

METHOD FOR CLEANING ANODIZED PARTS OF SEMICONDUCTOR EQUIPMENT

FIELD OF THE INVENTION

5 [0001] The present invention generally relates to a method for cleaning anodized parts of a semiconductor equipment, specifically those with anodic oxide films.

BACKGROUND

[0002] Conventional methods for cleaning anodized parts of a semiconductor equipment
10 typically involve prolonged hot water soaking followed by manual scrubbing. These methods have multiple disadvantages. First, the conventional methods are inefficient, as prolonged soaking times in hot water reduce production efficiency. Secondly, manual scrubbing increases labor costs and is not conducive to automation or semi-automation. Thirdly, physical scrubbing is ineffective for complex-shaped parts of the semiconductor equipment, leaving residues in
15 intricate areas. Lastly, manual cleaning can cause damage to the delicate anodized layer on the semiconductor equipment parts, compromising their integrity and functionality.

[0003] Therefore, there is a need for a more efficient cleaning method that addresses these shortcomings, reduces labor, increases cleaning efficiency, thoroughly cleans even complex-shaped parts, and minimizes damage to the anodized layer.

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SUMMARY

[0004] The invention provides an efficient cleaning method for cleaning parts of a semiconductor equipment that have an anodized aluminum surface, using an ultrasonic cleaning process in combination with a specially formulated cleaning composition. The method
25 preserves the integrity of the anodized layer while effectively removing contaminants.

[0005] In one aspect, the present disclosure refers to a method of cleaning an anodized part of a semiconductor equipment, comprising

(a) submerging the anodized part of the semiconductor equipment in water and heating the water to 50-80 °C;

30 (b) adding a cleaning solution comprising 10-20 mass% polyoxyethylene ether, 3-8 mass% auxiliary agent, 1-3 mass% coupling agent, 1-3 mass% wetting agent, 10-15 mass% organic diluent, and pure water to the water of step (a) to obtain a mixed solution; and

(c) applying ultrasonic waves to the mixed solution at a frequency of 40-120 kHz for 15 min – 2.5 h.

[0006] Advantageously, the method of the present disclosure saves time and labour. After adding the cleaning agent, ultrasonic cleaning is carried out for 15 min -2.5 h, for example 15-20 minutes, using the disclosed parameters, and pure water rinsing is done after the ultrasonic cleaning. Significantly less labour is involved. In addition, complex-shaped parts can be cleaned thoroughly, as ultrasonic cleaning can reach and clean every dead corner of the parts. Furthermore, only pure water is required for rinsing the cleaned parts, which adds to the simplicity and convenience of the process. Last by not least, the cleaning method of the present invention minimizes product damage and loss, with minimal manual intervention. The method also reduces risk of damage to the anodized surface. The method also increases the time of recycled use of the parts by 30% to 50% compared to current methods.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] The invention will be better understood with reference to the detailed description when considered in conjunction with the non-limiting examples and the accompanying drawings, in which:

[0008] **Figure 1** is schematic flow diagram of the cleaning process, including receiving, cleaning, and packaging of anodized parts of a semiconductor equipment.

[0009] **Figure 2** are microscopic images of the surfaces of anodized parts of a semiconductor equipment, before and after cleaning using the method of the present invention, using 180-200 times magnification by the microscope. (a), (b), (c) and (d) are microscopic images of four different anodized part surfaces of a semiconductor equipment.

[0010] **Figure 3** are line graphs of (a) weight change; (b) thickness change; and (c) roughness change of the anodized parts of a semiconductor equipment, before and after various cleaning times using the method of the present invention.

DETAILED DESCRIPTION

[0011] The present invention addresses the shortcomings of traditional cleaning methods of anodized parts of a semiconductor equipment, by introducing an ultrasonic cleaning process combined with a specially formulated cleaning composition. This method significantly reduces

cleaning time, lowers labor costs, and ensures thorough cleaning of complex parts without damaging the anodic oxide film of the anodized semiconductor equipment parts.

[0012] **Cleaning method**

[0013] In one aspect, the present disclosure refers to a method of cleaning an anodized part
5 of a semiconductor equipment, comprising

(a) submerging the anodized part of the semiconductor equipment in water and heating the water to 50-80 °C;

(b) adding a cleaning solution comprising 10-20 mass% polyoxyethylene ether, 3-8 mass% auxiliary agent, 1-3 mass% coupling agent, 1-3 mass% wetting agent, 10-15 mass% organic
10 diluent, and pure water to the water of step (a) to obtain a mixed solution; and

(c) applying ultrasonic waves to the mixed solution at a frequency of 40-120 kHz for 15 min – 2.5 h.

[0014] In Step (a) of the cleaning method of the present invention, the anodized part of the semiconductor equipment is submerged in water. In one example, the volume of water to
15 submerge the anodized part of the semiconductor equipment is about 1-5 L. In another example, the volume of water to submerge the anodized part of the semiconductor equipment is about 4.5 L. The volume of water should be enough to fully submerge the anodized part of the semiconductor equipment to be cleaned.

[0015] The water is then heated to 50-80 °C using a heater commonly used in the field, such
20 as a heating rod or an immersion heater. In one example, the water is heated to about 50 °C. In another example, the water is heated to about 55 °C. In another example, the water is heated to about 60 °C. In another example, the water is heated to about 65 °C. In another example, the water is heated to about 70 °C. In another example, the water is heated to about 75 °C. In another example, the water is heated to about 80 °C. In another example, the water is heated to 50-60
25 °C, 55-65 °C, 60-70 °C, 65-75 °C, or 70-80 °C. In another example, the water is heated to 70-80 °C. Heating the water to 50-80 °C is to enhance the activity of the cleaning solution as disclosed herein.

[0016] In Step (b) of the cleaning method of the present invention, a cleaning solution comprising 10-20 mass% polyoxyethylene ether, 3-8 mass% auxiliary agent, 1-3 mass%
30 coupling agent, 1-3 mass% wetting agent, 10-15 mass% organic diluent, and pure water, was prepared. In one example, the cleaning solution comprises 10-20 mass% polyoxyethylene ether. In another example, the cleaning solution comprises about 10 mass%, about 11 mass%,

about 12 mass%, about 13 mass%, about 14 mass%, about 15 mass%, about 16 mass%, about 17 mass%, about 18 mass%, about 19 mass%, about 20 mass%, 10-13 mass%, 11-14 mass%, 12-15 mass%, 13-16 mass%, 14-17 mass%, 15-18 mass%, 16-19 mass%, or 17-20 mass% polyoxyethylene ether. In another example, the cleaning solution comprises 3-8 mass% auxiliary agent. In another example, the cleaning solution comprises about 3 mass%, about 4 mass%, about 5 mass%, about 6 mass%, about 7 mass%, about 8 mass%, 3-5 mass%, 4-6 mass%, 5-7 mass%, or 6-8 mass% auxiliary agent. In another example, the cleaning solution comprises 1-3 mass% coupling agent. In another example, the cleaning solution comprises about 1 mass%, about 2 mass%, or about 3 mass% coupling agent. In another example, the cleaning solution comprises 1-3 mass% wetting agent. In another example, the cleaning solution comprises about 1 mass%, about 2 mass%, or about 3 mass% wetting agent. In another example, the cleaning solution comprises 10-15 mass% organic diluent. In another example, the cleaning solution comprises about 10 mass%, about 11 mass%, about 12 mass%, about 13 mass%, about 14 mass%, about 15 mass%, 10-13 mass%, 11-14 mass%, or 12-15 mass% organic diluent. The rest of the cleaning solution is pure water.

[0017] In one example, the polyoxyethylene ether is fatty alcohol polyoxyethylene ether (AEO). In another example, AEO is about 15 mass% of the cleaning solution. In another example, the polyoxyethylene ether is selected from the group consisting of alkylphenol polyoxyethylene ether (TX-10), and isotridecyl alcohol polyethylene ether (1309). As a nonionic surfactant, the polyoxyethylene ether provides emulsification, cleaning, wetting and other functions.

[0018] In one example, the auxiliary agent is sodium carbonate. In another example, sodium carbonate is about 3 mass% of the cleaning solution. In another example, the auxiliary agent is selected from the group consisting of sodium bicarbonate and sodium citrate.

[0019] In one example, the coupling agent is N- β -(aminoethyl)- γ -aminopropyltrimethoxysilane. In another example, N- β -(aminoethyl)- γ -aminopropyltrimethoxysilane is about 2 mass% of the cleaning solution. In another example, the coupling agent is selected from the group consisting of N- β -(aminoethyl)- γ -aminopropyl dimethoxysilane, and N-phenylaminomethyl triethoxysilane. The coupling agent improves the compatibility between two substances of different properties and improves the interaction between the cleaning agent and the surface to be cleaned.

[0020] In one example, the wetting agent is an alkyl polyglucoside (APG). In another example, APG is about 2 mass% of the cleaning solution. In another example, the wetting agent is selected from the group consisting of polyethylene glycol (PEG), and alcohol ether glycoside (AEG). The wetting agent further enhances the wetting properties of the cleaning solution, allowing the cleaning solution to spread faster and more evenly on the surface being cleaned.

[0021] In one example, the organic diluent is anhydrous ethanol. In another example, the anhydrous ethanol is about 10 mass% of the cleaning solution. In another example, the organic diluent is selected from the group consisting of isopropyl alcohol and acetone. The organic diluent acts to adjust the viscosity of the cleaning solution.

[0022] In Step (b) of the method as disclosed herein, the cleaning solution as disclosed herein is added to the water to achieve a 5-15 vol% concentration, depending on the level of contamination on the parts. Higher level of contamination to be cleaned would need a higher concentration of the cleaning solution. In one example, the cleaning solution as disclosed herein is added to the water to achieve about 5 vol% concentration. In another example, the cleaning solution as disclosed herein is added to the water to achieve about 10 vol% concentration. In another example, the cleaning solution as disclosed herein is added to the water to achieve about 15 vol% concentration. In another example, to prepare a 10 vol% concentration cleaning solution, 500 mL of the cleaning solution is added to 4500 mL of water.

[0023] In one example, the cleaning solution is added to the water of step (a) to obtain a mixed solution.

[0024] In step (c) of the method as disclosed herein, the anodized part of the semiconductor equipment is submerged in the mixed solution, followed by applying ultrasonic waves at a frequency of 40 -120 kHz for 15 min – 2.5 h, depending on the level of contamination on the parts. Higher level of contamination to be cleaned would need a longer period of ultrasonic cleaning. Ultrasonication generates heat and maintains the temperature of the mixed solution at 50-80 °C.

[0025] In one example, the ultrasonic waves are applied at a frequency of 40-120 kHz for about 15 min, about 20 min, about 25 min, about 30 min, about 35 min, about 40 min, about 45 min, about 50 min, about 1 h, about 1.5 h, about 2 h, about 2.5 h, 15-20 min, 15-25 min, 20-30 min, 25-35 min, 30-40 min, 35-45 min, 40-50 min, 45-55 min, 50-60 min, 55-65 min, 60-70 min, 1-2 h, or 1.5-2.5 h.

[0026] In another example, the ultrasonic waves are applied at a frequency of 40 -120 kHz, about 40 kHz, about 50 kHz, about 60 kHz, about 70 kHz, about 80 kHz, about 90 kHz, about 100 kHz, about 110 kHz, about 120 kHz, 40-60 kHz, 50-70 kHz, 60-80 kHz, 70-90 kHz, 80-100 kHz, 90-110 kHz, or 100-120 kHz.

5 [0027] In the final step of the method as disclosed herein, after ultrasonic cleaning, the anodized part of the semiconductor equipment is rinsed with pure water to remove any residual cleaning solution.

[0028] The method is particularly suitable for cleaning anodized aluminum parts used in semiconductor equipment, but it can also be adapted for other materials such as ceramics, with
10 adjustments to the ultrasonic parameters. In one example, the anodized part of a semiconductor equipment to be cleaned using the method of the present invention is an anodized aluminum substrate.

[0029] **Cleaning Composition**

[0030] In another example, the present disclosure refers to a cleaning composition for use
15 in the method as disclosed herein, comprising:

- i. a polyoxyethylene ether (10-20 mass%) selected from the group consisting of fatty alcohol polyoxyethylene ether (AEO), alkylphenol polyoxyethylene ether (TX-10), and isotridecyl alcohol polyethylene ether (1309);
- ii. an auxiliary agent (3-8 mass%) selected from the group consisting of sodium carbonate,
20 sodium bicarbonate and sodium citrate;
- iii. a coupling agent (1-3 mass%) selected from the group consisting of N- β -(aminoethyl)- γ -aminopropyltrimethoxysilane, N- β -(aminoethyl)- γ -aminopropyl dimethoxysilane, and N-phenylaminomethyl triethoxysilane;
- iv. a wetting agent (1-3 mass%) selected from the group consisting of an alkyl
25 polyglucoside (APG), polyethylene glycol (PEG), and alcohol ether glycoside (AEG);
- v. an organic diluent (10-15 mass%) selected from the group consisting of anhydrous ethanol, isopropyl alcohol and acetone; and
- vi. pure water.

[0031] In one example, the cleaning agent composition for use in the method as disclosed
30 herein comprises the following ingredients:

- i. fatty alcohol polyoxyethylene ether, AEO, about 15 mass%;
- ii. sodium carbonate, about 3 mass%;

- iii. N- β -(aminoethyl)- γ -aminopropyltrimethoxysilane, about 2 mass%;
- iv. alkyl polyglucosides, APG, about 2 mass%;
- v. anhydrous ethanol, about 10 mass%; and
- vi. pure water, about 68 mass%.

5 [0032] The cleaning composition is prepared by mixing the above components in the indicated proportions. This cleaning agent is effective in removing contaminants from the anodic oxide film without causing any damage to the surface or altering its properties.

[0033] Advantages of the invention are manifold:

- 10 • Time and Labor Efficiency: The ultrasonic cleaning process combined with the specialized cleaning solution significantly reduces cleaning time to just 15-20 minutes, compared to the at least 2-hour soaking time in traditional methods. This process also requires minimal manual intervention.
- Thorough Cleaning: The ultrasonic waves ensure that even the most complex and intricate parts are thoroughly cleaned, reaching areas that are inaccessible through manual cleaning.
- 15 • Reduced Damage: By eliminating manual scrubbing, the method minimizes the risk of damaging the anodic oxide film, preserving the surface integrity and thickness.
- Increased Cleaning Frequency: The method allows for increased time of recycled use of the parts by 30-50%, enhancing the overall maintenance and longevity of the semiconductor equipment.
- 20

[0034] The present invention offers a significant improvement over existing cleaning methods for anodized semiconductor equipment parts, providing a faster, more efficient, and less damaging cleaning process. The invention's advantages in terms of time savings, labor reduction, and enhanced cleaning capabilities make it a valuable contribution to the field of semiconductor equipment maintenance.

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[0035] As used in this application, the singular form “a,” “an,” and “the” include plural references unless the context clearly dictates otherwise. For example, the term “a metal” includes a plurality of metals, including mixtures and combinations thereof.

[0036] As used herein, the term “comprising” means “including.” Variations of the word “comprising”, such as “comprise” and “comprises,” have correspondingly varied meanings. Thus, for example, a composition “comprising” X may consist exclusively of X or may include one or more additional unrecited components.

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[0037] As used herein, the term “about” in the context of concentration of a substance, size of a substance, length of time, or other stated values means +/- 5% of the stated value, or +/- 4% of the stated value, or +/- 3% of the stated value, or +/- 2% of the stated value, or +/- 1% of the stated value, or +/- 0.5% of the stated value.

5 [0038] Throughout this disclosure, certain embodiments may be disclosed in a range format. It should be understood that the description in range format is merely for convenience and brevity and should not be construed as an inflexible limitation on the scope of the disclosed ranges. Accordingly, the description of a range should be considered to have specifically disclosed all the possible sub-ranges as well as individual numerical values within that range.
10 For example, description of a range such as from 1 to 6 should be considered to have specifically disclosed sub-ranges such as from 1 to 3, from 1 to 4, from 1 to 5, from 2 to 4, from 2 to 6, from 3 to 6 etc., as well as individual numbers within that range, for example, 1, 2, 3, 4, 5, and 6. This applies regardless of the breadth of the range.

[0039] The disclosure illustratively described herein may suitably be practiced in the
15 absence of any element or elements, limitation or limitations, not specifically disclosed herein. Thus, for example, the terms "comprising", "including", "containing", etc. shall be read expansively and without limitation. Additionally, the terms and expressions employed herein have been used as terms of description and not of limitation, and there is no intention in the use of such terms and expressions of excluding any equivalents of the features shown and described
20 or portions thereof, but it is recognized that various modifications are possible within the scope of the invention claimed. Thus, it should be understood that although the present invention has been specifically disclosed by preferred embodiments and optional features, modification and variation of the inventions embodied herein disclosed may be resorted to by those skilled in the art, and that such modifications and variations are considered to be within the scope of this
25 invention.

[0040] The invention has been described broadly and generically herein. Each of the narrower species and subgeneric groupings falling within the generic disclosure also form part of the invention. This includes the generic description of the invention with a proviso or negative limitation removing any subject matter from the genus, regardless of whether or not
30 the excised material is specifically recited herein.

[0041] Unless otherwise indicated, all technical and scientific terms used herein have the same meaning as commonly understood to one of ordinary skill in the art to which the invention belongs.

[0042] Other embodiments are within the following claims and non-limiting examples.

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EXAMPLES

[0043] Non-limiting examples of the disclosure will be further described in greater detail by reference to specific Examples, which should not be construed as in any way limiting the scope of the disclosure.

10 [0044] **Example 1- the cleaning process**

(a) Submerge the anodized part of the semiconductor equipment in 4500 mL water and the water is heated to 70-80 °C;

(b) Prepare 500 mL of cleaning solution comprising about 15 mass% fatty alcohol polyoxyethylene ether, AEO; about 3 mass% sodium carbonate; about 2 mass% N-β-
15 (aminoethyl)-γ-aminopropyltrimethoxysilane; about 2 mass% Alkyl polyglycoside, APG; about 10 mass% anhydrous ethanol, and pure water. Add the cleaning solution to the water of step (a), and stir well. Thus, a 10 vol% concentration cleaning solution is prepared.

(c) Apply ultrasonic waves at a frequency of 40 -120 kHz for 15 min – 2.5 h.

(d) Rinse the parts with pure water and dry.

20 [0045] Formulations of the cleaning solution used in the method as disclosed herein is listed in Table 1.

[0046] **Table 1. Formulation of the cleaning solution used in the method as disclosed herein**

Ingredient	Concentration	Example	
polyoxyethylene ether	10-20 mass%	fatty alcohol polyoxyethylene ether (AEO)	15 mass%
auxiliary agent	3-8 mass%	sodium carbonate	3 mass%
coupling agent	1-3 mass%	N-β-(aminoethyl)-γ-aminopropyltrimethoxysilane	2 mass%

wetting agent	1-3 mass%	alkyl polyglucoside (APG)	2 mass%
organic diluent	10-15 mass%	anhydrous ethanol	10 mass%
pure water	Remaining amount	pure water	68 mass%

[0047] **Example 2- Result**

[0048] The entire process of receiving, cleaning, and packaging an anodized part of a semiconductor equipment is depicted in Figure 1.

[0049] The cleaning method effectively cleans anodized aluminum parts by removing
5 etching products and color patterns on the anodized surface, without damaging the anodized layer, as demonstrated by weight, thickness, and surface roughness measurements before and after cleaning, which are not changed (Tables 2-4). The method as disclosed herein does not affect the microscopic appearance, roughness and thickness of the anodized surface (Figure 2, Figure 3). As can be seen in Figure 2, four anodized part surfaces of a semiconductor equipment
10 did not show any topological or surface change before and after cleaning using the method as disclosed herein. Figure 3 represented the weight, thickness and roughness of 6 samples of the anodized part of a semiconductor equipment before and after 15 min-2.5 h ultrasonic cleaning using the method as disclosed herein, which showed no substantive change before and after cleaning. The process is faster and more efficient than traditional methods, with minimal
15 manual intervention required. Additionally, the parts' time of recycled use is increased by 30-50% due to the preservation of the anodized layer's integrity. The cost of buying replacement parts is substantially reduced.

[0050] **Table 2. Measurement of weight of the anodized layer before and after cleaning using the method as disclosed herein**

sample	measurement term	pre-cleaning	Cleaning 15min	Cleaning 0.5h	Cleaning 1h	Cleaning 1.5h	Cleaning 2.5h
1	weights	2.3893	2.3793	2.3754	2.3663	2.3678	2.3646
2	weights	2.3593	2.3482	2.3394	2.3283	2.3357	2.3344
3	weights	2.3609	2.3468	2.3413	2.335	2.3386	2.3419
4	weights	2.3708	2.3646	2.3553	2.3418	2.3403	2.3487
5	weights	2.3719	2.3621	2.347	2.34	2.3414	2.3461
6	weights	2.3377	2.3257	2.3236	2.3114	2.3118	2.3124

[0051] **Table 3. Measurement of thickness of the anodized layer before and after cleaning using the method as disclosed herein**

sample	measurement term	pre-cleaning	Cleaning 15min	Cleaning 0.5h	Cleaning 1h	Cleaning 1.5h	Cleaning 2.5h
1	film thickness	67	68	67	68	68	68
2	film thickness	70	72	71	71	70	71
3	film thickness	68	68	68	66	68	70
4	film thickness	72	71	71	71	71	71
5	film thickness	68	68	68	68	68	68
6	film thickness	66	68	67	66	68	68

[0052] **Table 4. Measurement of average roughness of the anodized layer before and after cleaning using the method as disclosed herein**

sample	measurement term	pre-cleaning	Cleaning 15min	Cleaning 0.5h	Cleaning 1h	Cleaning 1.5h	Cleaning 2.5h
1	Average roughness	1.63025	1.75275	1.62925	1.68	1.6255	1.567
2	Average roughness	1.55025	1.782	1.675	1.6625	1.67125	1.65
3	Average roughness	1.32425	1.43325	1.398	1.44625	1.4855	1.50425
4	Average roughness	1.493	1.44075	1.3925	1.4125	1.47275	1.54025
5	Average roughness	1.249	1.36175	1.2145	1.2254	1.2845	1.2005
6	Average roughness	1.29625	1.272	1.274	1.20025	1.198	1.233

[0053] **Industrial Applicability**

[0054] Various other modifications and adaptations of the invention will be apparent to the person skilled in the art after reading the foregoing disclosure without departing from the spirit and scope of the invention and it is intended that all such modifications and adaptations come within the scope of the appended claims.

Claims

1. A method of cleaning an anodized part of a semiconductor equipment, comprising
 - (a) submerging the anodized part of the semiconductor equipment in water and heating the water to 50-80 °C;
 - 5 (b) adding a cleaning solution comprising 10-20 mass% polyoxyethylene ether, 3-8 mass% auxiliary agent, 1-3 mass% coupling agent, 1-3 mass% wetting agent, 10-15 mass% organic diluent, and pure water to the water of step (a) to obtain a mixed solution; and
 - (c) applying ultrasonic waves to the mixed solution at a frequency of 40-120 kHz for 15 min – 2.5 h.
- 10 2. The method of claim 1, further comprising (d) rinsing the anodized part of the semiconductor equipment with pure water after ultrasonic cleaning.
3. The method of claim 1, wherein the polyoxyethylene ether is selected from the group consisting of fatty alcohol polyoxyethylene ether (AEO), alkylphenol polyoxyethylene ether (TX-10), and isotridecyl alcohol polyethylene ether (1309).
- 15 4. The method of claim 3, wherein the AEO is about 15 mass% of the cleaning solution.
5. The method of claim 1, wherein the auxiliary agent is selected from the group consisting of sodium carbonate, sodium bicarbonate, and sodium citrate.
6. The method of claim 5, wherein the sodium carbonate is about 3 mass% of the cleaning solution.
- 20 7. The method of claim 1, wherein the coupling agent is selected from the group consisting of N- β -(aminoethyl)- γ -aminopropyltrimethoxysilane, N- β -(aminoethyl)- γ -aminopropyl dimethoxysilane, and N-phenylaminomethyl triethoxysilane.
8. The method of claim 7, wherein the N- β -(aminoethyl)- γ -aminopropyltrimethoxysilane is about 2 mass% of the cleaning solution.
- 25 9. The method of claim 1, wherein the wetting agent is selected from the group consisting of an alkyl polyglucoside (APG), polyethylene glycol (PEG), and alcohol ether glycoside (AEG).
10. The method of claim 9, wherein the APG is about 2 mass% of the cleaning solution.
11. The method of claim 1, wherein the organic diluent is selected from the group consisting
 - 30 of anhydrous ethanol, isopropyl alcohol and acetone.
12. The method of claim 11, wherein the anhydrous ethanol is about 10 mass% of the cleaning solution.

13. The method of claim 1, wherein the cleaning solution added to the water to achieve a 5-15 vol% concentration.
14. The method of claim 13, wherein the cleaning solution added to the water to achieve an about 10 vol% concentration.
- 5 15. The method of claim 1, wherein the ultrasonic waves are applied for 15-20 min.
16. The method of claim 1, wherein the ultrasonic waves are applied at a frequency of about 40 kHz.
17. The method of claim 1, wherein the anodized part of a semiconductor equipment is an anodized aluminum substrate.