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TITLE OF THE INVENTION

POLISHING METHOD



G00002

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to the field of a polishing apparatus and a polishing method, and more particularly to a polishing method capable of automating recovery of a polished object (hereinafter also referred to as a "workpiece").

2. Description of the Related Art

A double side polishing apparatus has been widely used as a polishing apparatus for hard disks and glass substrates for use in the liquid crystal display since it can polish both sides at the same time (Japanese Patent Application Unexamined Publication No. 5-169365/1993). However, double side polishing has had its inherent problem that a workpiece tends to stick to the upper plate of the polisher when it is removed after polishing. Consequently, complicated removal of the workpiece is required and damage to the workpiece due to the falling thereof is caused, leading to reduction of yield.

SUMMARY OF THE INVENTION

The present invention intends to solve the above-

described problem associated with prior art by preventing a polished object from sticking to the upper polishing mechanism so as to increase the yield and improve the removal of the polished object.

The present invention provides an apparatus for polishing an object such as a substrate, wherein the upper and lower polishing mechanisms are designed such that the adsorption strength of a contact surface of the upper mechanism onto the object (workpiece) is weaker than that of the lower mechanism. As a result, when the upper mechanism is moved upward (is released) after polishing, the polished workpiece does not stick to the upper mechanism; the workpiece (object such as substrate) is not damaged; and the polished workpiece can be efficiently recovered.

Specifically, the present invention provides a double side polishing method comprising steps of: inserting an object between a pair of upper and lower polishing mechanisms and polishing the object by rotating or sliding the object therebetween, wherein an adsorption strength of a contact surface of the upper polishing mechanism onto the object is weaker than an adsorption strength of a contact surface of the lower polishing mechanism onto the object. The present invention also provides a double side polishing method comprising steps of: inserting an object between a pair of upper and lower polishing mechanisms and polishing the object

by rotating or sliding the object therebetween, wherein a ratio of said adsorption strength of said upper polishing mechanism onto said object to said adsorption strength of said lower polishing mechanism onto said object is 0.95 or less.

According to the present invention, when a double side polisher is used, the polished workpiece does not stick to the upper polishing mechanism and remains entirely on the lower polishing mechanism so that the object such as the substrate is free from damage and the polished object can be taken off.

It should be noted that the word "polish" in the specification and claims should be taken in the broad sense of the word including lap, rub, abrade and chafe.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 shows a method for measuring the adsorption strength.

FIG. 2 shows the result of Example 1.

FIG. 3 shows the result of Comparative Example 1.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

The workpiece to be polished may preferably comprise glass, B, C or Si, or a metal or an alloy of two or more metals selected from the group consisting of Fe, Cr, Ni, Cu,

Co, Al, Sn, Mo, W, Ta, Ti and Nb. The workpiece may be the one coated with any of these materials. It may be preferable that the workpiece has flat surfaces and is a plate such as a circular, square or rectangular plate. Specifically, it may include a glass substrate for liquid crystal display, a hard disk substrate and a semiconductor wafer.

The polishing apparatus used in the present invention has upper and lower polishing mechanisms capable of polishing the surfaces of a workpiece from the upper and lower sides. The sliding or rotation can polish away defects and irregularities on the surfaces of the workpiece.

The upper and lower polishing mechanisms may, for example, have vertically moving shafts to be rotated by a drive motor or the like. The rotation mechanisms may be preferably synchronized and optionally have a mechanism capable of changing torque or of reverse rotation. The upper and lower mechanisms may be typically rotated in the opposite directions to each other.

The upper and lower polishing mechanisms may preferably comprise rotating plates (sliding plates) and rotating shafts, and optionally polishing pads. The mechanisms have a construction in which a processing carrier with a workpiece arranged therein is placed between these upper and lower polishing mechanisms and is fitted with gears at inner and outer peripheries. The object may be polished without being

fixed to the carrier, namely with floating, while the processing carrier is rotated on its own axis and revolved.

The processing carrier may have a mechanism that an object is polished, while holding the object and transmitting the rotation or revolution force of abrasives to the object. The processing carrier may have any shape without particular limitation as far as it can perform surface polishing. The carrier may preferably be a plate having a through-hole. The object is mounted in the through-hole for polishing the both surfaces of the object projected from the through-hole. For example, when the object has a cylindrical form, the diameter of the through-hole is made larger than the diameter of the object. The processing carrier may preferably comprise one or more materials selected from the group consisting of brass, stainless steel (SUS), epoxy-impregnated glass, iron, copper, aluminum, nickel and carbon. The carrier may be coated with any of these materials.

Such a polishing method can be applicable for a lapping machine to adjust the thickness of a workpiece, polishing for mirror finishing of a workpiece and the like.

The upper and lower polishing mechanisms have means to polish a workpiece at the upper and lower sides.

A lapping machine or the like can have the upper and lower polishing mechanisms which can polish a workpiece, using polishing plates of material such as SUS 410 together

with an abrasive liquid.

A polishing machine can have the upper and lower polishing mechanisms wherein polishing pads are mounted on the rotating (or evolving) or sliding plates of the mechanisms. The polishing pads used in the polishing machine may be made of non-woven fabric, polyurethane or suede-based material.

A workpiece may be held between the upper and lower polishing mechanisms through the carrier. The abrasive liquid may be introduced through a passage and then the upper and lower polishing mechanisms are operated for polishing.

The abrasive liquid may preferably include an abrasive liquid containing an inorganic abrasive such as diamond, silicon carbide, colloidal silica, ceria, alumina, zirconia or titanium oxide.

According to the present invention, the adsorption strength (sticking strength) of a contact surface of the upper polishing mechanism onto a workpiece is made weaker than the adsorption strength of a contact surface of the lower polishing mechanism onto the workpiece. Consequently, the polished workpiece is prevented from sticking to the upper polishing mechanism.

The adsorption strengths of contact surfaces of the upper and lower polishing mechanisms can be controlled by setting the ratio of the sticking strength (adsorption

strength) of the contact surface of the upper polishing mechanism (plate) to that of the lower polishing mechanism (plate) preferably at 0.95 or less, more preferably in the range of 0.1 to 0.85. When the ratio is larger than 0.95, the polished object may stick to the upper and lower polishing mechanisms, preventing automatic recovery of the polished objects. The method for determining the ratio of the adsorption strengths is described in Examples below.

The adsorption strengths of the contact surfaces of the upper and lower polishing mechanisms can be controlled preferably by using different materials as polishing pads which are parts of the upper and lower polishing mechanisms. Alternately, the adsorption strengths can be controlled preferably by controlling the contact surface areas of the polishing mechanisms onto the workpiece.

When the adsorption strengths of the contact surfaces of the upper and lower polishing mechanisms are controlled by the difference of the polishing pad materials which are parts of the upper and lower polishing mechanisms, the polishing pads may be preferably selected from non-woven fabric, polyurethane and suede-based polishing cloth.

For example, at a stage of final polish of semiconductor wafers, suede is used for the lower mechanism, while non-woven fabric or polyurethane is used for the upper mechanism. Consequently, the polished workpiece remains on the lower

mechanism when the upper mechanism is lifted.

When the adsorption strengths of the contact surfaces of the upper and lower polishing mechanisms are controlled by controlling the contact surface areas of the polishing mechanisms onto the workpiece, for example, the contact surface area of the upper plate (mechanism) may be designed smaller than that of the lower plate (mechanism) by providing one or more grooves or holes in the upper plate as polishing cloth is used. If one or more grooves or holes are present in the lower plate, the contact surface area of the upper plate can be controlled by increasing the number or size of one or more grooves or holes in the upper plate. The polishing member of the mechanisms may include diamond, alumina, titanium oxide and silicon carbide. The material for the polishing cloth may include suede, non-woven fabric and polyurethane as described above.

Especially, grooves such as radial grooves, spiral grooves, grooves consisting of multiple chords parallel to the diameter, lattice grooves, dimple grooves, or stripe grooves may be preferably formed in the contact surfaces of the plates (mechanisms) which are in contact with the object. The ratio of the contact area of the upper plate to that of the lower plate may be preferably 0.99 or less, more preferably in the range of 0.3 to 0.95.

According to the present invention, the adsorption

strength of the upper and lower polishing mechanisms is controlled. For example, the contact areas of the polishing mechanisms are controlled. Consequently, the upper polishing mechanism is prevented from sticking to the object so that complicated removal of the polished object and the yield are improved. Thus, the polishing process can be automated according to the present invention.

The present invention will be described on basis of examples. However, it should not be construed that the present invention is limited to the examples.

<Example 1>

As workpieces, 30 pieces of 2.5 inch glass (0.6 mm thick) substrates were provided.

As a lapping machine, a 9B type double side polisher (9 inches in carrier size) was used. The upper plate (mechanism) was latticed with the grooves having a width of 3 mm and a depth of 2 mm at a pitch of 30 mm, while the lower plate (mechanism) was latticed with the grooves having a width of 3 mm and a depth of 2 mm at a pitch of 40 mm. Accordingly, the ratio of the contact area of the upper plate with the workpieces to that of the lower plate with the workpieces was set at 0.95. The polishing plates were made of iron.

Both surfaces of the workpieces were lapped using a 10%

slurry (dispersed in water) of FO#240 (silicon carbide made by Fujimi Incorporated) as abrasives. As a result, the workpieces were polished to the target thickness of 0.5 mm.

After the polishing, the upper plate was raised to see whether or not the workpieces had stuck to the upper plate. It was found that all of the workpieces remained on the lower plate together with the processing carrier as shown in FIG. 2. The ratio of the adsorption strength of the upper plate to that of the lower plate was 0.85.

<Comparative Example 1>

As a comparison to Example 1, the ratio of the contact area of the upper plate with the workpieces to that of the lower plate with the workpieces was set at 1.00 by providing grooves of a width of 3 mm and a depth of 2 mm at a pitch of 40 mm for both of the upper and lower plates. Both surfaces of the workpieces were polished in the same manner as in Example 1. After the polishing, the upper plate was raised to see whether or not the workpieces had stuck to the upper plate. It was found that six pieces of 30 pieces stuck to the upper plate as shown in FIG. 3. The ratio of the adsorption strength of the upper plate to that of the lower plate was 1.00.

<Examples 2 to 7 and Comparative Examples 2 to 3>

As workpieces, 200 pieces of one inch glass (0.4 mm thick) substrates were provided. The tests were performed using mirror finished workpieces.

As a polishing machine, a 9B type double side polisher (9 inches in carrier size) was used. Suede-based polishing pads were mounted on the upper and lower plates.

The polishing pads were provided with various grooves to control the ratio of the adsorption strength per unit area of the upper plate to that of the lower plate. After the upper and lower polishing pads were mounted, the workpieces were set together with a processing carrier on the lower plate of the double side polisher. The workpieces were polished for 10 minutes while adding an abrasive liquid (10% colloidal silica dispersion, made by Fujimi Incorporated). Subsequently, the upper plate was raised to see whether or not the workpieces had stuck to the upper plate.

<Examples 8 to 13, Comparative Examples 4 to 5>

One inch Si-substrates were used as workpieces and tested in the same manner as in Examples 2 to 7.

<Examples 14 to 16, Comparative Examples 6 to 8>

As workpieces, 40 pieces of 50 mm square glass (0.5 mm thick) substrates were prepared. Non-woven, polyurethane or suede-based polishing pads were mounted on the upper and

lower plates and tested for the sticking onto the workpieces. The other conditions for the polishing were same as those of Examples 2 to 7.

<Method for determining the ratio of adsorption strengths>

A method for measuring the adsorption strength is shown in FIG. 1. A mirror-finished SUS plate 2 (ϕ 40 mm) is placed on a polishing pad or surface plate 1 which has been wetted with water or an abrasive liquid. A load cell or spring balance 4 which has been connected with the SUS plate at a connection 3 is pulled at the same speed as the lift speed of the polishing pad or surface plate 1.

According to the above described measuring method, the highest value of the adsorption strength per unit area is measured. The values of the adsorption strengths of the upper and lower plates are evaluated as the ratio of adsorption strengths.

For example, when the adsorption strength of the lower plate is 20 g/cm^2 and the adsorption strength of the upper plate is 18 g/cm^2 , the ratio of the adsorption strengths is: $18 \text{ g/cm}^2 \div 20 \text{ g/cm}^2 = 0.90$.

The results are shown in Tables 1 and 2.

It was found that workpieces mostly remained on the lower plate at the ratio of adsorption strengths of 0.95 or

less. Further, 100% of the workpieces remained on the lower plate at the ratio of 0.85 or less. Thus, it was possible to leave the polished workpieces on the lower plate by controlling the ratio of adsorption strengths of the upper and lower plates or polishing pads.

Furthermore, it was also possible to leave the polished workpieces on the lower plate by selecting an appropriate combination of polishing pads used for the upper and lower plates. Thus, according to the present invention, the polished objects can be efficiently taken off without being damaged.

Table 1

	polishing apparatus *1	polish pad	ratio of contact surface area of upper to lower plates	ratio of adsorption strength of contact surfaces of upper to lower plates	the position where the polished workpieces remain		
					lower plate (pieces)	upper plate (pieces)	remaining on lower plate (%)
Example 1	lapping	none	0.95	0.85	30	0	100
Comp. Ex. 1	lapping	none	1.00	1.00	24	6	80
Comp. Ex. 2	polishing	suede-based	1.05	1.09	86	114	43
Comp. Ex. 3	polishing	suede-based	1.00	1.00	105	95	53
Example 2	polishing	suede-based	0.99	0.95	195	5	98
Example 3	polishing	suede-based	0.95	0.85	199	1	100
Example 4	polishing	suede-based	0.90	0.75	200	0	100
Example 5	polishing	suede-based	0.80	0.51	200	0	100
Example 6	polishing	suede-based	0.70	0.28	200	0	100
Example 7	polishing	suede-based	0.60	0.05	200	0	100
Comp. Ex. 4	polishing	suede-based	1.05	1.09	90	110	45
Comp. Ex. 5	polishing	suede-based	1.00	1.00	115	85	58
Example 8	polishing	suede-based	0.99	0.95	198	2	99
Example 9	polishing	suede-based	0.95	0.85	199	1	100
Example 10	polishing	suede-based	0.90	0.75	200	0	100
Example 11	polishing	suede-based	0.80	0.51	200	0	100
Example 12	polishing	suede-based	0.70	0.28	200	0	100
Example 13	polishing	suede-based	0.60	0.05	200	0	100

*1 "lapping" means a lapping machine and "polishing" means a polishing machine.

Table 2

	polishing apparatus *1	polishing pad		ratio of adsorption strength of contact surfaces of upper to lower plates	the position where the polished workpieces remain		
		lower plate	upper plate		lower plate (pieces)	upper plate (pieces)	remaining on lower plate (%)
Example 14	polishing	suede-based	polyurethane	0.25	40	0	100
Example 15	polishing	suede-based	non-woven fabric	0.50	40	0	100
Example 16	polishing	non-woven fabric	polyurethane	0.80	40	0	100
Comp. Ex. 6	polishing	non-woven fabric	suede-based	2.00	2	38	5
Comp. Ex. 7	polishing	polyurethane	non-woven fabric	2.00	5	35	13
Comp. Ex. 8	polishing	polyurethane	suede-based	4.00	1	39	3

*1 "lapping" means a lapping machine and "polishing" means a polishing machine.

CLAIMS

1. A double side polishing method comprising steps of:
inserting an object between a pair of upper and lower
polishing mechanisms and

polishing the object by rotating or sliding the object
therebetween,
wherein an adsorption strength of a contact surface of the
upper polishing mechanism onto the object is weaker than an
adsorption strength of a contact surface of the lower
polishing mechanism onto the object.

2. The double side polishing method according to claim 1,
wherein a ratio of said adsorption strength of the contact
surface of said upper polishing mechanism onto said object to
said adsorption strength of the contact surface of said lower
polishing mechanism onto said object is 0.95 or less.

3. The double side polishing method according to claim 1,
wherein a ratio of said adsorption strength of the contact
surface of said upper polishing mechanism onto said object to
said adsorption strength of the contact surface of said lower
polishing mechanism onto said object is from 0.1 to 0.85.

4. The double side polishing method according to any one
of claims 1 to 3, wherein a contact surface area of said
upper polishing mechanism with said object is smaller than a

contact surface area of said lower polishing mechanism with said object.

5. The double side polishing method according to any one of claims 1 to 4, wherein a contact surface of said upper polishing mechanism with said object comprises a groove.

6. The double side polishing method according to any one of claims 1 to 5, wherein a ratio of the contact surface area of said upper polishing mechanism with said object to the contact surface area of said lower polishing mechanism with said object is 0.99 or less.

7. The double side polishing method according to any one of claims 1 to 5, wherein a ratio of the contact surface area of said upper polishing mechanism with said object to the contact surface area of said lower polishing mechanism with said object is from 0.3 to 0.95.