liquid was performed under these conditions, the maximum Ra was 1.94 μm, the minimum Ra was 1.50 μm, and the average Ra was 1.73 μm, and it was possible to increase the average value of Ra by about 3.2 times as compared with that in the state of Comparative Example 4.

[0031]

[Example 5]

The inner surface and outer surface of a quartz tube with an outer diameter of 282.0 mm and an inner diameter of 275.0 mm used in a film forming process in semiconductor manufacturing were rinsed with pure water, pure water was sprayed with an atomizer until immediately before entering a surface treatment liquid tank, and surface treatment with a surface treatment liquid was performed immediately thereafter. At this time, the surface treatment liquid has a HF concentration of 14.8 wt% and an acetic acid concentration of 48.4 wt%, and the liquid temperature is 21.3°C. When the surface treatment with the surface treatment liquid was performed under these conditions, the

maximum Ra was 2.86 μm , the minimum Ra was 1.46 μm , and the average Ra was 2.12 μm , and it was possible to increase the average value of Ra by about 1.6 times as compared with that in the state of Comparative Example 5.

[0032]

5 [Example 6]

The inner surface and outer surface of a quartz tube with an outer diameter of 434.0 mm and an inner diameter of 422.0 mm used in a film forming process in semiconductor manufacturing were rinsed with pure water, pure water was sprayed with an atomizer until immediately before entering a surface treatment liquid tank, and surface
10 treatment with a surface treatment liquid was performed immediately thereafter. At this time, the surface treatment liquid has a HF concentration of 14.8 wt% and an acetic acid concentration of 48.4 wt%, and the liquid temperature is 21.3°C. When the surface treatment with the surface treatment liquid was performed under these conditions, the maximum Ra was 3.54 μm , the minimum Ra was 1.97 μm , and the average Ra was 2.47 μm ,
15 and it was possible to increase the average value of Ra by about 1.5 times as compared with that in the state of Comparative Example 6.

[0033]

[Example 7]

A quartz capillary with an outer diameter of 12.7 mm and an inner diameter of
20 8.7 mm used in a film forming process in semiconductor manufacturing was stored in a container humidified with pure water using a humidifier, and held for 30 minutes in a state of a temperature of 22.5°C and a humidity of 70 to 75% (high humidity) in the container. The quartz capillary was taken out from the high humidity container and subjected to surface treatment with a surface treatment liquid. At this time, the surface treatment liquid has a
25 HF concentration of 14.5 wt% and an acetic acid concentration of 48.8 wt%, and the liquid temperature is 20.3°C. When the surface treatment with the surface treatment liquid was performed under these conditions, the maximum Ra was 2.34 μm , the minimum Ra was 2.01 μm , and the average Ra was 2.17 μm , and it was possible to increase the average value of Ra by about 3.4 times as compared with that in the state of Comparative Example 7.

[0034]

[Comparative Example 1]

A quartz capillary with an outer diameter of 8 mm and an inner diameter of 4 mm used in a film forming process in semiconductor manufacturing was sufficiently dried and then subjected to surface treatment with a surface treatment liquid. At this time, the surface treatment liquid has a HF concentration of 14.7 wt% and an acetic acid concentration of 48.5 wt%, and the liquid temperature is 22.0°C. When the surface treatment with the surface treatment liquid was performed under these conditions, the maximum Ra was 0.69 μm , the minimum Ra was 0.34 μm , and the average Ra was 0.54 μm .

[0035]

[Comparative Example 2]

A quartz capillary with an outer diameter of 12.7 mm and an inner diameter of 8.7 mm used in a film forming process in semiconductor manufacturing was sufficiently dried and then subjected to surface treatment with a surface treatment liquid. At this time, the surface treatment liquid has a HF concentration of 14.8 wt% and an acetic acid concentration of 48.3 wt%, and the liquid temperature is 23.2°C. When the surface treatment with the surface treatment liquid was performed under these conditions, the maximum Ra was 1.27 μm , the minimum Ra was 0.38 μm , and the average Ra was 0.65 μm .

[0036]

[Comparative Example 3]

A quartz capillary with an outer diameter of 24.0 mm and an inner diameter of 20.0 mm used in a film forming process in semiconductor manufacturing was sufficiently dried and then subjected to surface treatment with a surface treatment liquid. At this time, the surface treatment liquid has a HF concentration of 14.9 wt% and an acetic acid concentration of 48.5 wt%, and the liquid temperature is 21.3°C. When the surface treatment with the surface treatment liquid was performed under these conditions, the maximum Ra was 1.03 μm , the minimum Ra was 0.38 μm , and the average Ra was 0.56 μm .

[0037]

[Comparative Example 4]

A quartz capillary with an outer diameter of 106.0 mm and an inner diameter of 100.0 mm used in a film forming process in semiconductor manufacturing was sufficiently dried and then subjected to surface treatment with a surface treatment liquid. At this time,

the surface treatment liquid has a HF concentration of 14.8 wt% and an acetic acid concentration of 48.4 wt%, and the liquid temperature is 21.3°C. When the surface treatment with the surface treatment liquid was performed under these conditions, the maximum Ra was 0.89 μm, the minimum Ra was 0.35 μm, and the average Ra was 0.55 μm.

5 [0038]

[Comparative Example 5]

A quartz tube with an outer diameter of 282.0 mm and an inner diameter of 275.0 mm used in a film forming process in semiconductor manufacturing was sufficiently dried and then subjected to surface treatment with a surface treatment liquid. At this time, the surface treatment liquid has a HF concentration of 14.9 wt% and an acetic acid concentration of 48.5 wt%, and the liquid temperature is 21.3°C. When the surface treatment with the surface treatment liquid was performed under these conditions, the maximum Ra was 1.96 μm, the minimum Ra was 0.52 μm, and the average Ra was 1.30 μm.

10 [0039]

15 [Comparative Example 6]

A quartz tube with an outer diameter of 434.0 mm and an inner diameter of 422.0 mm used in a film forming process in semiconductor manufacturing was sufficiently dried and then subjected to surface treatment with a surface treatment liquid. At this time, the surface treatment liquid has a HF concentration of 14.9 wt% and an acetic acid concentration of 48.5 wt%, and the liquid temperature is 21.3°C. When the surface treatment with the surface treatment liquid was performed under these conditions, the maximum Ra was 2.76 μm, the minimum Ra was 0.50 μm, and the average Ra was 1.61 μm.

20 [0040]

[Comparative Example 7]

25 A quartz capillary with an outer diameter of 12.7 mm and an inner diameter of 8.7 mm used in a film forming process in semiconductor manufacturing was sufficiently dried under an environment of a room temperature of 21.3°C and a humidity of 50 to 60%, and then subjected to surface treatment with a surface treatment liquid. At this time, the surface treatment liquid has a HF concentration of 14.5 wt% and an acetic acid concentration of 48.7 wt%, and the liquid temperature is 20.5°C. When the surface treatment with the surface treatment liquid was performed under these conditions, the maximum Ra was 1.31 μm, the minimum Ra was 0.31 μm, and the average Ra was 0.63 μm.

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[0041]

Table 1 below summarizes the respective condition values of Examples 1 to 7 and Comparative Examples 1 to 7. Further, FIG. 1 shows a graph showing the surface roughness (Ra) of the quartz capillaries surface-treated in Examples 1 to 7 and

5 Comparative Examples 1 to 7.

[0042]

[Table 1]

		Contact of moisture with glass surface	Quartz capillary or quartz tube		Surface treatment liquid			Surface roughness (Ra)		
			Outer diameter (mm)	Inner diameter (mm)	HF concentration (wt%)	Acetic acid concentration (wt%)	Liquid temperature (°C)	Maximum value Ra (μm)	Minimum value Ra (μm)	Average Ra (μm)
Example	1	Yes	φ8	φ4	14.9	48.3	22.8	1.92	1.56	1.78
	2	Yes	φ12.7	φ8.7	14.8	49.1	24.4	2.13	1.69	2.01
	3	Yes	φ24	φ20	14.8	48.4	21.3	2.29	1.62	1.94
	4	Yes	φ106	φ100	14.9	48.3	23.8	1.94	1.50	1.73
	5	Yes	φ282	φ275	14.8	48.4	21.3	2.86	1.46	2.12
	6	Yes	φ434	φ422	14.8	48.4	21.3	3.54	1.97	2.47
	7	Yes	φ12.7	φ8.7	14.5	48.8	20.3	2.34	2.01	2.17
Comparative Example	1	No	φ8	φ4	14.7	48.5	22.0	0.69	0.34	0.54
	2	No	φ12.7	φ8.7	14.8	48.3	23.2	1.27	0.38	0.65
	3	No	φ24	φ20	14.9	48.5	21.3	1.03	0.38	0.56
	4	No	φ106	φ100	14.8	48.4	21.3	0.89	0.35	0.55
	5	No	φ282	φ275	14.9	48.5	21.3	1.96	0.52	1.30
	6	No	φ434	φ422	14.9	48.5	21.3	2.76	0.50	1.61
	7	No	φ12.7	φ8.7	14.5	48.7	20.5	1.31	0.31	0.63

CLAIMS:

1. A method for producing quartz glass with irregularities on a glass surface by performing surface treatment of quartz glass using a surface treatment liquid, the method
5 comprising: bringing a solvent component not involved in the surface treatment with the surface treatment liquid into contact with the surface of quartz glass in advance; and then performing the surface treatment with the surface treatment liquid before the solvent component is dried to form irregularities having a surface roughness (Ra) of 1.5 to 3.5 μm on the glass surface.
- 10 2. The method for producing quartz glass according to claim 1, wherein the solvent component not involved in the surface treatment is water or pure water.
3. The method for producing quartz glass according to claim 1 or 2, wherein the method
15 of bringing a solvent component not involved in the surface treatment into contact with the surface of quartz glass is a method in which the solvent component over the quartz glass surface is flown, a method in which the solvent component is sprayed with an atomizer, and a method in which a mist of the solvent component is generated or the solvent component is brought into contact with the quartz glass surface in a state that humidity caused by the
20 solvent component is 70% or more.
4. The method for producing quartz glass according to any one of claims 1 to 3, wherein a component of the surface treatment liquid of quartz glass is a mixed acid containing HF, NH_4F , and acetic acid.
- 25 5. The method for producing quartz glass according to any one of claims 1 to 4, wherein the quartz glass produced by the production method is a quartz glass jig used in a film forming process in semiconductor manufacturing.
- 30 6. The method for producing quartz glass according to claim 5, wherein the quartz glass jig is a quartz capillary with an inner diameter of 4.0 to 100.0 mm and an outer diameter of 8.0 to 106.0 mm.