DESCRIPTION

[Title of Invention]

MAGNETIC-DISK SUBSTRATE AND MAGNETIC DISK

[Technical Field]

[0001] The present invention relates to a magnetic-disk substrate and a magnetic disk.

[Background Art]

[0002] Nowadays, in order to record data, hard disk drives (HDDs) are incorporated in personal computers, DVD (digital versatile disc) recording devices, and the like. A magnetic disk obtained by providing a magnetic layer on a substrate is used in a hard disk drive, and magnetic recording information is recorded in or read from the magnetic layer with a magnetic head that flies slightly away from the surface of the magnetic disk.

[0003] In order to form the magnetic layer on the substrate, the edge surface of the substrate is held by being sandwiched between claw-like jigs at three to four locations, the substrate is then transported to a film formation room and thin films such as a magnetic layer and a protecting layer are formed on a main surface of the substrate with a vapor deposition method such as a vacuum deposition method, a sputtering method, a CVD method, or an IBD method.

There is a risk that the substrate will generate dust or crack due to minute fragments occurring as a result of rubbing of an edge surface thereof when the substrate is sandwiched or transported, and thus chamfering is performed on the outer circumferential edge portion of the substrate. For example, Patent Literature 1 discloses that an angle formed between the main surface of the substrate and a chamfered surface is set to at least 48 degrees and not more than 80 degrees.

[Citation List]

[Patent Literature]

[0004] [PLT1]: JP H11-265506A

[Summary of Invention]

[Technical Problem]

[0005] When the outer circumferential edge portion of a substrate whose outer circumferential portion had been chamfered was held by a jig, and processing for forming a film such as a magnetic film was performed to produce a magnetic disk, foreign matter was detected on the main surface in the vicinity of a portion in contact with the jig.

[0006] In view of this, an object of the present invention is to provide a magnetic-disk substrate according to which no foreign matter remains on the main surface on which a film has been formed.

[Solution to Problem]

[0007] When on a magnetic-disk substrate, foreign matter that was detected in the vicinity of the portion in contact with a claw-like sandwiching jig (a holding jig) used at the time of film formation was analyzed, it was confirmed that components of the foreign matter were the components of the film composition, which were formed when a magnetic layer or the like was formed. When the jig was thoroughly observed because a portion of the foreign matter had a layered structure, it was confirmed that a portion of the components of the film composition that were deposited on the surface of the jig were separated from a portion abutting against the substrate. It is thought that a magnetic film or the like deposited on the jig was scraped off when the substrate came into contact with the jig, and the separated film attached (transferred) to the vicinity of the main surface of the substrate as foreign matter. It is thought that the above-described phenomenon is caused by the fact that in recent years, a transportation speed has been on the increase for the improvement of the production efficiency, and in order to prevent the substrate from falling at the time of transportation, the force with which the substrate is sandwiched by the sandwiching jig has been increased or the tip of the holding jig has been formed into a V-shape.

Also, a defect in which marks are scattered radially with the portion of contact with the jig as the origin on the main surface of the magnetic disk was observed. When analyzed in detail, the defect was a mixture of metal components of a magnetic film, an interlayer, and the like used in the magnetic disk. It was found that this was caused by arc discharge at a point of contact between the holding jig and the magnetic disk due to a bias voltage applied to the substrate when a protecting film made of diamond like carbon (DLC) is formed with a plasma CVD method or an ion beam deposition (IBD) method. Nowadays, although the above-described film formation methods are mainly used to reduce the thickness of the protecting film, it is inferred that the bias voltage tends to be high in order to obtain a denser film.

In this manner, the conventional substrate has had various problems in some cases when its chamfered portion comes into contact with the holding jig.

In the production of magnetic disks, a plurality of holding jigs are used in one film formation apparatus, many substrates that are introduced are held and transported to the film formation room in succession, and a film is then formed. Strictly speaking, at this time, there are cases where the holding jigs do not all have the same shape and have slightly different shapes. Also, because the holding jigs are used repeatedly, their surface states change according to the amount of time from the start of film formation. For example, as the amount of components of the film composition that are deposited on the surface of the jig increases over time, the film composition becomes easier to separate as foreign matter when the jig comes into contact with the substrate. These complicated factors cause variation in the position of contact with the holding jig or foreign matter that separates, for each substrate. The inventor of the present invention found that if the contact point is located in the vicinity of a main surface of the substrate, the above-described problem is prominent, and improving the shape of the edge portion makes it possible to eliminate random variation of the position of contact and to reduce the above-described problem.

[0008] In order to resolve the above-described issues, a first aspect of the present invention is a magnetic-disk substrate, including:

a first inclined surface that is connected to an outer outline of a main surface of the substrate;

a second inclined surface that connects the first inclined surface and a side wall surface of the substrate; and

a ridge line that is formed by the first inclined surface and the second inclined surface, in which

the ridge line is provided inward of the main surface in a thickness direction of the substrate.

[0009] It is preferable that when an obtuse angle formed between the main surface and the first inclined surface is θ_1, 130 degrees$\leq\theta_1\leq$170 degrees is satisfied.

It is preferable that when an obtuse angle formed between the first inclined surface and the second inclined surface is θ_3, 110 degrees$\leq\theta_4\leq$170 degrees is satisfied.

It is preferable that when an obtuse angle formed between the second inclined surface and the side wall surface of the substrate is θ_4, 130 degrees$\leq\theta_3\leq$170 degrees is satisfied.

[0010] It is preferable that a distance in a radial direction from an outer outline of the main surface to the ridge line is at least 10 μm.

[0011] It is preferable that a distance of the ridge line from the main surface in the thickness direction of the substrate is at least 10 μm.

[0012] Another aspect of the present invention is a magnetic-disk substrate including:

a main surface;

a side wall surface orthogonal to the main surface; and

a chamfered surface that has two linear portions that connect the main surface and the side wall surface in a cross-section orthogonal to the main surface and the side wall surface, in which

a border between the two linear portions forms a shape that protrudes outward on a surface of the substrate.

[0013] Another aspect of the present invention is a magnetic disk in which

at least a magnetic layer is provided on the main surface of any of the above-described magnetic-disk substrates.

[Advantageous Effects of the Invention]

[0014] A substrate of the present invention abuts against a jig at a ridge line formed by a two-step chamfered surface having a first inclined surface and a second inclined surface. Even if a substance is separated from a portion at which the ridge line and the jig abut against each other, unless the flight distance of the separated substance exceeds the distance from the ridge line to the outer outline of the main surface, the separated substance does not reach the main surface due to the first inclined surface being between the ridge line and the main surface, and the attachment of the separated substance to the main surface can be prevented. On the other hand, even if the flight distance of the separated substance exceeds the distance from the ridge line to the outer outline of the main surface, the ridge line is provided inward of the main surface in the thickness direction of the substrate and the first inclined surface is inclined with respect to the main surface, and thus the main surface is not present in a pathway on which the separated substance will fall or in a direction in which the separated substance moves, whereby the attachment of the separated substance to the main surfaces can be prevented.

[Brief Description of Drawings]

[0015] FIG. 1 is a side view of a magnetic-disk substrate of this embodiment.

FIG. 2 is an enlarged view of a II portion of FIG. 1.

FIG. 3 is an enlarged view of a portion at which the magnetic-disk substrate abuts against a jig.

FIG. 4 is an enlarged view similar to FIG. 2 of a magnetic-disk substrate of Comparative Example 2.

[Description of Embodiments]

[0016] Hereinafter, a magnetic-disk substrate according to an embodiment of the present invention will be described in detail.

The magnetic-disk substrate has a disk shape, and a central hole having a circle concentric with the outer circumference is hollowed out so that the substrate has a ring shape. A magnetic disk is formed by forming magnetic layers (recording regions) in annular regions of both surfaces of the magnetic-disk substrate. A metal substrate (an aluminum alloy substrate or an aluminum alloy substrate plated with a NiP-based alloy) or a glass substrate can be used as the magnetic-disk substrate. In particular, a glass substrate that is less likely to undergo plastic deformation compared to a metal substrate or the like is suitably used. Although glass is used as a magnetic-disk substrate in the following description, the magnetic-disk substrate may be a metal substrate.

[0017] FIG. 1 is a side view of a substrate according to an embodiment of the present invention, and FIG. 2 is an enlarged view of a II portion of FIG. 1.

A portion of an edge surface of a substrate 1 of the present embodiment that is connected to a main surface is provided with a two-step chamfered surface. That is, the substrate 1 has a main surface 10 and an edge surface 20, and the edge surface 20 has a side surface 21, a first inclined surface 22, and a second inclined surface 23. As shown in FIG. 2, in the cross-section orthogonal to the main surface 10 and the side wall surface 21, the chamfered surface has two linear portions (the first inclined surface 22 and the second inclined surface 23) that connect the main surface 10 and the side wall surface 21.

[0018] As shown in FIG. 2, the first inclined surface 22 is connected to an outline C (outer outline) on the outside in the radial direction of the main surface 10. That is, the outline C is a border line (border) between the main surface 10 and the first inclined surface 22. The first inclined surface 22 has a portion that is linear in the cross-section orthogonal to the main surface 10 and the side wall surface 21.

The second inclined surface 23 connects the first inclined surface 22 and

the side wall surface 21. The second inclined surface 23 has a portion that is linear in the cross-section orthogonal to the main surface 10 and the side wall surface 21.

The first inclined surface 22 and the second inclined surface 23 form an annular ridge line E. The ridge line E is a connection portion that connects the first inclined surface 22 and the second inclined surface 23, and is a border between the first inclined surface 22 and the second inclined surface 23. The ridge line E is provided inward of the main surface 10 in the thickness direction of the substrate 1. The ridge line E forms a shape that protrudes outward on a surface of the substrate 1.

[0019] The substrate 1 is held by a jig 30 (see FIG. 3) at the edge surface 20 when a magnetic layer is formed. FIG. 3 is an enlarged view showing a portion at which the substrate 1 and the jig 30 abut against each other when a magnetic layer is formed. As shown in FIG. 3, the substrate 1 abuts against the jig 30 at the ridge line E. Even if foreign matter attached to the jig 30 is separated from the portion at which the substrate 1 and the jig 30 abut against each other and a separated substance is formed, unless the flight distance of the separated substance exceeds the distance from the ridge line E to the outer outline C of the main surface 10, the separated substance does not reach the main surface 10 due to the first inclined surface 22 being between the ridge line E and the main surface 10. This makes it possible to prevent the attachment of the separated substance to the main surface 10. On the other hand, even if the flight distance of the separated substance exceeds the distance from the ridge line E to the outer outline C of the main surface 10, the ridge line E is provided inward of the main surface 10 in the thickness direction of the substrate 1 and the first inclined surface 22 is inclined with respect to the main surface 10, and thus the main surface 10 is not present on the trajectory of the separated substance, making it possible to prevent the attachment of the separated substance to the main surface 10.

Note that as shown in FIG. 4, if a chamfered portion between the main

surface 10 and the side wall surface 21 has a rounded shape, a point of contact between the substrate and the jig can be located at any position on the chamfered portion due to variation in the relative positions of the substrate and the jig, and thus the point of contact between the chamfered portion and the sandwiching jig is located in the vicinity of the main surface 10 in some cases. If the point of contact between the chamfered portion and the jig is located in the vicinity of the main surface 10, there is a risk that with this point of contact as the origin, foreign matter will attach to the main surface of a magnetic-disk substrate to be manufactured, or a defect will form.

In contrast, in the present embodiment, even if there is variation in the relative positions of the substrate 1 and the jig 30, the point of contact between the substrate 1 and the jig 30 is always located at the ridge line E. Therefore, the point of contact between the substrate 1 and the jig 30 can be sufficiently set apart from the main surface 10, and the attachment of foreign matter to the main surface 10 and the formation of defects thereon can be suppressed.

[0020] It is preferable that when an obtuse angle formed between the main surface 10 and the first inclined surface 22 is θ_1, 130 degrees$\leq\theta_1\leq$170 degrees is satisfied.

If $\theta_1<$110 degrees is satisfied, it becomes difficult for the substrate 1 to be held by the jig 30 at the ridge line E. If the substrate 1 is not held at the ridge line E and is held at the first inclined surface 22 or the outer outline C of the main surface 10, in the case where foreign matter attached to the jig 30 is separated from the portion abutting against the jig 30 and a separated substance forms, there is a risk that the separated substance will reach the main surface 10.

On the other hand, if $\theta_1>$170 degrees is satisfied, the trajectory of the substance separated from the ridge line E at which the substrate 1 and the jig 30 abut against each other cannot be sufficiently set apart from the main surface 10, and there is a risk that the separated substance will attach to the main surface 10.

Here, the first inclined surface 22 is provided along the outer outline C of the circular main surface 10, and has the shape of a side surface of a truncated cone whose central axis coincides with the central axis of the substrate 10, the main surface 10 being the upper bottom thereof and a plane including the ridge line E being the lower bottom thereof. The obtuse angle θ_1 is an obtuse angle formed between the generating line of the side surface of this truncated cone and the main surface 10. That is, the obtuse angle θ_1 is an angle formed between the first inclined surface 22 and the main surface 10 in the cross-section in the radial direction of the substrate 1 (the plane including the central axis of the substrate 1).

[0021] When the obtuse angle formed between the main surface 10 and the second inclined surface 23 is θ_2, $\theta_2<\theta_1$ is satisfied. If $\theta_2\geq\theta_1$ is satisfied, the ridge line E is not formed.

Here, the second inclined surface 23 has the shape of a side surface of a truncated cone whose central axis coincides with the central axis of the substrate 10, the plane including the ridge line E being the upper bottom thereof and a plane including a ridge line F formed between the second inclined surface 23 and the side wall surface 21 being the lower bottom thereof. The obtuse angle θ_2 is an obtuse angle formed between the generating line of the side surface of this truncated cone and the main surface 10. That is, the obtuse angle θ_2 is an angle formed between the second inclined surface 23 and the main surface 10 in the cross-section in the radial direction of the substrate 1 (the plane including the central axis).

[0022] It is preferable that when the obtuse angle formed between the first inclined surface 22 and the second inclined surface 23 is θ_3, 110 degrees$\leq\theta_3\leq$170 degrees is satisfied. If $\theta_3<$110 degrees is satisfied, there is a risk that the substrate 1 will crack when the substrate 1 is held by the jig 30 at the ridge line E. On the other hand, if $\theta_3>$170 degrees is satisfied, there is a risk that it will be difficult for the substrate 1 to be held by the jig 30 at the ridge line E.

Here, θ_3 is an obtuse angle formed between the generating line of the

side surface of the truncated cone that forms the first inclined surface 22 and the generating line of the side surface of the truncated cone that forms the second inclined surface 23. That is, the obtuse angle θ_3 is an angle formed between the first inclined surface 22 and the second inclined surface 23 in the cross-section in the radial direction of the substrate 1 (the plane including the central axis of the substrate 1). At this time, $\theta_3+\theta_1-\theta_2=180$ degrees is satisfied.

[0023] It is preferable that when an obtuse angle formed between the second inclined surface 23 and the side wall surface 21 is θ_4, 130 degrees$\leq\theta_4\leq$170 degrees is satisfied. If $\theta_4<130$ degrees is satisfied, there is a risk that it will be difficult for the substrate 1 to be held by the jig 30 at the ridge line E. On the other hand, if $\theta_4>170$ degrees is satisfied, there is a risk that the substrate 1 will crack when the substrate 1 is held by the jig 30 at the ridge line E.

Here, θ_4 is an obtuse angle formed between the generating line of the side surface of the truncated cone that forms the second inclined surface 23 and the side wall surface 21. That is, the obtuse angle θ_4 is an angle formed between the second inclined surface 23 and the side wall surface 21 in the cross-section in the radial direction of the substrate 1 (the plane including the central axis of the substrate 1). At this time, $\theta_1+\theta_3+\theta_4=450$ degrees is satisfied.

[0024] A distance W (see FIG. 2) in the radial direction of the substrate 1 from the outer outline C of the main surface 10 to the ridge line E is preferably at least 10 μm. If W is less than 10 μm, there is a risk that the effect of preventing the attachment of a separated substance to the main surface 10 will be reduced.

[0025] Also, a distance H (see FIG. 2) of the ridge line E from the main surface 10 in the thickness direction of the substrate 1 is preferably at least 10 μm. If H is less than 10 μm, there is a risk that the effect of preventing the attachment of a separated substance to the main surface 10 will be reduced.

[0026] Next, a method for manufacturing a magnetic-disk substrate according to an embodiment of the present invention will be described in detail.

[0027] Method for manufacturing magnetic-disk glass substrate

Next, a method for manufacturing a magnetic-disk glass substrate that

is an example of the magnetic-disk substrate will be described. First, a glass blank for a magnetic disk, which serves as a raw material for a plate-shaped magnetic-disk glass substrate having a pair of main surfaces is produced by press molding (press molding processing). Here, a glass blank for a magnetic disk (hereinafter simply referred to as a glass blank) is a circular glass plate produced by press molding, and is in a form in which the central hole is not yet hollowed out.

[0028] Next, a circular hole is created in a central portion of the produced glass blank, and a ring-shaped (annular) glass substrate is produced (circular hole formation processing). Next, shape processing is performed on the glass substrate in which the circular hole is formed (shape processing). In this shape processing, the above-described first inclined surface 22 and the second inclined surface 23 are formed by performing two-step chamfering processing. Accordingly, the glass substrate is produced.

[0029] Shape processing

In the shape processing of the present embodiment, the two-step chamfering processing is performed on the edge portion of the glass substrate that has undergone the circular hole formation processing. Accordingly, the side wall surface 21 orthogonal to the main surface 10 and a two-step chamfered surface (the first inclined surface 22 and the second inclined surface 23) that connects the main surface 10 and the side wall surface 21 are formed on the edge surface of the glass substrate.

For example, after the second inclined surface 23 is formed in first chamfering processing, the outer outline C of the main surface 10 and the ridge line E are formed by changing the angle in second chamfering processing so as to form the first inclined surface 22.

Also, after the first inclined surface 22 is formed in first chamfering processing, the second inclined surface 23 may be formed by changing the angle in second chamfering processing.

[0030] Processing after shape processing

Next, edge surface polishing is performed on the glass substrate that has undergone shape processing (edge surface polishing processing). Grinding is performed with fixed abrasive particles on the glass substrate on which edge surface polishing has been performed (grinding processing). Next, first polishing is performed on the main surfaces of the glass substrate (first polishing processing). Next, chemical strengthening is performed on the glass substrate (chemical strengthening processing). Next, second polishing is performed on the chemically strengthened glass substrate (second polishing processing). A magnetic-disk glass substrate can be obtained through the above-described processing.

[0031] Since various processes are performed after shape processing in this manner, the ridge line E of the obtained magnetic-disk substrate may have a roundness having a radius of curvature of not more than 50 μm in the cross-sectional shape, for example. If the radius of curvature is greater than 50 μm, there are cases where there is variation in the position at which the magnetic-disk substrate is sandwiched by the sandwiching jig. The radius of curvature of the ridge line E is preferably not more than 20 μm. Even if the ridge line E has a roundness to this extent, the effect of preventing the attachment of the separated substance to the main surfaces 10 can be sufficiently obtained. Also, the radius of curvature of the ridge line E is preferably at least 1 μm and is more preferably at least 5 μm. If the radius of curvature of the ridge line E is smaller than 1 μm, there is a possibility that the substrate will crack when sandwiched.

[0032] As described above, according to the substrate 1 of the present embodiment, since the substrate 1 abuts against the jig 30 at the ridge line E, even if a separated substance is formed at a portion at which the substrate 1 abuts against the jig 30, unless the flight distance of the separated substance exceeds the distance from the ridge line E to the outer outline C of the main surface 10, the separated substance does not reach the main surface 10 due to the first inclined surface 22 being between the ridge line E and the main surface 10, and thus the attachment of the separated substance to the main surface 10

can be prevented. On the other hand, even if the flight distance of the separated substance exceeds the distance from the ridge line E to the outer outline C of the main surface 10, the ridge line E is provided inward of the main surface 10 in the thickness direction of the substrate 1 and the first inclined surface 22 is inclined with respect to the main surface 10, and thus the main surface 10 is not present on the trajectory of the separated substance, making it possible to prevent the attachment of the separated substance to the main surface 10.

[0033] Note that the present invention is not limited to the above-described embodiment and working examples, and it will be appreciated that various improvements and modifications can be made without departing from the gist of the present invention.

Hereinafter, experimental examples according to the present invention will be described.

[0034] Working Examples

In Working Examples 1 to 9, two-step chamfering processing was performed on substrates to manufacture substrates. In Working Examples 1 to 9, substrates were manufactured by changing θ_1, θ_2, θ_3, and θ_4 as shown in Table 1. The obtained substrates were held by a jig as shown in FIG. 3, and a base layer, a magnetic layer, and a protecting layer were formed in sequence using a film formation apparatus provided with a plurality of vacuum chambers. Note that the base layer and the magnetic layer were formed with a sputtering method, and the protecting layer made of DLC was formed by a plasma CVD method while applying a bias to the substrate. 10000 magnetic disks were manufactured in each working example.

Comparative Example

In Comparative Example 1, only an inclined surface in which a chamfering angle with respect to the main surface was θ_2 and an angle with respect to the side wall surface was θ_4 was formed by first chamfering processing.

In Comparative Example 2, as shown in FIG. 4, chamfering processing

was performed on the substrate using a formed grindstone that was formed such that the chamfered portion had a rounded shape with a radius of curvature R of 150 μm in the cross-sectional shape.

[0035] Measurement of foreign matter and defects

The number of substrates on which foreign matter (specific foreign matter) caused by a film deposited on the holding jig being separated or radial defects (specific defects) caused by arc discharge were observed was measured by inspecting the main surfaces of the substrates on which the base layers, the magnetic layers, and the protecting layers were formed, using a laser surface defect inspection apparatus, and by checking the foreign matter and defects detected on the main surfaces of the magnetic disks in detail by eyesight or with a SEM.

The results are shown in Table 1.

[0036] [Table 1]

	Work. Ex. 1	Work. Ex. 2	Work. Ex. 3	Work. Ex. 4	Work. Ex. 5	Work. Ex. 6	Work. Ex. 7	Work. Ex. 8	Work. Ex. 9	Comp. Ex. 1	Comp. Ex. 2
θ_1 (degrees)	145	145	155	160	160	160	171	125	130	-	-
θ_2 (degrees)	125	135	135	133	131	111	110	110	106	135	-
θ_3 (degrees)	160	170	160	153	151	131	119	165	156	-	-
θ_4 (degrees)	145	135	135	138	141	160	160	160	164	135	-
W (μm)	60	60	60	8	13	37	68	29	33	-	-
H (μm)	42	42	28	3	5	14	11	42	40	-	-
Number of substrates having specific foreign matter or defects	18	20	23	42	40	25	39	45	30	55	51

[0037] In Working Examples 1 to 9, the number of pieces of foreign matter was reduced compared to Comparative Examples 1 and 2.

In Comparative Example 1, it is conceivable that the substrate and the sandwiching jig came into contact with each other at the border between the main surface and the chamfered surface, and foreign matter attached to the main surface with this contact point as the origin, or a defect formed.

In Comparative Example 2, the number of substrates having foreign

matter or defects was significantly higher than in the working examples. If the chamfered portion has a rounded shape as in Comparative Example 2, the point of contact between the substrate and the sandwiching jig can be located at any position on the chamfered portion, and thus there are cases where the point of contact between the chamfered portion and the sandwiching jig is located in the vicinity of the main surface 10 due to variation in the relative positions of the substrate and the sandwiching jig. Thus, it is conceivable that defects were formed on or foreign matter attached to a main surface of the magnetic-disk substrate in which the point of contact between the chamfered portion and the sandwiching jig is located in the vicinity of the main surface 10, with the contact point as the origin.

In contrast, in Working Examples 1 to 9, even if there was variation in the relative positions of the substrate and the sandwiching jig, the point of contact between the chamfered portion and the sandwiching jig and the main surface were set apart from each other at a sufficient distance due to the contact point being always located at the position of the ridge line E, and the attachment of foreign matter and the formation of defects was suppressed.

CLAIMS

1. A magnetic-disk substrate comprising:

a first inclined surface that is formed outward of a main surface of a substrate;

a second inclined surface that connects the first inclined surface and a side wall surface of the substrate; and

a ridge line that is formed by the first inclined surface and the second inclined surface, wherein

the ridge line is provided inward of the main surface in a thickness direction of the substrate , wherein

when an obtuse angle formed between the main surface and the first inclined surface is θ1, 130 degrees≤θ1≤170 degrees is satisfied.

2. A magnetic-disk substrate comprising:

a first inclined surface that is formed outward of a main surface of a substrate;

a second inclined surface that connects the first inclined surface and a side wall surface of the substrate; and

a ridge line that is formed by the first inclined surface and the second inclined surface, wherein

the ridge line is provided inward of the main surface in a thickness direction of the substrate, and

when an obtuse angle formed between the first inclined surface and the second inclined surface is θ_3, 110 degrees≤θ_3≤170 degrees is satisfied.

3. The magnetic-disk substrate according to claims 1 or 2, wherein

when an obtuse angle formed between the second inclined surface and a side wall surface of the substrate is θ_4, 130 degrees≤θ_4≤170 degrees is satisfied.

4. The magnetic-disk substrate according to any one of claims 1 to 3, wherein

a distance in a radial direction from an outer outline of the main surface to the ridge line is at least 10 μm.

5. The magnetic-disk substrate according to any one of claims 1 to 4, wherein

a distance of the ridge line from the main surface in the thickness direction of the substrate is at least 10 μm.

6. A magnetic-disk substrate comprising:

a main surface;

a side wall surface orthogonal to the main surface; and

a chamfered surface that has two linear portions that connect the main surface and the side wall surface in a cross-section orthogonal to the main surface and the side wall surface, wherein

a border between the two linear portions forms a shape that protrudes outward on a surface of the substrate, wherein

when an obtuse angle formed between the main surface and a first liner portion of the two linear portions, the first portion connecting the main surface, is θ_1, 130 degrees$\leq\theta_1\leq$170 degrees is satisfied.

7. A magnetic-disk substrate comprising:

a main surface;

a side wall surface orthogonal to the main surface; and

a chamfered surface that has two linear portions that connect the main surface and the side wall surface in a cross-section orthogonal to the main surface and the side wall surface, wherein

a border between the two linear portions forms a shape that protrudes outward on a surface of the substrate, wherein

when an obtuse angle formed between the two linear portions is θ_3, 110 degrees$\leq\theta_3\leq$170 degrees is satisfied.

8. A magnetic disk in which at least a magnetic layer is provided on the main surface of the magnetic-disk substrate according to any one of claims 1 to 7.