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(71) Applicants:
- **Speedfam Co., Ltd.**
  Kanagawa 252-1123 (JP)
- **Hitachi Zosen Metal Works Co., Ltd.**
  Maizuru-city, Kyoto-pref., 625-0087 (JP)

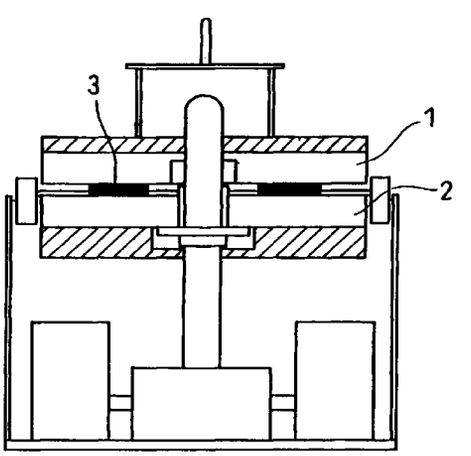
(72) Inventors:
- **Seino, Toshihiro,**
  c/o Speedfam Co., Ltd.
  Ayase-city, Kanagawa-pref., 252-1123 (JP)
- **Yoshida, Akiro,**
  c/o Speedfam Co., Ltd.
  Ayase-city, Kanagawa-pref., 252-1123 (JP)
- **Amano, Kenji,**
  c/o Speedfam Co., Ltd.
  Ayase-city, Kanagawa-pref., 252-1123 (JP)
- **Aizawa, Tomohiro,**
  c/o Speedfam Co., Ltd.
  Ayase-city, Kanagawa-pref., 252-1123 (JP)
- **Ito, Takara,**
  c/o Hitachi Zosen Metal Works Co.,Ltd
  Maizuru-city, Kyoto-pref., 625-0087 (JP)
- **Furusawa, Shinji**
  c/o Hitachi Zosen Metal Works Co.
  Maizuru-city, Kyoto-pref., 625-0087 (JP)

(74) Representative:
Weisert, Annekäte, Dipl.-Ing. Dr.-Ing. et al
Patentanwälte
Kraus Weisert & Partner
Thomas-Wimmer-Ring 15
80539 München (DE)

(54) Lapping machine

(57) This invention relates to a lapping machine having a platen (1) which is stable to the temperature change, and provide a lapping machine which possesses a platen (1) made of cast iron alloy containing 1.0~4.0 wt% of carbon, smaller than 38 wt% of summed weight of nickel and cobalt, smaller than 2.0 wt% of silicon, smaller than 2.0 wt% of manganese, smaller than 0.1 wt% of sulfur, smaller than 0.15 wt% of phosphorus, smaller than 0.1 wt% of magnesium and balancing weight of iron. Spherical graphite grains smaller than 50 μm diameter are dispersed in said cast iron alloy by smaller than 150pieces/mm^2 density, and the thermal expanding co-efficiency of said cast iron alloy is smaller than 5×10^{-6}/°C.

FIG.1



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Description

BACK GROUND OF THE INVENTION

FIELD OF THE INVENTION

[0001] This invention relates to a material of platen belonging to a lapping machine which laps both sides of a flat shape work-piece which is required to have a very precise flatness and parallelism, more in detail, relates to a lapping machine which has a platen whose thermal expansion coefficient is low and thermal deformation is very small.

DESCRIPTION OF THE PRIOR ART

[0002] In general, the surface processing of a plate shape work-piece made of glass, metal, semi-conductor, ceramics or carbon which is required to have precise flatness and parallelism is carried out by a lapping machine having a platen at both upper and lower position, or a platen at either of the positions. The work-piece is held and pressed between said upper and lower platens or pressed onto said one platen, the platens and the work-piece are rotated under the constant supply of aqueous slurry containing fine abrasive grains, and the work-piece is lapped as to have an even thickness, further to improve flatness and parallelism.

[0003] Recently, according to the necessity for the improvement of memory capacity and productivity of integrated circuit (IC) or large-scale integration (LSI), a silicon water or a compound semiconductor wafer (hereinafter shortened to wafer) which is the starting material of IC or LSI is becoming to be required to have a homogeneous thickness and to improve the machining accuracy and the dimensional stability, further the size of water is becoming bigger and bigger. Therefore, for the lapping of wafer, not only a main condition of machine but also the machine itself is becoming to be required to have excellent accuracy and stability, further, regarding other incidental conditions, more severe control is becoming necessary. Especially, in a case of silicon wafer, a production technique of silicon single crystal ingot is improved, and recently it become possible to produce a large size wafer for example 12 inch or 16 inch diameter. To carry out the effective on these large size wafer by higher productivity, a lapping machine having bigger size platens which can use 24 inch size or 32 inch size carrier is becoming popular.

[0004] The lapping platen of this invention indicates a disk plate having considerable thickness made of metal such as cast iron, copper, tin or steel or nonmetallic materials such as ceramics or glass, on the front surface of which, for example, narrow grooves are engraved to form a grit pattern. The lapping platen as mentioned above is arranged at the upper and lower position or at the lower position of the lapping machine. At the lapping process, in a case of double sided lapping machine, a work-piece is held and pressed between two platens, and in a case of single sided lapping machine, a work-piece is pressed to the platen by means of a holder. The work-piece and/or platens are rotated, under the constant supply of polishing compound slurry containing abrasives. By the effect of the abrasive, the surface of work-piece is removed gradually and a flat and precise surface can be generated. In a case of above mentioned lapping, the surface flatness of the lapped work-piece is an imitation of that of platen. Therefore, the dimensional accuracy and the flatness of the platen must be kept in precise level. And when the brittle material such as silicon wafer is used as a work-piece, a cast iron platen can be ordinary used.

[0005] As the material for the cast iron platen, so called cast iron containing 1~5 % of carbon by weight is generally used, whose thermal expanding co-efficiency α is in the level of about $10\sim11 \times 10^{-6}$/°C. When said cast iron platen is used as the 24B size (outer diameter Φ is 1592mm and 70mm thickness), a warp of about 70 μm generates to the thickness direction by 1°C temperature difference. As above mentioned, the surface flatness of the lapped work-piece is an imitation of that of platen, meanwhile, since the upper limit of TTV for the lapped 8 inches size silicon wafer is about 0.7 μm, a warp of 70 μm of the platen can not be permitted. Therefore, at the practical use, it is necessary to correct the surface of platens by a mutual lapping after adjusted to the lapping temperature. Consequently, the wear of platen is remarkable and it is necessary to change the expensive platen every several months. That is, the conventional type lapping machine is not only hard for handling at the practical use, but also is not sufficient from the economical view point.

[0006] Namely, considering the silicon wafer lapping, by the effect of the lapping temperature generated with lapping or the temperature generated from a driving motor or a speed reducer, the temperature of platens raises about 5~10°C from the initial state and are warped. And the warped platens gives severe affect to the dimensional accuracy of the lapped wafer. To prevent above mentioned bad influence, the methods to control the temperature raising of platen by making a coolant flow inside of platen and lap the work-piece at a stable cooled condition, or to heat the platen to the stable temperature and lap the work-piece at the stable temperature are already proposed (for example, Japanese Patent Laid open publication 63-245368, Japanese Patent Laid open publication 4-53671 and Japanese Patent Application 9-317735). These references are effective from the view point of the solution of the problem, however, since these references are characterized to attach the additional parts to the original lapping machine, they can not be said as the fundamental solution.

[0007] As the fundamental countermeasure to solve the above mentioned problem, the method to use a specific cast iron alloy whose thermal expanding co-effi-

ciency α is low as a material of platen is also proposed. For example, as disclosed in Japanese Patent Publication 60-51547 or Japanese Patent Publication 3-90541, an alloy composed by carbon steel as the main component, nickel and cobalt as the sub component is proposed as a material whose thermal expanding co-efficiency α is lower than 5×10^{-6}/°C. These alloy of low thermal expanding co-efficiency contains about 1~5% of carbon and large amount of nickel and cobalt.

[0008] In a case of ordinary type cast iron, the added carbon is dispersed into fused iron during the fusion procedure and deposits as the spherical graphite homogeneously at the quenching process. When this cast iron is used as the lapping platen, said spherical graphite particles exists at the surface of the platen are removed by the friction caused by lapping action and forms fine hole. And the hole contributes to form an adequate surface roughness and catches fine particles of abrasive grain, and can be used as the lapping platen. Meanwhile, in a case of above mentioned low thermal expanding co-efficiency cast iron alloy, since the content of nonferrous metals is large, the sphering of graphite is not sufficient and forms amorphous carbon or needle shape crystalline, and affect the property as a platen. Such a platen has a problems to cause abnormal lines (scratches) and deteriorate TTV, and is difficult to be used as the platen for precise lapping use. That is, the cast iron alloy only the thermal expanding co-efficiency is low can not be used as a lapping platen used for the purpose of ultra precision processing.

BRIEF SUMMARY OF THE INVENTION

[0009] The inventors of this invention have carried out an intensive study to solve above mentioned problem which conventional lapping machine has, and have found that the use of specific Fe-Ni-Co type cast iron alloy as the material of lapping platen gives good results and accomplished the present invention. Namely, the inventors have took a metal component ratio of alloy into consideration as to control the state of carbon in the matrix of cast iron alloy, and have found a specific Fe-Ni-Co type cast iron alloy has not only low thermal expanding co-efficiency but also has proper features necessary as a platen such as stiffness or machinability. That is, the object of this invention is to provide a lapping machine which possesses a platen whose distortion by heat is small and not necessary to correct the surface so frequently.

[0010] The above mentioned object can be accomplished by a lapping machine which possesses a platen made of cast iron alloy containing 1.0~4.0 wt% of carbon, smaller than 38 wt% of summed weight of nickel and cobalt, smaller than 2.0 wt% of silicon, smaller than 2.0 wt% of manganese, smaller than 0.1 wt% of sulfur, smaller than 0.15 wt% of phosphorus, smaller than 0.1 wt% of magnesium and balancing weight of iron which contains small amount of impurity, wherein spherical graphite grains smaller than 50 μm diameter are dispersed in said cast iron alloy by smaller than 150pieces/mm^2, and the thermal expanding co-efficiency of said cast iron alloy is smaller than 5×10^{-6}/°C.

BRIEF DESCRIPTION OF THE DRAWING

[0011]

FIG.1 is a longitudinal sectional view of the double sided lapping machine. In the drawing, 1 indicates an upper platen, 2 indicates a lower platen and 3 indicates a work-piece.

DETAIL DESCRIPTION OF THE INVENTION

[0012] A lapping machine used in this invention is indicated by FIG.1, possesses a rotatable upper platen 1 at upper position and a rotatable lower position 2 at lower position as to faced, a work-piece 3 such as silicon wafer is held between said platens and rotated under the constant supply of lapping compound, and as the platen a cast iron platen having about 50~70 mm thickness is used. At the lapping process, since the surface accuracy of the lapped work-piece is an imitation of that of platen, the platen must be stable against the external condition change such as temperature change. The specific cast iron alloy used as the lapping platen in this invention has characteristics to satisfy above mentioned matter. That is, in this invention, by use of Fe-Ni-Co austenitic type alloy composed mainly by carbon steel which has good stiffness and containing smaller than 38 wt% of summed weight of nickel and cobalt, the thermal expanding co-efficiency (linear) of platen can be dropped to the level lower than 5×10^{-6}/°C.

[0013] Further, to disperse the carbon component as the spherical graphite homogeneously into the matrix of the cast iron alloy structure so as to provide a casting property, machinability and vibration absorbing ability which ordinary cast iron has, it is necessary to add smaller than 2.0 wt% of silicon, smaller than 2.0 wt% of manganese, smaller than 0.1 wt% of sulfur, smaller than 0.15 wt% of phosphorus, smaller than 0.1 wt% of magnesium. Thus, the above mentioned properties are provided to the alloy and the desired low thermal expanding co-efficiency alloy can be obtained.

[0014] In a case of ordinary use of the cast iron, the diameter of said spherical graphite fine particle and the dispersing density of fine particles does not effect significantly to the ability of the cast iron, however, in a case of use as a platen, these factors are very important. That is, in the present invention, it is necessary that the diameter of spherical graphite dispersed in the matrix of alloy is smaller than 50 μm. When the spherical graphite is present at the surface of lapping platen, it is removed from the surface by the friction and the mark forms a fine pore. When the size of fine particles of abrasive is smaller than said pore, the particles of abrasive are

caught and accumulated in the pore during the lapping and affect the surface of work-piece. Meanwhile, when the pore size is smaller than the size of abrasives, above mentioned problem can be effectively prevented. When the diameter of spherical graphite is bigger than 50 μm, since abrasives and other chemicals are accumulated in the removed mark and forms very hard particles, it can not be used as the platen for a precision lapping.

[0015] Further, in the present invention, it is necessary to disperse said fine particles of spherical graphite homogeneously in the matrix of alloy by smaller than 150/mm^2 density. If the dispersion in the alloy is not homogeneous, since the abnormal scratches are generated during the lapping process, the alloy can not be used as a platen.

THE BEST EMBODYMENT TO CARRY OUT THE INVENTION

[0016] The present invention will be understood more readily with reference to the following Examples, however not intended to limit the scope of the invention.

EXAMPLE

[0017] The cast iron alloy composed by following component is prepared. Content of carbon is 1~2 wt%, summed weight of nickel and cobalt is 36 wt%, smaller than 2 wt% of silicon, smaller than 2.0 wt% of manganese, smaller than 0.1 wt% of sulfur, smaller than 0.15 wt% of phosphorus, smaller than 0.1 wt% of magnesium and balancing weight of iron. The thermal expanding co-efficiency of the obtained cast iron alloy is 5×10^{-6}/°C, in which spherical graphite particles bigger than 50 μm diameter are not contains and the dispersing density of spherical graphite particles is not bigger than 150/mm^2. By this alloy, a platen of 24B size (outer diameter is 1592 mm, thickness is 70 mm) is prepared and a double sided lapping machine having said platen at upper and lower position is assembled. The work-piece of 8 inches (200 mm) size silicon wafer is processed by said double sided lapping machine. At the starting of the lapping, the platens are not previously heated and any dummy runs are not carried out. From the first run, the products whose dimensional accuracy such as TTV or surface roughness are within the limit of quality standard can be obtained by 100% around productivity.

COMPARATIVE EXAMPLE

[0018] The cast iron alloy composed by following component is prepared. Content of carbon is 3.6 wt%, silicon content is 2.5 wt%, manganese content is 0.2 wt%, smaller than 0.04 wt% of sulfur, smaller than 0.1 wt% of phosphorus, smaller than 0.06 wt% of magnesium and balancing weight of iron. The thermal expanding co-efficiency of the obtained cast iron alloy is 11×10^{-6}/°C. By this cast iron alloy, a platen of 24B size (outer diameter is 1592 mm, thickness is 70 mm) is prepared and a double sided lapping machine having said platen at upper and lower position is assembled. The work-piece of 8 inches (200 mm) size silicon wafer is processed by said double sided lapping machine. Before the starting of the lapping, the platens are not previously heated and any dummy runs are not carried out. Until 3rd runs, the lapped work-pieces are not stable from the view point of the dimensional accuracy and the productivity during first 3 runs is very low. From the 5th run, products having adequate quality can be obtained by high productivity.

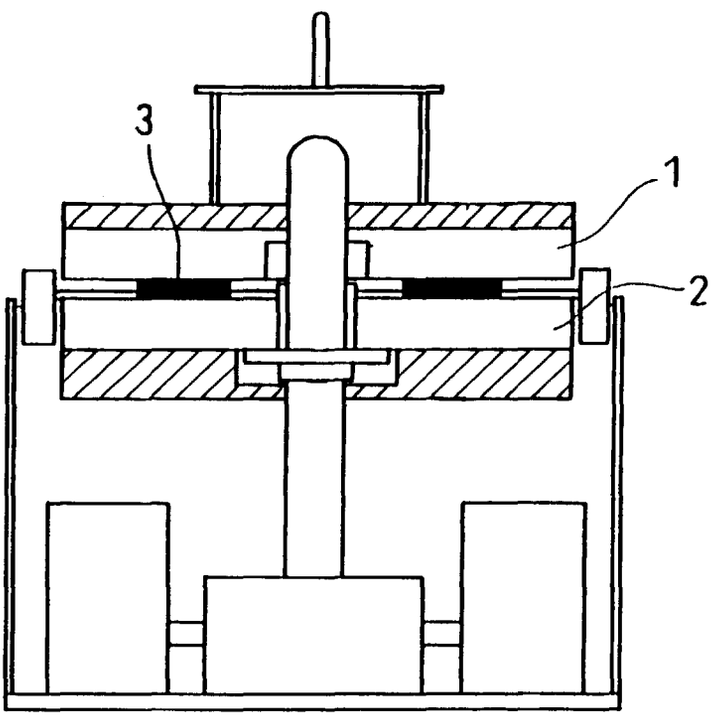
[0019] It is clearly understood from the above mentioned Example and Comparative Example that by use of the lapping machine of this invention serviceability ratio of machine and productivity are remarkably improved without previous heating of a platen or any dummy runs. Namely, by the lapping machine of this invention it is possible to start the actual lapping immediately.

Claims

1. A lapping machine which possesses a platen made of cast iron alloy containing 1.0~4.0 wt% of carbon, smaller than 38 wt% of summed weight of nickel and cobalt, smaller than 2.0 wt% of silicon, smaller than 2.0 wt% of manganese, smaller than 0.1 wt% of sulfur, smaller than 0.15 wt% of phosphorus, smaller than 0.1 wt% of magnesium and balancing weight of iron which contains small amount of impurity, wherein spherical graphite grains smaller than 50 μm diameter are dispersed in said cast iron alloy by smaller than 150pieces/mm^2 density, and the thermal expanding co-efficiency of said cast iron alloy is smaller than 5×10^{-6}/°C.

2. The lapping machine of claim 1 is a double sided lapping machine which has two platens at the upper and lower position.

FIG.1



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EUROPEAN SEARCH REPORT

Application Number
EP 99 10 5171

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	13 July 1999	Garella, M

CATEGORY OF CITED DOCUMENTS

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