

DESCRIPTION

Title of Invention:

CARRIER AND SUBSTRATE MANUFACTURING METHOD USING THIS
CARRIER

Technical Field

[0001]

The present invention relates to a carrier that is to be used when a main surface of a plate-shaped substrate such as a substrate for magnetic recording, glass for a liquid crystal screen, or a silicon wafer is polished, and a method for manufacturing a substrate using this carrier.

Background Art

[0002]

In recent years, information recording technology, and in particular, magnetic recording technology, has advanced remarkably accompanying the advancement of information technology. A glass substrate or an aluminum alloy substrate has been used as a substrate in a magnetic recording medium such as an HDD (hard disk drive), which is one type of information recording medium.

[0003]

Front and back main surfaces of a substrate are simultaneously polished using a double-side polishing apparatus, for example. With the double-side polishing apparatus, the substrate is held in a carrier having a holding hole, and an upper surface plate and a lower surface plate to which polishing pads are attached sandwich the carrier, for example. Next, the entireties of the main surfaces of the substrate are polished thoroughly by moving the substrate held in the carrier and the polishing pads relative to each other using a planetary gear mechanism or the

like while a polishing liquid is supplied between the substrate and the polishing pads. A plurality of substrates can be polished simultaneously, and thus the kind of polishing method is excellent in terms of production efficiency.

[0004]

With this polishing method, the upper surface plate is raised after the surfaces of the substrate are polished, and then the polished substrate is removed from the carrier. However, there has been a problem in that when the upper surface plate is raised, the carrier attaches to the upper surface plate, then falls off from the upper surface plate onto the substrate, and scratches a surface of the substrate.

[0005]

To address the above-described problem, in PLTs 1 and 2, attachment of a carrier to an upper surface plate is prevented using a carrier whose front and back sides have different surface roughnesses or have different contact angles.

Citation List

Patent Literature(s)

[0006]

PTL1: JP 2013-132744 A

PTL2: JP 2013-132745 A

Summary of Invention

Technical Problem

[0007]

However, with the carrier disclosed in the patent literatures above, it has not been possible to sufficiently suppress attachment of the carrier to the upper surface plate. Furthermore, the carriers disclosed in the patent literatures above were problematic in that manufacturing cost was high.

[0008]

In view of such issues, an object of the present invention is to provide a carrier with which high-quality substrates can be obtained at a higher yield than with a conventional method, and to provide a method for manufacturing a substrate using this carrier.

Solution to Problem

[0009]

Upon conducting intensive studies on the causes of the above-described issues, the inventors of the present invention made the following inferences. That is, a main surface of a carrier and a surface of a polishing pad are made of the same type of material called "resin", and thus originally have a high affinity. Also, a relatively soft resin is used as a resin material of the surface of the polishing pad, and thus the polishing pad tends to follow and be in close contact with the shape of the surface of the carrier. Thus, the inventors thought that even if the front and back main surfaces of the carrier had slight differences in roughness or waviness, no significant difference occurred in the adsorption force with which the main surfaces of the carrier adsorbed on the surfaces of the polishing pads, as a result of which adsorption of the carrier on the upper surface plate was not suppressed sufficiently.

[0010]

Note that in the above-described patent literature, roughness had been formed by pressing the upper surface of the carrier, but in this case, the surface of the carrier is kept covered by resin. In view of this, the inventors of the present invention thought that by devising the material and shape of the surface of the carrier, it would be possible to significantly change the adsorption forces of the front and back sides of the carrier compared with the conventional method.

[0011]

That is, a representative configuration of a carrier according to the present

invention is a carrier for polishing or grinding having a holding hole for holding a substrate, in which a plurality of protrusions containing glass as a main component are present in at least one portion of a region of at least one surface of the carrier.

[0012]

According to the above-described configuration, when an upper surface plate is raised, air tends to enter between an upper surface of the carrier and a polishing pad on the upper surface plate side due to the plurality of protrusions containing glass as a main component being present on the surface of the carrier, and thus it is possible to prevent attachment. Also, in this invention, the main component of the protrusions is glass, whereas the polishing pad or a grinding pad attached to the surface of the surface plate is mainly made of a resin-based component, and thus the materials of the two are different from each other. Therefore, the present invention has a high effect of preventing attachment (adsorption) of the carrier to (on) the upper surface plate. Moreover, the protrusions have a high wear resistance (durability) due to these protrusions being made of a glass material, and thus it is possible to prevent attachment of the carrier to the upper surface plate in a greater number of instances of polishing processing using the same carrier. That is, polishing processing can be performed many times using the same carrier, and the carrier can be used for a long time.

[0013]

Also, in other words, the above-described configuration is a carrier for polishing or grinding having a holding hole for holding a substrate, in which a protrusion formation region in which a plurality of protrusions containing glass as a main component are present is present on at least one surface of the carrier.

[0014]

The protrusions preferably have a height of 2 μm or more. If the height of the protrusions is less than 2 μm , there are cases where the effect of suppressing the attachment of the carrier to the upper surface plate is not exhibited. Also, the

protrusions preferably have a height of 3 μm or more because the above-described suppression effect is further increased. On the other hand, although there is no particular limitation on the upper limit of the height of the protrusions from the viewpoint of the above-described suppression effect, if the height of the protrusions exceeds 50 μm and both surfaces of a substrate are processed, the front and back sides of the processed substrate have a difference in surface shape in some cases. It is inferred that this phenomenon occurs because if the protrusions have an excessively high height, the surface of the polishing pad on the opposing surface plate side is scratched and roughened. Thus, the protrusions preferably have a height of 50 μm or less. According to the above, the protrusions more preferably have a height of 2 to 50 μm .

[0015]

The protrusions preferably have a width of 50 μm or more. Setting the width of the protrusions in this range makes it possible to increase the wear resistance of the protrusions and to maintain the effect of suppressing the attachment of the carrier to the upper surface plate for a long time. Note that the width of the protrusions refers to the maximum length in a direction parallel to the main surface of the carrier. On the other hand, there is no upper limit of the width of the protrusions from the viewpoint of the attachment suppression effect, but if the width thereof is larger than 600 μm and protrusions are formed on one surface in particular, there are cases where friction of the front and back sides of the carrier varies and abnormal sound occurs during processing. The occurrence of abnormal sound is not preferable because it requires a checking operation such as stopping a processing apparatus, and thus the manufacturing efficiency decreases. Therefore, the protrusions preferably have a width of 600 μm or less. According to the above description, the protrusions even more preferably have a width of 50 to 600 μm .

[0016]

The above-described protrusion preferably has a circular arc shape protruding upward as a whole. Note that in other words, the circular arc shape protruding upward includes a shape in which a cross-sectional area of the plane parallel to the main surface of the carrier decreases as the upper portion of the protrusion is approached, or a mountain-like shape as a whole, or the like. With such a shape, the protrusion has no corners that are approximately 90 degrees at its apex, and has a round shape. Thus, the protrusions are unlikely to scratch the polishing pads, and as a result, it is possible to polish both surfaces of a glass substrate using a carrier whose front and back sides have different specifications, such that both surfaces have an equal quality.

[0017]

The above-described carrier is preferably made of a material obtained by weaving glass fibers and impregnating the glass fibers with resin. At this time, a plurality of protrusions of the carrier may contain fibrous glass. Also, the plurality of protrusions of the carrier are preferably formed approximately regularly in stitches of glass fibers. Also, the plurality of protrusions of the carrier may be formed by glass fibers that protrude from the stitches of the glass fibers, or may be formed due to parts of the glass fibers rising. Note that one glass fiber may be a bundle of thin glass fibers.

[0018]

If a plate material obtained by weaving glass fibers and impregnating the glass fibers with resin is used as a base plate material for a carrier in this manner, in general, the glass fibers are woven in a bundle state and pressed in a state in which the glass fibers are impregnated with resin so as to form a thin sheet. That is, the bundles of the glass fibers are fixed by resin in a state in which the bundles are pressed in the thickness direction of the sheet. Thus, when the resin around the glass fibers is removed, stress is released and the glass fibers protrude, and thereby protrusions are formed in some cases. Also, if parts of the glass fibers are

cut at this time, protrusions are sometimes formed in a state in which parts of the glass fibers rise. It is also possible to form protrusions containing glass as a main component, in this manner.

[0019]

The above-described protrusions are preferably formed away from a periphery of the holding hole by a predetermined width. If a protrusion is formed close to the contour of the holding hole, there are cases where an inner wall surface of the holding hole is scratched or the shape of the holding hole is changed. In such a case, there are cases where free movement of the substrate is inhibited during polishing processing, uniform polishing of a main surface of the substrate is inhibited, or an edge surface of the substrate is scratched. Note that from the viewpoint of operation efficiency, the predetermined width is preferably 1 mm or more, and more preferably 2 mm or more, for example.

[0020]

The above-described protrusions may be formed in a plurality of regions that are located apart from each other. In other words, regions in which protrusions are present on the surface of the carrier may be present as the plurality of regions that are located apart from each other. This makes it possible to provide regions including protrusions away from the space located between two holding holes in a case where multiple holding holes are provided in order to increase the manufacturing efficiency and the space located between two holding holes becomes extremely narrow, and thus to increase the protrusion formation operation efficiency.

[0021]

Also, a configuration may be adopted in which a plurality of regions that each are a recessed portion having a predetermined depth are formed on the surface of the carrier and protrusions are formed in the recessed portions. This makes it possible to further increase the durability of the protrusions by reducing

the possibility of contact between the protrusions and the polishing pads, and to further increase the quality of the surface of the processed substrate by suppressing the formation of dust caused by the protrusions being rubbed against the polishing pad. It is sufficient that the depth of the recessed portion is 0.3 to 30 μm , for example. Also, on one surface of the carrier, the area obtained by adding all of the regions in which the recessed portions are formed is preferably 5 to 80% of the entire area.

[0022]

In order to resolve the above-described issues, a representative configuration of a method for manufacturing a substrate using this carrier according to the present invention includes polishing processing in which a substrate is held in a holding hole of the above-described carrier for polishing, the substrate is sandwiched between an upper surface plate and a lower surface plate that are provided with polishing pads or grinding pads, and both surfaces of the substrate are polished simultaneously. At this time, the above-described carrier for polishing is installed in a polishing apparatus with a surface having protrusions oriented upward.

[0023]

In the polishing processing of this invention, the surface of the carrier having the protrusions is opposite to the polishing pad or the grinding pad on the upper surface plate side, for example. Basically, the carrier is slightly thinner than the substrate, but the difference in thickness between the carrier and the substrate is small, and the carrier repeatedly comes into contact with and is separated from the substrate during processing. The main component of the protrusions is glass, and the polishing pad or the grinding pad is mainly constituted by a resin-based component, and thus the materials thereof are significantly different from each other. Therefore, the present invention has a high effect of preventing attachment (adsorption) of the carrier to (on) the upper surface plate. Thus, when the upper

surface plate is raised after polishing processing, the carrier will not attach to the upper surface plate, be raised, then fall off from the upper surface plate onto the substrate, and scratch a surface of the substrate.

[0024]

Note that "grinding pad" refers to a fixed abrasive particle tool including diamond abrasive particles, for example. The fixed abrasive particle tool is molded such that the diamond abrasive particles are fixed by resin or metal, for example. Also, an aggregate abrasive particle obtained by binding a plurality of diamond abrasive particles with a glass material (vitrified), metal, resin, or the like into one particle may be used instead of one diamond abrasive particle. The substrate is processed by making these diamond abrasive particles or aggregate abrasive particles be expressed on the surface of the fixed abrasive particle tool. In the present invention, the diamond abrasive particles included in the fixed abrasive particle tool preferably have an average particle diameter (abbreviated as "average particle size" hereinafter) of 0.1 to 10 μm .

[0025]

Also, another representative configuration of the carrier according to the present invention is a carrier for polishing or grinding having a holding hole for holding a substrate, in which on at least one surface of the carrier, a plurality of recessed portions are provided in a region other than a circumferential edge of the holding hole.

[0026]

According to the above-described configuration, the surface of the carrier is provided with the plurality of recessed portions, and thus it is possible to store, in the recessed portions, a polishing liquid supplied to the carrier from above when the surface of the substrate is polished. Accordingly, the area of close contact between resins on the surfaces of the polishing pad and the carrier decreases even when the polishing pad and the carrier attempt to come into close contact with each

other, and thus the force with which the front and back sides of the carrier adsorb on the polishing pads decreases and the carrier has a high attachment (adsorption) prevention effect.

[0027]

At least one of the above-described plurality of recessed portions is preferably formed such that a contour that forms a recessed portion is not in contact with a gear portion of the carrier. This makes it possible to reliably store the polishing liquid in the recessed portions when the surface of the substrate is polished, and thus this configuration has a high attachment prevention effect.

[0028]

The recessed portions preferably have a depth of 0.3 to 30 μm . Setting the depth of the recessed portions to 0.3 μm or more makes it possible to sufficiently store the polishing liquid in the recessed portions and to prevent the attachment of the carrier. On the other hand, if the depth of the recessed portions exceeds 30 μm , there are cases where the carrier warps during polishing processing, a substrate to be polished comes off from the carrier, and the productivity decreases. Thus, the recessed portions more preferably have a depth of 0.3 μm or more and 30 μm or less.

[0029]

Contours that form the above-described recessed portions are preferably constituted by free curves. A curve can be used as the free curve, for example. Use of a free curve makes it possible to increase surface tension. This increases the effect of storing the polishing liquid, and thus this configuration has a high attachment prevention effect.

[0030]

An area occupied by all of the plurality of recessed portions is preferably 5% or more of an area of at least one entire surface of the carrier. Herein, if a percentage of the total area of the recessed portions is less than 5%, there are

cases where a sufficient attachment prevention effect cannot be obtained due to attachment of a polishing agent or the like to the surface of the carrier. On the other hand, there is no particular limitation on the upper limit of the percentage of the total area of the recessed portions. However, if the percentage is excessively high, there is a possibility that the carrier will warp and the substrate to be polished will come off from the carrier, and thus the upper limit of the percentage is preferably 80% or less.

[0031]

Also, the plurality of recessed portions preferably each have an area of 1 cm² or more. If this area is less than 1 cm², there are cases where a sufficient attachment prevention effect is not obtained. Note that the recessed portions more preferably have an area of 2 cm² or more. On the other hand, from the viewpoint of the attachment prevention effect, there is no particular limitation on the upper limit of the above-described area. However, if the area is excessively large, there is a possibility that the carrier will warp and the substrate to be polished will come off from the carrier, and thus the area is more preferably 400 cm² or less. Note that if there are a plurality of recessed portions, half or more of all of the recessed portions preferably have an area of 1 cm² or more. The number of recessed portions having an area of 1 cm² or more is more preferably 2/3 or more of the entirety, and even more preferably all of the recessed portions. If the number of recessed portions having an area of 1 cm² or more is less than 1/2 of the number of all of the regions, the number of small recessed portions increases, and thus it is difficult to form recessed portions through masking or the like, and the productivity of carriers deteriorates in some cases.

[0032]

The plurality of recessed portions are preferably formed away from a periphery of the holding hole by a predetermined width. If a recessed portion is formed close to the contour of the holding hole, there are cases where an inner wall surface of

the holding hole is scratched or the shape of the holding hole is changed. In such a case, there are cases where free movement of the substrate is inhibited during polishing processing, uniform polishing of a main surface of the substrate is inhibited, or an edge surface of the substrate is scratched. Note that from the viewpoint of operation efficiency, the predetermined width is preferably 1 mm or more, and more preferably 2 mm or more.

[0033]

Also, the plurality of recessed portions are preferably formed so as to include a region surrounded by at least three or more holding holes. If a recessed portion is provided between two holding holes, the strength of the whole carrier decreases and the possible number of instances of carrier usage decreases in some cases.

[0034]

The above-described carrier is preferably made of a material obtained by weaving glass fibers and impregnating the glass fibers with resin. Use of a chemical method or a mechanical method for the carrier made of such a material makes it possible to provide a plurality of recessed portions on the surface of the carrier.

[0035]

In order to resolve the above-described issues, another representative configuration of a method for manufacturing a substrate using this carrier according to the present invention includes polishing processing in which a substrate is held in a holding hole of the above-described carrier for polishing, the substrate is sandwiched between an upper surface plate and a lower surface plate that each include a polishing pad or a grinding pad, and both surfaces of the substrate are polished simultaneously. At this time, the above-described carrier for polishing is installed in a polishing apparatus with the surface having the recessed portions being oriented upward.

[0036]

In this manner, in the polishing processing of this invention, the surface of the carrier having the recessed portions is in contact with the polishing pad or the grinding pad of the upper surface plate. Thus, even when the polishing pad and the carrier attempt to come into close contact with each other, the area of close contact between the resins on the surfaces decreases. Therefore, the force with which the front and back sides of the carrier adsorb on the polishing pads decreases and the carrier has a high attachment (adsorption) prevention effect. Thus, when the upper surface plate is raised after polishing processing, the carrier will not attach to the upper surface plate, be raised, then fall off from the upper surface plate onto the substrate, and scratch a surface of the substrate.

Advantageous Effects of the Invention

[0037]

According to the present invention, it is possible to provide a carrier with which high quality substrates can be obtained at a higher yield than with a conventional method, and to provide a method for manufacturing a substrate using this carrier.

Brief Description of Drawings

[0038]

FIG. 1 is a diagram showing a cross section of main portions of a double-side polishing apparatus used to polish surfaces of a substrate in this embodiment.

FIG. 2 is a schematic diagram showing an enlarged portion of an upper surface of the carrier in FIG. 1.

FIG. 3 is a diagram showing an example in which a carrier in this embodiment is manufactured.

FIG. 4 is a schematic diagram of an upper surface of the carrier before

protrusions are formed.

FIG. 5 is a schematic diagram of the upper surface of the carrier after protrusions are formed.

FIG. 6 is a top view showing the carrier in FIG. 1.

FIG. 7 is a schematic diagram showing recessed portions provided on the upper surface of the carrier in FIG. 6 and their periphery.

FIG. 8 is a schematic diagram showing an enlarged region B in FIG. 7(a).

Description of Embodiments

[0039]

Hereinafter, preferred embodiments of the present invention will be described in detail with reference to the attached drawings. The dimensions, materials, and any other specific values or the like described in the embodiments are merely examples for facilitating understanding of the invention, and do not limit the present invention unless otherwise stated. Note that in the specification and drawings, elements having substantially the same functions and configurations will be assigned the same reference numerals to omit redundant descriptions, and elements that are not directly related to the present invention will be omitted in the drawings.

[0040]

[First Embodiment]

FIG. 1 is a diagram showing a cross section of main portions of a double-side polishing apparatus used to polish surfaces of a substrate in the present embodiment. Note that although only the double-side polishing apparatus will be described in the present embodiment, the present embodiment is not limited to this, and by changing a polishing pad to be set in a surface plate to a grinding pad, for example, a double-side grinding apparatus having a similar function or the like can also be provided.

[0041]

An annular or a rectangular plate-shaped substrate can be used as a substrate (workpiece), for example. Although specific examples of these substrates include magnetic-disk substrates such as glass substrates, aluminum-alloy substrates, and aluminum alloy substrates provided with an NiP alloy plating film on their surfaces, rectangular glass substrates for a liquid crystal panel or the like, cover glass for screen protection, mask blanks, and silicon wafers, the materials, shapes, and sizes of the substrates are not limited to these. Note that from the viewpoint of needing to have low roughness and few defects on both surfaces of a substrate and being capable of processing many substrates at once with a high quality, in particular, this invention is suitably applied when a magnetic-disk substrate is processed. Hereinafter, a case where a magnetic-disk glass substrate is used as a workpiece will be described as one example.

[0042]

A double-side polishing apparatus 100 is an apparatus that polishes upper and lower surfaces of glass substrates 102, and includes a carrier mounting portion 106 on which carriers 104 are mounted, an upper surface plate 108, and a lower surface plate 110. The carrier mounting portion 106 has an internal gear 112 and a sun gear 114 that are driven so as to rotate at predetermined rotation ratios, and the carriers 104 are mounted on the carrier mounting portion 106.

[0043]

A gear portion 115 is formed on an outer circumference of each of the carriers 104, and the carriers 104 are mounted on the carrier mounting portion 106 such that the gear portions 115 engage with the internal gear 112 and the sun gear 114. The carriers 104 undergo planet gear movement in a state in which the carriers 104 are mounted on the carrier mounting portion 106, and revolve while rotating about the sun gear 114.

[0044]

The upper surface plate 108 and the lower surface plate 110 are driven so as to rotate inversely to each other sandwiching the carrier mounting portion 106. Also, polishing pads 116 and 118 are respectively attached to surfaces of the upper surface plate 108 and the lower surface plate 110 that are opposite to the glass substrates 102. The upper surface plate 108 is movable in the vertical direction and presses the polishing pads 116 and 118 against the upper and lower surfaces of the glass substrates 102. Note that foam of a synthetic resin such as polyurethane or polyester is used as the polishing pads 116 and 118.

[0045]

A slurry (polishing liquid) containing polishing abrasive particles is supplied from above the carriers 104 through a supply pipe 120 provided in the upper surface plate 108. In this manner, in the double-side polishing apparatus 100, the carriers 104 undergo planet gear movement and the upper surface plate 108 and the lower surface plate 110 rotate inversely to each other while the polishing liquid is supplied. Thus, in the double-side polishing apparatus 100, the upper and lower main surfaces of the glass substrate 102 are polished by moving the glass substrates 102 and the polishing pads 116 and 118 relative to each other.

[0046]

The carriers 104 have one or more holding holes 122. The carriers 104 hold, in the holding holes 122, one or more glass substrates 102 that are sandwiched between the polishing pad 116 of the upper surface plate 108 and the polishing pad 118 of the lower surface plate 110. Furthermore, in the double-side polishing apparatus 100, the upper surface plate 108 is raised after the upper and lower main surfaces of the glass substrate 102 are polished, and the polished glass substrates 102 are removed from the carriers 104.

[0047]

Note that although the carriers 104 are used in the polishing processing herein, the present embodiment is not limited to this, and the carriers 104 can be

widely used in main surface grinding processing other than polishing, such as lapping using loose abrasive particles, or grinding processing using a grinding pad with fixed abrasive particles. Furthermore, with the carrier 104, a carrier main body having the holding holes 122 and a gear portion 115 are separate members, and the carriers 104 may be of a type in which the carrier main body and the gear portion 115 are used in combination during use.

[0048]

FIG. 2 is a schematic diagram showing an enlarged portion of an upper surface of the carrier 104 in FIG. 1. FIG. 2(a) is a top view showing an enlarged portion of an upper surface 124 of the carrier 104. FIG. 2(b) is a cross-sectional view taken along A-A in FIG. 2(a).

[0049]

As shown in FIG. 2(a), a plurality of protrusions 136 are formed on the upper surface 124 of the carrier 104. The main component of the plurality of protrusions 136 is glass. The surface other than the protrusions is made of resin, for example. For example, epoxy, polyvinyl chloride, polycarbonate, phenol, polyacetal copolymers, polyethylene terephthalate, or the like can be used as the resin. Among these, in particular, an epoxy resin is particularly suitable because the bending strength and the elastic modulus can be increased when glass fibers are impregnated with the epoxy resin, and the epoxy resin has a high water resistance and chemical resistance.

[0050]

Also, if the carrier 104 is made of a material obtained by weaving glass fibers and impregnating the glass fibers with resin, the material may contain fibrous glass and be approximately regularly arranged, such as in an approximate lattice shape although details will be described later. Also, although the protrusions 136 are formed only on the upper surface 124 of the carrier 104 in FIG. 2(b) and are not provided on a lower surface 135, the protrusions 136 may be provided on both the

upper and lower surfaces as long as they do not inhibit the effect of suppressing adsorption on the upper surface plate 108. If the protrusions 136 are formed on the upper and lower surfaces, it is sufficient that the height and the number of protrusions 136, the regions in which the protrusions 136 are formed (protrusion formation regions), and the like are adjusted as appropriate on each surface.

[0051]

With the protrusions 136 shown in FIG. 2(b), it is preferable to set a height L_a to 2 to 50 μm , and a width L_b to 50 to 600 μm , for example. Note that the width L_b is the maximum length of the protrusion in the direction of the main surface 134 of the carrier 104.

[0052]

The protrusions 136 have a circular arc shape protruding upward and have a mountain-like shape in FIG. 2(b). However, the shape of the protrusions is not limited to this as long as the protrusions have a circular arc shape protruding upward as a whole, and the protrusions may have a shape in which the area decreases as the upper portion is approached, or in other words, a shape in which the cross-sectional area of the plane parallel to the main surface 134 of the carrier 104 decreases as the upper portion is approached. Furthermore, the protrusions may have an elliptical shape or a hemispherical shape protruding upward, for example. With such a shape, the protrusions 136 have no corners that are approximately 90 degrees at their apexes 136A, and are rounded.

[0053]

Also, if the carriers 104 are made of a material obtained by weaving glass fibers and impregnating the glass fibers with resin, use of the method for manufacturing the carrier 104 in the present embodiment, which will be described later, makes it possible to form the protrusions 136 by the glass fibers protruding from the stitches of the glass fibers, or cutting parts of the glass fibers so as to bring about a state in which the parts of glass fibers rise. That is, the plurality of

protrusions 136 made of a glass material can be formed approximately regularly on the upper surface 124 of the carrier 104. The protrusions 136 made of the glass material have a higher wear resistance compared to a protrusion made of a resin material, and are not easily worn away even though polishing processing is repeatedly performed.

[0054]

In other words, the protrusions 136 made of the glass material may be formed by exposing parts of the glass fibers included in the carrier on the outermost surface or causing parts thereof to be expressed on the outermost surface.

Furthermore, these exposed or expressed glass fibers may include cut glass fibers.

[0055]

The above-described protrusions 136 are not necessarily formed on the entire main surface of the carrier. The protrusions 136 containing glass as a main component according to the present invention have an extremely high attachment prevention effect, and thus by forming the protrusions 136 in at least a portion of the main surface, the protrusions 136 can exhibit a sufficient effect. In this specification, a region in which the above-described protrusions 136 are formed is also referred to as "protrusion formation region". If the above-described protrusion formation region is provided in a portion of the main surface of the carrier, a plurality of regions may be formed separately.

[0056]

Also, an area occupied by the protrusion formation region (if a plurality of protrusion formation regions are formed, the total area thereof) is preferably 10% or more of the area of at least one entire surface of one carrier out of the carriers having this protrusion formation region. If the percentage of the area occupied by this protrusion formation region is less than 10%, there are cases where the attachment prevention effect decreases due to attachment of a polishing agent or the like to the surface of the carrier at the last stage of long-term continuous

processing. The percentage of the area is more preferably 20% or more. Note that if the percentage of the area is low, the attachment prevention effect can be improved even with a small area by mainly forming protrusions in the vicinity of the outer circumference of the carrier.

[0057]

Also, the area of each of the protrusion formation regions is preferably 1 cm² or more. If this area is less than 1 cm², there are cases where a sufficient attachment prevention effect is not obtained. Note that the area of each protrusion formation region is more preferably 2 cm² or more. On the other hand, from the viewpoint of the attachment prevention effect, there is no particular limitation on the upper limit of the above-described area. However, if the above-described area is excessively large, there are cases where a masking operation or the like is required in order to avoid the holding holes and the productivity of the carriers deteriorates, and thus, the area is more preferably 400 cm² or more. Note that if the carrier has a plurality of protrusion formation regions, less than half of all of the protrusion formation regions may have an area of less than 1 cm². The number of protrusion formation regions having an area of less than 1 cm² is more preferably less than 1/3 of the entirety, and even more preferably zero. If the number of protrusion formation regions having an area of less than 1 cm² is 1/2 or more of the number of all of the regions, a protrusion formation operation through masking or the like becomes difficult, and the productivity of carriers deteriorates in some cases.

[0058]

Also, in the above-described protrusion formation region, it is preferable to form the protrusions at a density of 0.5 or more protrusions per 1 mm². Setting the density of protrusions to be larger than 0.5 protrusions per 1 mm² makes it possible to reliably obtain the effect of suppressing the attachment of the carrier to a surface plate. The density thereof is more preferably 1 or more protrusions per 1 mm².

On the other hand, although there is no particular limitation on this density from the viewpoint of the above-described attachment suppression effect, from the viewpoint of damage to the polishing pads or the grinding pads (these are also collectively referred to as "processing pads" in this specification) installed on the surfaces of the surface plates, the density is more preferably 10 or less protrusions per 1 mm². If damage occurs on these processing pads and a substrate is manufactured through long-term continuous processing, there is a concern that front and back sides of the substrate will differ significantly at the last stage of the manufacture. The density of the protrusions may be obtained as an average value by observing the protrusion formation regions at a plurality of locations using a scanning electron microscope (abbreviated as "SEM" hereinafter), for example.

[0059]

The carrier 104 of the present invention can be manufactured using the following method, for example. For example, if the carrier is made of a material obtained by weaving glass fibers and impregnating the glass fibers with resin, it is sufficient that parts of the glass fibers located near the surface of the carrier are exposed by removing resin or glass, which is a substance that constitutes the carrier, using a chemical or mechanical method (see FIG. 3). Note that whichever method is used, the protrusions 136 can be formed in any region of the surface of the carrier 104 by combining masking processing as appropriate when the carrier 104 is manufactured.

[0060]

A method such as dissolving or etching can be used as the chemical method, for example. In these methods, a substance that can dissolve or etch resin or glass need only be selected as appropriate and be brought into contact with resin or glass. Note that a substance that can dissolve or etch both resin and glass may be used.

[0061]

FIG. 3(a) is a diagram showing an example in which the carrier 104 in the present embodiment is manufactured using a chemical method. Herein, an etching agent 138 for dissolving resin is applied to a region 126 (protrusion formation region), which is indicated by cross-hatching in FIG. 3(a), of the upper surface 124 of the carrier 104. A liquid etching agent or a cream etching agent may be selected as the etching agent 138 as appropriate.

[0062]

The region 126 may be the entirety or a portion of the upper surface 124 of the carrier 104 as long as the above-described protrusions 136 can be formed. In FIG. 3, a region of the upper surface 124 of the carrier 104 that is located at a position other than circumferential edges 130 of three holding holes 122a, 122b, and 122c and is surrounded by these holding holes 122a, 122b, and 122c is shown as the region 126. Note that when the carrier 104 is manufactured, by performing masking as appropriate, the above-described chemical method or mechanical method can be applied to only a portion of the surface of the carrier 104.

[0063]

As described above, if the protrusions 136 are formed on a portion of the surface of the carrier 104, the protrusions 136 are preferably formed in the region 126 surrounded by at least three or more holding holes 122a, 122b, and 122c. If a region for forming the protrusions 136 is provided between two holding holes, there are cases where cost and labor for manufacturing the carrier 104 increase.

[0064]

Also, it is preferable to form the protrusions 136 away from the peripheries of the holding holes 122 by a predetermined width, for example, at positions other than the circumferential edges 130. If the protrusion 136 is formed close to the contours of the holding holes 122, there are cases where the inner wall surface of the holding hole 122 is scratched or the shape of the holding hole 122 is changed. In such a case, there are cases where free movement of the substrate is inhibited

during polishing processing, uniform polishing of a main surface of the substrate is inhibited, or an edge surface of the substrate is scratched. Note that from the viewpoint of operation efficiency, the predetermined width is preferably 1 mm or more, and more preferably 2 mm or more.

[0065]

Also, a plurality of the regions 126 in which the protrusions 136 are to be provided may be provided apart from each other. By doing so, in the case where multiple holding holes 122 are provided in order to increase the manufacturing efficiency and the space located between two holding holes 122 becomes extremely narrow, it is possible to provide a region having the protrusions 136 away from the two holding holes 122, and therefore the efficiency of manufacturing the carrier 104 can be increased.

[0066]

Also, a plurality of regions, which are recessed portions having a predetermined depth, may be formed on the surface of the carrier 104, and the protrusions 136 may be formed in the recessed portions. Doing this makes it possible to further increase the durability of the protrusions 136 by reducing the possibility of contact between the protrusions 136 and the polishing pad, and to further increase the quality of the surface of the processed substrate by suppressing the formation of dust caused by the protrusions being rubbed against the polishing pad. Note that the recessed portions need only have a depth of 0.3 to 30 μm , for example. Also, the total area of all of the regions in which the recessed portions are formed on one surface of the carrier 104 is preferably 5 to 80% of the area of the entire surface of the carrier 104.

[0067]

Also, as shown in FIG. 3(b), a mechanical method in which the surface of the carrier 104 is rubbed or ground using a polishing tool (grinding tool) such as sandpaper, a file, or a grinder may be used. Herein, a polishing tool 146 is

attached to a front end 144 of a grinder 142 and is brought into contact with the surface of the region 126 as appropriate, for example, and thereby the surface of the region 126 is polished.

[0068]

Note that if the carrier 104 is made of a material obtained by weaving glass fibers and impregnating the glass fibers with resin, glass and resin have significantly different hardnesses and physical properties, and thus one or both of the resin and the glass fibers can be removed by selecting the above-described etching agent 138, a polishing tool, or the like as appropriate.

[0069]

Also, the above-described chemical method and mechanical method may be used in combination. For example, by roughly removing resin using a mechanical method, and then removing the resin using a chemical method, a surface with few burrs can be obtained. Note that if a large number of burrs remain on the surface of the carrier, there is a concern that the polishing pad of the double-side polishing apparatus 100 will be scratched, or the burrs will separate during processing, serve as foreign matter, and cause contamination of the surface of the substrate.

[0070]

In addition to the above-described method, a resin film or metal film may be stacked on the carrier in a state in which the region 126 of the surface of the carrier where the recessed portions 128 need to be formed is masked, then the mask may be removed, and thereby the recessed portions 128 may be formed.

[0071]

Hereinafter, with regard to the case where the carrier 104 is made of a material obtained by weaving glass fibers and impregnating the glass fibers with resin, a process in which the protrusions 136 are formed in the region 126 of the upper surface 124 of the carrier 104 using the above-described chemical method or

mechanical method. FIG. 4 is a schematic diagram of the upper surface 124 of the carrier 104 before the protrusions 136 are formed. FIG. 5 is a schematic diagram of the upper surface 124 of the carrier 104 after the protrusions 136 are formed. Note that FIGS. 4 and 5 schematically show an enlarged portion of the region 126.

[0072]

The carrier 104 shown in FIG. 4 is an enlarged view of a surface of a sheet material obtained by weaving glass fibers 150 and impregnating the glass fibers 150 with resin. This sheet material is a material obtained by stacking fabrics (one fabric impregnated with resin is referred to as "prepreg") that are obtained by forming fiber bundles obtained by collecting several tens of glass fibers 150 to several hundreds of glass fibers 150, and weaving the fiber bundles alternately. This sheet material is so-called a plain woven fabric in which vertical bundles and horizontal bundles of the glass fibers 150 are exposed alternately on the surface side at every stitch 152. Note that the thickness of the prepreg is 0.1 to 0.2 mm, for example, which is extremely thin, and thus, in general, the above-described sheet material is formed by stacking a plurality of prepreps and crimping the plurality of prepreps, for example. Also, although not particularly shown in the drawings, the surface is covered with a resin layer.

[0073]

With such a carrier 104, the glass fibers 150 have a mountain-like shape in a state protruding toward the surface layer at positions at which the stitches 152 overlap with each other. As one example, the vertical bundles or the horizontal bundles of the glass fibers 150 approximately regularly protrude toward the surface such that every other stitch 152 swells. In general, the glass fibers 150 are embedded in the resin, and thus are almost flat in appearance, but if the resin on the surface is lost through dissolving or the like, the bundles of the glass fibers (or glass fibers) appear as mountain-like shapes. The reasons are as follows: the

glass fibers are pressed with a strong force when the prepregs are crimped, and are fixed by resin in that state. That is, stress of returning to the original thickness occurs in the bundles of the glass fibers. The stress occurring in the glass fibers is released utilizing this structure, and thereby, protrusions can easily be formed approximately regularly.

[0074]

FIG. 5(a) is a diagram schematically showing a state in which the protrusions 136 are formed approximately regularly. The protrusions 136 serving as protruding portions 154 where the bundles of the glass fibers (or glass fibers) appear as mountain-like shapes and protrude from the surface of the carrier are formed at every stitch 152 appearing on the surfaces of the vertical bundles and in one stitch appearing on a surface of the horizontal bundles. The vertical glass fibers and the horizontal glass fibers are not necessarily uniformly woven microscopically, and thus there are cases where the thickness of the resin that covers the surface varies depending on individual differences of the sheet materials or the positions in one sheet. FIG. 5(a) is an example of such a case.

[0075]

Thus, for example, there are cases where the protrusions 136 are formed in all of the nine stitches 152 that can be seen in FIG. 5(a), and there are cases where the protrusions 136 are formed in only five of the stitches 152 of the vertical glass fibers. However, in any case, the protrusions 136 are formed in approximately central portions of the stitches 152, and thus the protrusions 136 can be formed approximately regularly. In other words, the protrusions 136 can be formed approximately regularly following the stitches 152. Note that if a protrusion is formed so as to extend across borderlines of the stitches 152, the area of the resin that covers the surface decreases, and the strength of the carrier 104 decreases in some cases, and thus the protrusions 136 are preferably formed so as not to extend across the borderlines of the stitches 152. In other words, resin is

preferably present between the protrusions on the surface of the carrier.

[0076]

Note that when the protrusions 136 are formed, it is not always necessary to remove the resin until the glass fibers 150 embedded in the resin are completely exposed. If the carrier 104 is made of a material obtained by weaving the glass fibers 150 and impregnating the glass fibers 150 with resin, the glass fibers 150 (or the bundles of the glass fibers) are fixed by the resin in a state in which the glass fibers 150 are pressed in the thickness direction in the manufacturing process. Therefore, by removing part of the resin to the extent that stress occurring in the glass fibers 150 is released, it is also possible to form the protrusions 136 containing glass as a main component. Note that the above is also similar to the case where a substance embedded in the resin is non-fibrous glass, such as glass particles. That is, it is not always necessary to remove the resin until the glass embedded in the resin is completely exposed.

[0077]

If the protrusions are formed in this manner, the resin remains in part of the surfaces of the protrusions in some cases, but it is sufficient that a glass component is exposed at at least part of the surfaces. Whether or not the glass component is exposed at the surfaces of the protrusions can be checked using SEM and energy dispersive X-ray analysis (abbreviated as EDX hereinafter), for example.

[0078]

Also, if the resin that covers the glass fibers 150 is relatively thin on the surface of the carrier 104, a substance that can dissolve or etch glass may be used. In this case, a glass dissolving substance permeates the resin layer and reaches the glass fibers 150 in the inner portion of the resin layer, and a substance obtained by dissolving parts of the glass fibers 150 overcomes the resin coating and is deposited on the surface. As a result, the resin coating is ruptured, and thus protrusions including the glass fibers 150 are formed.

[0079]

Furthermore, as shown in FIG. 5(b), parts of the glass fibers 150 that constitute the protrusions 136 may be cut. If the parts of the glass fibers 150 are cut, fragments of the glass fibers 150 tend to protrude from the surface. In other words, the cut glass fibers 150 tend to rise with respect to the surface of the carrier 104. As a result of some of the protrusions 136 including the cut glass fibers in this manner, the above-described attachment effect can be improved. Note that according to the studies conducted by the inventor, only parts of the glass fibers are cut in etching conditions using a general glass etching liquid, and thus the glass fibers have a low rigidity and are unlikely to scratch the opposing polishing pad or grinding pad. It is inferred that this is because several hundreds of glass fibers are bundled, but the resin is also present between individual glass fibers.

[0080]

In addition to the above-described method, if resin is used as a component of the surface of the carrier, protrusions may be formed using a method in which parts of glass microparticles that have a predetermined particle size and contain glass as a main component are embedded in the surface of the carrier by spraying the glass microparticles on the surface of the carrier and pressing the carrier while heating, a method in which glass microparticles are sprayed after an adhesive is applied to the surface of the carrier, or the like.

[0081]

After the protrusions 136 containing glass as a main component are formed using the above-described method, cleaning processing or burr removal processing may be carried out as appropriate. Also, the height of the protrusions is adjusted using a dresser such as a diamond dresser, or burr removal processing may be further performed.

[0082]

Also, the shape such as the height or the length of the protrusions 136 of

the completed carrier 104 can be checked using a stylus-type or optical surface shape measurement apparatus as appropriate, for example. Also, by carrying out SEM observation and element analysis through EDX on the protrusions 136, for example, it can be confirmed that the protrusions 136 contain a glass component or glass fibers, and whether or not the protrusions 136 contain cut glass fibers. Also, the depth of resin removal and a change in the thickness of the carrier 104 can be checked using a micrometer or a length measuring machine.

[0083]

According to the carrier 104 of the present embodiment, because the upper surfaces 124 of the carriers 104 have the plurality of protrusions 136, when the upper surface plate 108 is raised, air tends to enter between the upper surfaces 124 of the carriers 104 and the upper polishing pad 116. Thus, it is possible to prevent the carrier 104 from attaching to the upper surface plate 108. Moreover, the protrusions 136 are made of a glass material, and thus have a high wear resistance, and therefore it is possible to prevent attachment of the carriers 104 to the upper surface plate 108 over a greater number of instances.

[0084]

Furthermore, air evenly enter between the upper surfaces 124 of the carriers 104 and the upper polishing pad 116 due to the regularly formed protrusions 136, and thus it is possible to more effectively prevent the attachment.

[0085]

Also, the protrusions 136 may have a smooth protruding shape as a whole. Also, their apexes 136A have no corners that are approximately 90 degrees. Moreover, the protrusions 136 have a round shape as a whole, and thus are unlikely to scratch the polishing pad 116 that comes into contact with the protrusions 136. As a result, both surfaces of the glass substrate 102 can be equally polished even though a carrier whose front and back sides have different specifications is used.

[0086]

As is clear in working examples described next, the height L_a shown in FIG. 2(b) is 2 μm or more (see Table 1), and thus the protrusions 136 have a high wear resistance and can more effectively prevent attachment. Note that if the carrier is made of a sheet material obtained by weaving glass fibers and impregnating the glass fibers with resin, for example, the height and the width of the protrusions 136 can also be adjusted by appropriately setting the thickness of the glass fibers 150, the number of bundled glass fibers 150, the weaving method, and the size (length) of a stitch, in addition to a change in the etching amount.

[0087]

Note that if the carrier is made of a sheet material obtained by weaving glass fibers and impregnating the glass fibers with resin, for example, the height and the width of the protrusions 136 can also be adjusted by appropriately setting the thickness of the glass fibers 150, the number of bundled glass fibers 150, the weaving method, and the size (length) of a stitch, in addition to a change in the etching amount. For example, the height and the width of the protrusions can be increased by increasing the resin etching amount.

[0088]

The height and the width of the protrusions 136 can be obtained as average values of the top 50 protrusions having larger values out of 100 protrusions when 100 protrusions are randomly sampled and their height and width are measured. By performing calculation in this manner, it is possible to obtain the dimensions of the protrusions that reliably contribute to the prevention of attachment to the upper surface plate.

[0089]

[Working Examples]

Hereinafter, although working examples of the present invention will be described below, the present invention is not limited to only the working examples

below.

[0090]

(Preparation of substrate to be processed)

A substrate to be processed was a nominal 2.5-size magnetic-disk glass substrate (diameter was about 65 mm), and the substrate that underwent the first polishing processing using a polishing liquid containing cerium oxide abrasive particles was prepared using a known method.

[0091]

(Preparation of carrier for experiment)

A carrier was manufactured through shape processing using a sheet material obtained by weaving glass fibers and impregnating the glass fibers with an epoxy resin. Then, additional processing was performed on one side of the carrier using the above-described method as appropriate such that a plurality of protrusions having specifications listed in Table 1 were formed. Note that with regard to the other specification, the width of the protrusions was 300 μm , the density of the protrusions was 3 (protrusions / mm^2), and the percentage of the area occupied by the protrusion formation regions with respect to the main surface of the carrier was 50%. Also, as a result of confirmation by SEM, cut glass fibers were not found. Herein, the height and the width of the protrusions were average values of the top 50 protrusions having larger values out of 100 protrusions that were randomly sampled and whose height and width were measured.

[0092]

(Experimental conditions)

Second polishing was carried out on the above-described substrate to be processed using the above-described or known method, except for the following. Both surfaces of the substrate to be processed were polished simultaneously using, as a polishing device, the above-described double-side polishing apparatus in which polishing pads were attached to the upper and lower surface plates. The

polishing pads were made of a polyurethane resin, and were suede-type having a surface layer including a nap layer provided with many elongated minute holes (nap) that were formed in the thickness direction utilizing a foaming agent. A polishing liquid containing colloidal silica having an average particle size (D50) of 30 nm as polishing abrasive particles was used as the polishing agent. Note that with regard to the orientation of the carriers, the carriers were set in the polishing device such that surfaces having the protrusions were oriented upward.

[0093]

In addition, by setting five carriers that held 10 substrates per carrier in one instance of polishing processing (one batch), both main surfaces of 50 substrates were polished at once. Continuous processing was performed on 20 batches without replacing the carriers while the substrates being processed were replaced. That is, in each experimental example, 100 instances' worth of attachment of the carriers to the upper surface plate was checked.

[0094]

Also, in each experimental example, a difference in microwaviness between the front and back main surfaces of the substrates that were processed in the 20th batch was obtained. Specifically, two substrates were sampled from one carrier, that is, ten substrates were sampled in total, and an average value of microwaviness on the upper surface plate side (for 10 surfaces) and an average value of microwaviness on the lower surface plate side (for 10 surfaces) were calculated, and a difference between those average values was calculated.

[0095]

Table 1 lists Comparative Example in which a surface of a carrier had no protrusions containing glass as a main component, and Working Examples 1 to 8 in which surfaces of carriers had protrusions and the protrusions had different heights. Note that in Table 1, "attachment occurrence count ratio" refers to a relative value when that of Comparative Example was "1.0".

[Table 1]

	Height of protrusions (μm)	Attachment occurrence count ratio	Difference in microwaviness between front and back main surfaces of substrate after processing on 20th batch
Comparative Example	no protrusion	1	–
Working Example 1	2	0.2	0.001 or less
Working Example 2	3	0	0.001 or less
Working Example 3	5	0	0.001 or less
Working Example 4	10	0	0.001 or less
Working Example 5	20	0	0.001 or less
Working Example 6	30	0	0.001 or less
Working Example 7	50	0	0.001 or less
Working Example 8	70	0	0.002

[0096]

As shown in Table 1, a high attachment prevention effect was obtained by merely forming protrusions having a height of 2 μm on the surface of the carrier. Moreover, if the height of the protrusions was 3 μm or more (Working Examples 2 to 8), it was possible to substantially avoid attachment of the carriers to the upper surface plate. On the other hand, if the height of the protrusions exceeded 50 μm (Working Example 8), a difference in the processed substrate surface shape between the front and back sides was slightly larger than that of the other working examples. Thus, the protrusions preferably have a height of 50 μm or less. It is inferred that in Working Example 8, the protrusions had an excessively high height, and the surface of the polishing pad on the opposing upper surface plate side was scratched and roughened. In this manner, from the results of Table 1, it was confirmed that the protrusions particularly preferably have a height of 2 to 50 μm .

[0097]

Note that microwaviness in Table 1 was measured using an optical surface shape measurement apparatus using a laser. In a measurement method, laser

light having a predetermined wavelength entered the surface of a measurement object at a predetermined angle, and light reflected from the measurement object was detected, and thereby information on the height of the main surface was obtained. A wavelength bandwidth of microwaviness is 10 to 500 μm . In the present embodiment, with regard to the front and back sides of the glass substrate having a diameter of about 65 mm, a range with a radius of 15 mm to 30 mm on the main surface was measured as the measurement region, and a difference in microwaviness between the front and back sides was calculated. If both surfaces need to have the same processing quality as in a case of a magnetic-disk substrate, an increase in this difference is not preferable because the productivity deteriorates, or more specifically, polishing failure occurs under the influence of a main surface with greater microwaviness, necessitating re-polishing, or the like.

[0098]

Note that with regard to Working Example 8, when a difference in microwaviness of the 1st batch and the 10th batch was similarly checked, the difference was 0.001 or less, which was a good result. Accordingly, it was confirmed that a difference in microwaviness occurs when long-term continuous processing is carried out.

[0099]

Thus, according to the carrier 104 of the present embodiment and a method for manufacturing the glass substrate 102 using this carrier 104, the plurality of protrusions 136 on the upper surface 124 of the carrier 104 prevent attachment of the carrier 104 to the upper surface plate 108, prevent an increase in the difference in microwaviness between the upper surface and the lower surface of the glass substrate 102, and thereby a high-quality glass substrate 102 can be obtained.

[0100]

Next, the carrier 104 with the protrusions 136 having a different width was

produced by appropriately changing the amount of etching an epoxy resin in the sheet material, which is the base material of the carrier 104, based on the conditions of Working Example 5. Thereafter, the surfaces were processed using a grinder such that the protrusions 136 had a height of 20 μm . Similarly to the above, continuous processing was performed on 100 batches using those carriers 104. The results are listed in Table 2.

[Table 2]

	Width of protrusions (μm)	Attachment
Working Example 9	25	attachment occurred in 90th batch
Working Example 10	50	no attachment occurred in 100 batches or more
Working Example 11	100	no attachment occurred in 100 batches or more
Working Example 12	300	no attachment occurred in 100 batches or more
Working Example 13	600	no attachment occurred in 100 batches or more
Working Example 14	900	no attachment occurred in 100 batches or more

As is evident from Working Examples 10 to 14, it was confirmed that the attachment suppression effect lasted long by setting the width of the protrusions 136 to 50 μm or more. On the other hand, with regard to Working Example 14 in which the width of the protrusions was set to 900 μm , abnormal sound was sometimes detected during processing. Thus, it was confirmed that it was preferable to set the width of the protrusions to 600 μm or less from the viewpoint of suppression of abnormal sound.

[0101]

(Relationship with density of protrusions)

Carriers with the density (protrusions / mm^2) of protrusions changed to 0.5, 1, 5, and 10 were prepared based on the conditions of Working Example 5, and 20-batch continuous polishing processing was performed on substrates. The experiment results are listed in Table 3. As understood from Working Examples 15 to 18, attachment of the carriers to the upper surface plate did not occur in any of Working Examples 15 to 18.

[Table 3]

	Density of protrusions (protrusions / mm ²)	Attachment after 20-batch processing
Working Example 15	0.5	no attachment occurred
Working Example 16	1	no attachment occurred
Working Example 17	5	no attachment occurred
Working Example 18	10	no attachment occurred

[0102]

(Relationship with the percentage of the area of protrusion formation regions)

Carriers with the percentage (%) of the area of the protrusion formation regions changed to 10, 20, 75, and 100 were prepared based on the conditions of Working Example 5, and 20-batch continuous polishing processing was performed on substrates. The results are listed in Table 4. As understood from Working Examples 19 to 22, attachment of the carriers to the upper surface plate did not occur up to the 20th batch in all of Working Examples 19 to 22.

[Table 4]

	Percentage of area of protrusion formation region (%)	Attachment after 20-batch processing
Working Example 19	10	no attachment occurred
Working Example 20	20	no attachment occurred
Working Example 21	75	no attachment occurred
Working Example 22	100	no attachment occurred

[0103]

(Relationship with cut glass fibers)

The carriers that were manufactured in the conditions of Working Example 1 were used as the base, their surfaces were treated using liquid containing hydrofluosilicic acid, and then the surfaces were processed using a grinder. Thus, carriers were prepared in which glass fibers protruded from the surfaces of the carriers, parts thereof were cut, and an average height of protrusions was equal to that of Working Example 1. 20-batch continuous polishing processing was

performed on substrates using those carriers. As a result, the attachment occurrence count ratio was 0.1, which was half of that of Working Example 1. Also, similarly to the above, when carriers that were manufactured in the conditions of Working Example 9 were processed and a continuous polishing processing experiment was performed, attachment was not detected for 100 batches or more. Based on those results, it was confirmed that a higher attachment prevention effect was obtained by cutting parts of the glass fibers.

[0104]

(Relationship with recessed portions)

Three types of carriers were prepared by further etching resin in the protrusion formation regions in the carrier of Working Example 8 such that recessed portions had a depth of 0.3, 10, or 30 μm . 20-batch continuous polishing processing was performed on substrates using those carriers. When a difference in microwaviness between the front and back main surfaces of the respective substrates that were processed in the 20th batch was evaluated similarly to the above, the differences were respectively 0.0017, 0.0012, and 0.001 or less. Note that attachment did not occur. Based on that result, it was confirmed that a difference in microwaviness between the front and back sides can be reduced by forming protrusions in the recessed portions.

[0105]

[Second Embodiment]

A second embodiment of a carrier according to the present invention and a method for manufacturing a substrate using this carrier will be described. Portions with descriptions redundant with the above-described first embodiment are denoted by the same reference numerals and description thereof is omitted.

[0106]

FIG. 6 is a top view showing a carrier 104 in FIG. 1. On an upper surface 124 of the carrier 104 exemplarily shown in FIG. 6, a plurality of regions 126

(protrusion formation regions) are provided with recessed portions 128 (see FIG. 7(b)). As shown in FIG. 6, the plurality of regions 126 are located at positions other than circumferential edges 130 of holding holes 122, and are located apart from each other. In particular, the plurality of regions 126 may be each a region that is surrounded by at least three holding holes 122 and is not continuous with the holding holes 122.

[0107]

Also, the contours that form the plurality of recessed portions 128 are constituted by free curves, and for example, these contours are formed so as not to be in contact with gear portions 115 formed on outer circumferences of the carriers 104. Also, the area occupied by all of the plurality of recessed portions 128 is 5% or more of the area of the entire upper surface 124 of the carrier 104, and the upper limit thereof is set to 80% or less. Furthermore, the area of each of the plurality of recessed portions 128 is set to a range of 1 cm² or more and 400 cm² or less. The number of recessed portions 128 that satisfy the area in this range is preferably 1/3 or more of all of the recessed portions 128. The number of recessed portions 128 is more preferably 1/2 or more of all of the recessed portions 128, and even more preferably all of the recessed portions 128. Note that if the number is less than 1/3 of all of the recessed portions 128, there are cases where an attachment suppression effect cannot be stably obtained.

[0108]

FIG. 7 is a schematic diagram showing a recessed portion 128 provided on the upper surface 124 of the carrier 104 in FIG. 6, and its periphery. FIG. 7(a) is a schematic diagram exemplarily showing the region 126 located on the upper surface 124 of the carrier 104. FIG. 7(b) is a cross-sectional view taken along A-A in FIG. 7(a).

[0109]

The region 126 shown in FIG. 7(a) includes a region surrounded by three

holding holes 122a, 122b, and 122c, and is not continuous with these holding holes 122a, 122b, and 122c. As shown in FIG. 7(b), the region 126 is provided with recessed portions 128. An entire periphery 132 of the recessed portion 128 serves as a main surface 134 of the carrier 104. That is, the recessed portion 128 has a pond-like shape or a pocket-like shape, and can store a polishing liquid. Furthermore, as shown in FIG. 7(b), the recessed portions 128 are provided on only the upper surface 124 of the carrier 104, and are not provided on a lower surface 135, but the recessed portions 128 may be provided on both the upper and lower surfaces as long as they do not inhibit the effect of suppressing adsorption on the upper surface plate 108. If the recessed portions 128 are provided on both the upper and lower surfaces, the area and the number of recessed portions 128, a depth L_c (see FIG. 8(b)), a region in which the recessed portions 128 are formed, and the like on each surface need only be adjusted as appropriate.

[0110]

FIG. 8 is a schematic diagram showing an enlarged region B in FIG. 7(a). FIG. 8(a) is a top view showing an enlarged region B. FIG. 8(b) is a cross-sectional view taken along C-C in FIG. 8(a). As shown in FIG. 8(a), a recessed portion 128 is provided in the region 126 located at a position other than the circumferential edges 130 of the holding holes 122. Also, the depth L_c of the recessed portion 128 shown in FIG. 8(b) is set to 0.3 to 30 μm .

[0111]

According to the carrier 104 of the present embodiment, a polishing liquid can be stored in the recessed portion 128 due to formation of the recessed portion 128 in the region 126 on the upper surface 124 of the carrier 104. Accordingly, even when the polishing pad 116 of the upper surface plate 108 and the carrier 104 attempt to come into close contact with each other, the area of close contact between the resins on their surfaces decreases. Thus, the force with which the surface of the carrier 104 adsorbs on the polishing pad 116 decreases and the

carrier 104 has a high attachment (adsorption) prevention effect.

[0112]

Also, the contour that forms the recessed portion 128 formed in the region 126 is preferably constituted by free curves and is formed so as not to be in contact with the gear portions 115 of the carriers 105. Thus, when the surface of the glass substrate 102 is polished, the polishing liquid can be reliably stored in the recessed portion 128, and thus the carrier 104 has a high attachment prevention effect.

[0113]

Also, the area occupied by all of the plurality of recessed portions 128 is preferably 5% or more and 80% or less of the area of the entire surface of the carrier 104. If a percentage of the total area of the recessed portions 128 is less than 5%, there are cases where an attachment prevention effect cannot be stably obtained for a long time due to attachment of a polishing agent or the like to the surface of the carrier 104. On the other hand, if the percentage of the total area of the recessed portions 128 is excessively high, there is a possibility that the carrier 104 will warp and the glass substrate 102, which is a substrate to be polished, will come off from the carrier 104. Thus, the upper limit of the percentage of the area is preferably 80% or less. Note that if the percentage of the area is low, the attachment prevention effect can be improved even with a small area by mainly distributing the recessed portions in the vicinity of the outer circumference of the carrier.

[0114]

Furthermore, at least $1/3$ or more of all of the recessed portions 128 have an area of 1 cm^2 or more and 400 cm^2 or less. If the area of each of the recessed portions 128 is less than 1 cm^2 , there are cases where an attachment prevention effect cannot be sufficiently obtained. Also, the area of each of the recessed portions 128 is more preferably 2 cm^2 or more. On the other hand, if the area of the recessed portions 128 is excessively large, there is a possibility that the carrier

104 will warp and the glass substrate 102 will come off from the carrier 104. Thus, the upper limit of the area of each of the recessed portions 128 is preferably 400 cm² or less.

[0115]

Furthermore, because the depth Lc of the recessed portion 128 shown in FIG. 8(b) is set to 0.3 to 30 μm (see Table 1), the polishing liquid can be sufficiently stored in the recessed portion 128. Thus, it is possible to prevent attachment of the carrier 104 and prevent the glass substrate 102 from coming off from the carrier 104 due to warping of the carrier 104.

[0116]

[Working Examples]

Hereinafter, although working examples of the present invention will be described below, the present invention is not limited to only the working examples below.

[0117]

(Preparation of substrate to be processed)

A substrate to be processed was a nominal 2.5-size (diameter was about 65 mm) magnetic-disk glass substrate, and the substrate that underwent the first polishing processing using a polishing liquid containing cerium oxide abrasive particles using a known method was prepared.

[0118]

(Preparation of carrier for experiment)

A carrier was manufactured through shape processing using a sheet material obtained by weaving glass fibers and impregnating the glass fibers with an epoxy resin. Then, additional processing was performed on one side of the carrier using the above-described method as appropriate such that a plurality of recessed portions having specifications shown in Table 1 were formed.

[0119]

(Experimental conditions)

Second polishing was carried out on the above-described substrate to be processed using the above-described or known method, except for the below. Both surfaces of the substrate to be processed were polished simultaneously using, as a polishing device, the above-described double-side polishing apparatus in which polishing pads were attached to the upper and lower surface plates. The polishing pads were made of a polyurethane resin, and were suede-type having a surface layer including a nap layer provided with many elongated minute holes (nap) that were formed in the thickness direction utilizing a foaming agent. A polishing liquid containing colloidal silica particles having an average particle size (D50) of 30 nm as polishing abrasive particles was used as the polishing agent. Note that with regard to the orientation of the carriers, the carriers were set in the polishing device such that surfaces having the recessed portions were oriented upward.

[0120]

In addition, by setting five carriers that held 10 substrates per carrier in one instance of polishing processing (one batch), both main surfaces of 50 substrates were polished at once. Continuous processing was performed on 20 batches without replacing the carriers while the substrates to be processed were replaced. That is, in each experimental example, the attachment of the carriers to the upper surface plate was checked 100 times in total.

[0121]

Table 3 lists Comparative Example 2 in which a surface of a carrier had no recessed portions, and Working Examples 15 to 21 in which surfaces of carriers had recessed portions and the recessed portions had different heights. Note that in Table 3, "attachment occurrence count ratio" refers to a relative value when that of Comparative Example 2 was "1.0". Also, the recessed portions of the working examples are formed so as not to be in contact with gear portions of the carriers.

Furthermore, with the recessed portions of the embodiments, a percentage of the area occupied by the entire surface of the carrier other than holding holes was 30%, and all of the recessed portions had an area of 1 cm² or more.

[0122]

Furthermore, "Deformation or the like of carrier" in Table 3 refers to the results of observation of surface states such as warping or deformation of the carriers that were removed from the double-side polishing apparatus after 100 batches ended. Note that if a carrier undergoes deformation such as warping and is continuously used, there is a possibility that a substrate will come off from a holding hole during polishing processing, and thus such a carrier is not preferable.

[Table 5]

	Depth of recessed portions (μm)	Attachment occurrence count ratio	Deformation or the like of carrier after 100 batches
Comparative Example 2	no recessed portions	1.0	—
Working Example 23	0.2	0.8	no change
Working Example 24	0.3	0.6	no change
Working Example 25	1	0.5	no change
Working Example 26	5	0.5	no change
Working Example 27	10	0.4	no change
Working Example 28	30	0.4	no change
Working Example 29	50	0.4	warping was confirmed

[0123]

As shown in Table 5, first, the depth of the recessed portions is preferably 0.3 μm or more (Working Examples 23 to 29) because the attachment occurrence count ratio can be reduced. On the other hand, if the depth of the recessed portions exceeded 30 μm (Working Example 29), warping of the carrier was confirmed. Thus, the depth of the recessed portions is preferably 30 μm or less. In this manner, based on the results of Table 5, it was confirmed that the depth of the recessed portions is preferably 0.3 to 30 μm.

[0124]

Therefore, according to the carrier 104 of the present embodiment and the method for manufacturing the glass substrate 102 using the carrier 104, attachment (adsorption) can be prevented by the plurality of recessed portions 128 provided in the regions 126 on the upper surface 124 of the carrier 104. Moreover, because it is possible to prevent the glass substrate 102 from coming off from the carrier 104 due to warping of the carrier 104 during polishing processing, the productivity does not decrease and a high-quality glass substrate 102 can be obtained at a higher yield than with a conventional method.

[0125]

Although preferred embodiments of the present invention have been described above with reference to the attached drawings, the present invention is, needless to say, not limited to the above-described examples. It is apparent that a person skilled in the art may conceive various variations and modifications within the scope of the appended patent claims, and those variations and modifications should be understood to be naturally encompassed in the technical scope of the present invention.

Industrial Applicability

[0126]

The present invention can be utilized as a carrier that is to be used when a main surface of a plate-shaped substrate such as a substrate for a magnetic recording medium, glass for a liquid crystal screen, or a silicon wafer is polished, and a method for manufacturing a substrate using this carrier.

List of Reference Numerals

[0127]

100 Double-side polishing apparatus

102	Glass substrate
104	Carrier
106	Carrier mounting portion
108	Upper surface plate
110	Lower surface plate
112	Internal gear
114	Sun gear
115	Gear portion
116, 118, 146	Polishing pad
120	Supply pipe
122, 122a, 122b, 122c	Holding hole
124	Upper surface of carrier
126	Region
128	Recessed portion
130	Circumferential edge of holding hole
132	Entire periphery of recessed portion
134	Main surface of carrier
135	Lower surface of carrier
136	Protrusion
138	Etching agent
142	Grinder
144	Front end of grinder
150	Glass fiber
152	Stitch
154	Protruding portion

CLAIMS

1. A carrier for polishing or grinding having a holding hole for holding a substrate,

wherein the carrier is made of a material obtained by weaving glass fibers and impregnating the glass fibers with resin;

wherein a plurality of protrusions are present in at least one portion of a region of at least one surface of the carrier, and

wherein a part of the glass fibers is exposed at at least part of surfaces of the protrusions.

2. The carrier according to claim 1, wherein the protrusions have a height of 2 μm or more.

3. The carrier according to claim 1 or 2, wherein the protrusions have a width of 50 μm or more.

4. The carrier according to any one of claims 1 to 3, wherein the protrusions have a circular arc shape protruding upward.

5. The carrier according to any one of claims 1 to 4, wherein the protrusions are formed approximately regularly in stitches of the glass fibers.

6. The carrier according to any one of claims 1 to 5, wherein the protrusions are present away from a periphery of the holding hole by a predetermined width.

7. The carrier according to any one of claims 1 to 6, wherein the protrusions are provided in a plurality of regions that are located apart from each other.

8. The carrier according to any one of claims 1 to 7, wherein the protrusions are formed in recessed portions formed on the surface of the carrier.

9. A method for manufacturing a substrate, comprising processing in which a substrate is held in a holding hole of the carrier according to any one of

claims 1 to 8, the substrate is sandwiched between an upper surface plate and a lower surface plate that each include a polishing pad or a grinding pad, and both surfaces of the substrate are polished or ground simultaneously.

10. The method for manufacturing a substrate according to claim 9, wherein the substrate is a magnetic-disk substrate.