

DESCRIPTION

CARRIER FOR USE IN DOUBLE-SIDE POLISHING APPARATUS AND METHOD OF DOUBLE-SIDE POLISHING WAFER

TECHNICAL FIELD

[0001]

The present invention relates to a carrier configured to hold a wafer in a double-side polishing apparatus, and a method of double-side polishing the wafer.

BACKGROUND ART

[0002]

In conventional double-side polishing processes of wafers, the wafers are held with carriers for use in a double-side polishing apparatus, and the carriers are disposed at a prescribed position between upper and lower turn tables of the double-side polishing apparatus. Each carrier is formed so as to have a thickness thinner than that of the wafer and a holding hole to hold the wafer. The wafer to be polished is inserted and held in the holding hole. The upper and lower surfaces of the wafer are interposed between polishing means such as polishing pads attached to opposing faces of the upper and lower turn tables and polished while a polishing agent is supplied to polishing surfaces.

[0003]

In double-side polishing, each carrier is driven by a sun gear and an internal gear, and the upper and lower main surfaces of this carrier, together with the surfaces of a wafer, are thereby polished. It is thus necessary to use a carrier made of a material having a

high strength to prevent the carrier from being damaged during double-side polishing.

The flatness of a wafer after double-side polishing depends on the difference between the thickness of the carrier and the finishing thickness of the wafer. The carrier to be used accordingly has a thickness such that this difference falls within a prescribed range, such as 0.5 μm or less.

[0004]

Since the carrier is polished during wafer double-side polishing as above, however, the thickness of the carrier decreases due to its wear. As the polishing operation is repeated, this decrease makes it impossible to hold the difference between the carrier thickness and the wafer finishing thickness within the prescribed range while the wafer finishing thickness is maintained in a given range. This also makes it impossible to achieve the required level of wafer flatness. When the finishing thickness is managed to be in the range between 774 μm and 778 μm , for example, such a difference cannot be maintained with a carrier worn by 4 μm . The carrier is disposed of when its thickness is decreased to such an extent that the required level of wafer flatness cannot be achieved.

[0005]

Conventional carriers are made of metal from the viewpoint of their strength. Carriers for use in polishing of silicon wafers are made of titanium (Ti) because the elements belonging to groups 4A and 5A in the periodic table are less likely to contaminate the silicon wafers (See Patent Documents 1 and 2, for example).

CITATION LIST

PATENT LITERATURE

[0006]

Patent Document 1: Japanese Unexamined Patent publication
(Kokai) No. 2006-26760

Patent Document 2: Japanese Unexamined Patent publication
(Kokai) No. 2008-23617

SUMMARY OF INVENTION

TECHNICAL PROBLEM

[0007]

Use of a material having a high abrasion resistance for a carrier is needed to increase its lifetime and decrease its cost. Titanium usually used for conventional carriers, however, is expensive and has a short lifetime because of a low abrasion resistance, although titanium has a high strength. This leads to a cost problem of the carrier.

The present invention was accomplished in view of the above-described problems. It is an object of the present invention to provide a carrier for use in a double-side polishing apparatus that has a high abrasion resistance and can reduce its cost.

SOLUTION TO PROBLEM

[0008]

To achieve this object, the present invention provides a carrier used in a double-side polishing apparatus such that the carrier is disposed between upper and lower turn tables to which polishing pads are attached in the double-side polishing apparatus and holds a wafer interposed between the upper and lower turn tables in a holding hole formed in the carrier

during polishing, comprising upper and lower main surface portions composed of a β -titanium alloy obtained from pure titanium containing 0.5 weight% or more of a β -stabilizing element.

[0009]

Such a carrier has a high abrasion resistance, thereby enabling increase in its lifetime and reduction in its cost.

[0010]

The entirety of the carrier may be composed of the β -titanium alloy.

Such a carrier has a high strength and can maintain its high abrasion resistance for a longer time for polishing.

[0011]

Alternatively, the carrier may include a metal matrix and a coating composed of the β -titanium alloy, the coating being formed so as to cover upper and lower main surfaces of the metal matrix.

Such a carrier can reduce its cost while achieving its high abrasion resistance due to the coating composed of the β -titanium alloy.

[0012]

Moreover, the metal matrix is preferably composed of pure titanium or the β -titanium alloy.

Such a carrier can eliminate the risk that when a silicon wafer, for example, is polished, the carrier contaminates the silicon wafer. In particular, use of the metal matrix composed of pure titanium allows for reuse of carriers restored by coating, for example, existing worn carriers with the β -titanium alloy coating, thereby enabling further reduction in the cost.

[0013]

Furthermore, the present invention provides a method of double-side polishing a wafer, comprising: disposing a carrier for use in a double-side polishing apparatus according to the present invention between upper and lower turn tables to which polishing pads are attached; and double-side polishing the wafer while holding the wafer in the holding hole formed in the carrier.

[0014]

Such a double-side polishing method can obtain wafers having the required level of flatness by using the inventive carrier having a high abrasion resistance without changing the carrier over a long period of time, thereby enabling reduction in the cost.

ADVANTAGEOUS EFFECTS OF INVENTION

[0015]

The inventive carrier for use in a double-side polishing apparatus includes upper and lower main surface portions composed of a β -titanium alloy obtained from pure titanium containing 0.5 weight% or more of a β -stabilizing element, and thereby has a high abrasion resistance and a long lifetime. Use of this carrier for double-side polishing of a wafer allows wafers having the required level of flatness to be obtained without changing the carrier over a long period of time, thereby enabling great reduction in wafer production cost.

BRIEF DESCRIPTION OF DRAWINGS

[0016]

FIG. 1 is a schematic sectional view of an exemplary double-side polishing apparatus including a carrier according to the present invention;

FIG. 2 is a diagram of an internal structure of the double-side polishing apparatus shown in FIG. 1;

FIGS. 3A and 3B are schematic diagrams of examples of the inventive carrier for use in a double-side polishing apparatus;

FIG. 4 is a graph of the result of the wear rate of carriers in example and comparative example; and

FIG. 5 is a graph of the result of GBIR of wafers in example and comparative example.

DESCRIPTION OF EMBODIMENTS

[0017]

Embodiments of the present invention will be hereinafter described, but the present invention is not limited to these embodiments.

A carrier for use in a double-side polishing apparatus according to the present invention will now be described.

The carrier for use in a double-side polishing apparatus (simply referred to as the carrier, below) according to the invention is used, for example, in the double-side polishing apparatus 20 as shown in FIGS. 1 and 2. As shown in FIGS. 1 and 2, the double-side polishing apparatus 20 includes an upper turn table 6 and a lower turn table 7 that are disposed so as to face one another in the vertical direction. Polishing pads 8 are attached to the respective turn tables 6 and 7. At the center between the upper turn table 6 and the lower turn table 7 is provided a sun gear 9; at a circumferential portion therebetween is provided an internal gear 10. As shown in FIG. 2, a holding hole 5 to hold a wafer W is formed in the inventive carrier 1. During double-side polishing, the carrier 1 is disposed

between the upper turn table 6 and the lower turn table 7 with the wafer W held in the holding hole 5.

[0018]

Some teeth of the sun gear 9 and the internal gear 10 engage with corresponding teeth of the outer circumferential gear of the carrier. Rotating the upper turn table 6 and the lower turn table 7 by a driving source (not shown) causes the carrier 1 to rotate and revolve around the sun gear 9. During this operation, both the surfaces of the wafer W held in the holding hole 5 of the carrier 1 are simultaneously polished by the upper and lower polishing pads 8. During the polishing of the wafer, a polishing agent is supplied to the polished surfaces of the wafer from a nozzle (not shown).

[0019]

In the polishing, since the upper and lower main surfaces of the carrier 1 come in contact with the polishing pads 8, these main surfaces of the carrier are polished together with the surfaces of the wafer and gradually wear out.

In view of this, as shown in FIG. 3A, an upper main surface portion 2 and a lower main surface portion 3 of the inventive carrier 1 are composed of a β -titanium alloy obtained from pure titanium containing 0.5 weight% or more of a β -stabilizing element. This type of carrier has a high abrasion resistance, thereby allowing long-term maintenance of the condition under which a wafer can be polished so as to have the required level of flatness. In other words, the inventive carrier has a longer lifetime than does a conventional carrier composed of, for example, pure titanium.

[0020]

In the inventive carrier 1, the material of a portion other than the main surface portions is not particularly limited, provided the upper and lower main surface portions 2 and 3 are composed of the β -titanium alloy, as above. As shown in FIG. 3B, for example, the carrier 1 can be thus constituted of a metal matrix 4 and a coating composed of the β -titanium alloy formed so as to cover the upper and lower main surfaces of the metal matrix. This β -titanium alloy coating can be formed, for example, by a sputtering method.

Such a carrier can achieve a high abrasion resistance by the upper and lower main surface portions 2 and 3 formed of the β -titanium alloy coating and reduce its cost by using a lower cost material for a portion other than the main surface portions. In addition, when repetitive polishing of wafers causes the carrier to wear to the extent that the required level of flatness cannot be achieved, the carrier can be thickened by forming the β -titanium alloy coating. This can significantly improve the frequency of reuse of the carrier, allowing the cost to be significantly improved.

[0021]

In this case, the metal matrix 4 may be composed of pure titanium. In other words, an existing pure titanium carrier can be reused by being coated with the β -titanium alloy coating; this reuse enables further reduction in the cost. Alternatively, the metal matrix 4 may be composed of the β -titanium alloy so that the strength of the carrier is increased. Both cases are preferable because the risk that a silicon wafer is contaminated during polishing of the silicon wafer can be eliminated.

[0022]

The β -stabilizing element is not particularly limited; examples thereof include V, Zr, Nb, Mo, Hf, Cr, Mn, Fe, Co, and Ni. Considering Fe is an inexpensive metal that is not a rare metal and has a low diffusion coefficient for silicon wafers, a preferable β -stabilizing element is Fe.

The content of the β -stabilizing element is equal to or more than 0.5 weight%. In particular, this content is preferably 1.5 weight% or more from the viewpoint of the abrasion resistance; this content is also preferably 2.0 weight% or less from the viewpoint of the inhibition of the contamination of silicon wafers. The content however is not particularly limited, provided it is 0.5 weight% or more.

[0023]

Each of the carriers 1 shown in FIG. 2 is configured to have a single holding hole 5 to hold one wafer W. The invention is not limited to this configuration. For example, the carrier may have plural holding holes 5 so that the carrier holds plural wafers W.

Moreover, a resin insert to protect the edge of a wafer from being damaged by the carrier may be attached along the inner circumference of the holding hole 5.

[0024]

A method of double-side polishing wafers according to the invention will now be described.

This embodiment of the inventive method of double-side polishing wafers uses the inventive carriers described above.

As shown in FIG. 1, first, the inventive carriers 1 including at least the main surface portions composed of the β -titanium alloy are disposed between the

polishing pads 8 attached to the upper and lower turn tables 6 and 7 of the double-side polishing apparatus 20.

Next, wafers W are inserted and held in the holding hole 5 of the respective disposed carriers 1.

[0025]

Next, the upper and lower surfaces of the wafers W are interposed between the polishing pads 8 attached to the upper and lower turn tables 6 and 7. While a polishing agent is supplied to the polishing surfaces, both the surfaces of the wafers are polished. Polishing conditions in this polishing process may be the same as conventionally.

The double-side polishing thus performed can obtain wafers having the required level of flatness by using the inventive carriers having a high abrasion resistance without changing the carriers over a long period of time, thereby reducing the cost.

EXAMPLE

[0026]

The present invention will be more specifically described below with reference to an example and a comparative example, but the present invention is not limited to this example.

[0027]

(Example)

A double-side polishing apparatus, as shown in FIG. 1, having the inventive carriers shown in FIG. 3A was used to evaluate the wear rate of the carriers.

Each of the inventive carriers was produced such that the entire carrier was composed of a β -titanium alloy obtained from pure titanium containing Fe. In this production, the Fe content of the β -titanium alloy

was changed to obtain five types of carriers: carrier A (0.5 weight%), carrier B (1.0 weight%), carrier C (1.5 weight%), and carrier D (2.0 weight%); five carriers were produced every carrier type. The thickness of these carriers was 770 μm . A resin insert was attached along the inner circumference of each holding hole. Note that the Fe content was measured by X-ray fluorescence analysis.

[0028]

The wear rate of the carriers was evaluated in a manner that, as shown in FIG. 2, the same type of five carriers having the same Fe content holding no wafer were disposed in the double-side polishing apparatus, and the double-side polishing apparatus was operated in the same manner as in polishing of wafers to calculate the wear rate of the carriers from a decrease in carrier thickness per hour.

The polishing conditions were as follows:

Urethane foam polishing pads were used;

An alkaline solution containing colloidal silica was used as a polishing agent and the solution was recycled; and

The pressure applied to the surfaces of the carriers was 200g/cm².

[0029]

The thickness of the carriers was measured at 400 points along the entire circumference of the holding hole. The average value of the measured thickness was used to calculate the wear rate.

The result of the wear rate is given in Table 1 and FIG. 4. As shown in Table 1 and FIG. 4, the wear rate was greatly decreased compared with the later-described comparative example. The wear rate of the

carriers decreased with an increase in the Fe content of the β -titanium alloy. The decrease in the wear rate, however, substantially terminated at a Fe content of 1.5 weight% or more (carrier C and carrier D). The wear rate after the termination was 0.04 $\mu\text{m}/\text{h}$.

[0030]

Next, 300-mm-diameter silicon wafers were double-side polished with the same carriers as the carriers D (having a Fe content of 2.0 weight%) except that the thickness of the carriers was 771 μm . The flatness, Global Back-Side Ideal Range (GBIR), of the polished wafers was evaluated. In the polishing, the target finishing thickness of the wafers was 775 μm .

[0031]

The polishing conditions were as follows: the same double-side polishing apparatus and polishing agent as in the evaluation of the wear rate of the carriers were used to polish five wafers per one batch. The pressure applied to the surfaces of the wafers to be polished was set at 200g/cm².

The GBIR of the polished wafers was measured with a flatness measuring instrument (Nanometro 300TT made by KURODA Precision Industries Inc.,). The GBIR of the wafers was obtained by calculating an average of GBIR values of the five polished wafers in the same batch.

[0032]

The result of the GBIR is given in FIG. 5. As shown in FIG. 5, the example demonstrated that the GBIR began to decrease when the usage time of the carriers exceeded 45,000 minutes, and the GBIR was 0.25 μm when the usage time of the carriers was 50,000 minutes. At this time, the carrier thickness was 767 μm .

The later-described comparative example, on the

other hand, demonstrated that the wafer flatness was 0.35 μm when the usage time of the carriers was 20,000 minutes.

[0033]

Thus, this example inhibited the degradation of the wafer flatness for a longer period of time and exhibited a longer carrier lifetime compared with the later-described comparative example.

The main surfaces of the carriers used for 50,000 minutes in the example were then coated with a β -titanium alloy having a Fe content of 2.0 weight% by the Ar sputtering method. The thickness of this β -titanium alloy coating was 4 μm in a total of the upper and lower main surfaces. The thickness of the coated carriers was 771 μm , which was the same as that before the start of polishing.

[0034]

With these coated carriers, double-side polishing of wafers was performed under the same conditions. The result was that the GBIR of the polished wafers was 0.17 μm ; thus the degradation of the GBIR was settled.

The wafer flatness was not degraded even when the carrier was then used for 15,000 minutes (65,000 minutes passed after the start of the usage).

[0035]

(Comparative example)

The carrier wear rate and the wafer flatness (GBIR) were evaluated under the same conditions as in the example except that a carrier composed of a β -titanium alloy obtained from pure titanium containing 0.2 weight% of Fe.

The result of the wear rate is given in Table 1 and FIG. 4. As shown in Table 1 and FIG. 4, the wear

rate was 0.13 $\mu\text{m/h}$ and became worse than that in the example. The wear rate of a conventional pure titanium carrier (containing no β -stabilizing element) is usually 0.14 $\mu\text{m/h}$. Compared to this pure titanium carrier, the comparative example merely exerted a small effect in improving the wear rate.

[0036]

The result of the GBIR is given in FIG. 5. As shown in FIG. 5, the GBIR began to decrease when the usage time of the carriers exceeded 12,500 minutes, and the wafer flatness was 0.35 μm when the usage time of the carrier was 20,000 minutes. At this time, the carrier thickness was 765 μm . Thus, the comparative example degraded the flatness in a shorter time and exhibited a shorter carrier lifetime compared with the example.

[0037]

[Table 1]

	EXAMPLE				COMPARATIVE EXAMPLE
Fe CONTENT IN Ti (wt%)	2.0	1.5	1.0	0.5	0.2
WEAR RATE ($\mu\text{m/h}$)	0.04	0.04	0.05	0.06	0.13

[0038]

It is to be noted that the present invention is not limited to the foregoing embodiment. The embodiment is just an exemplification, and any examples that have substantially the same feature and demonstrate the same functions and effects as those in the technical concept described in claims of the present invention are included in the technical scope of the present invention.

CLAIMS

1. A carrier used in a double-side polishing apparatus such that the carrier is disposed between upper and lower turn tables to which polishing pads are attached in the double-side polishing apparatus and holds a wafer interposed between the upper and lower turn tables in a holding hole formed in the carrier during polishing, comprising

upper and lower main surface portions composed of a β -titanium alloy obtained from pure titanium containing 0.5 weight% or more of a β -stabilizing element.

2. The carrier according to claim 1, wherein the entirety of the carrier is composed of the β -titanium alloy.

3. The carrier according to claim 1, comprising a metal matrix and a coating composed of the β -titanium alloy, the coating being formed so as to cover upper and lower main surfaces of the metal matrix.

4. The carrier according to claim 3, wherein the metal matrix is composed of pure titanium or the β -titanium alloy.

5. A method of double-side polishing a wafer, comprising:

disposing a carrier for use in a double-side polishing apparatus according to any one of claims 1 to 4 between upper and lower turn tables to which polishing pads are attached; and

double-side polishing the wafer while holding the wafer in the holding hole formed in the carrier.