

WHAT IS CLAIMED IS:

1. A glass substrate for a magnetic disk with an inside hole formed therein, wherein:
a value of S_k calculated from a shape profile over a whole circumference of the inside hole is in a range of 0.55 to -0.55, and

S_k is given by

$$S_k = \sum_{i=1}^n \frac{R_i^3}{n\sigma^3} \quad \dots(1)$$

where n is the number of samples, R_i is an i th difference between the shape profile and a least-square-approximated circle of the shape profile on a line drawn to the least-square-approximated circle of the shape profile from a center of a circle calculated by a least-square approximation of the shape profile over the whole circumference of the inside hole, and σ is a standard deviation.

2. A glass substrate for a magnetic disk with an inside hole formed therein, wherein:
a value ($K_u - 3$) obtained by subtracting 3 from K_u calculated from a shape profile over a whole circumference of the inside hole is in a range of 1.6 to -1.6, and

K_u is given by

$$K_u = \sum_{i=1}^n \frac{R_i^4}{n\sigma^4} \quad \dots(2)$$

where n is the number of samples, R_i is an i th difference between the shape profile and a least-square-approximated circle of the shape profile on a line drawn to the least-square-approximated circle of the shape profile from a center of a circle calculated by a least-square approximation of the shape profile of the inside hole, and σ is a standard deviation.

3. The glass substrate for a magnetic disk as recited in claim 1,

wherein a value $(K_u - 3)$ obtained by subtracting 3 from K_u calculated from the shape profile over the whole circumference of the inside hole is in a range of 1.6 to -1.6, and

K_u is given by

$$K_u = \sum_{i=1}^n \frac{R_i^4}{n\sigma^4} \quad \dots(3)$$

where n is the number of samples, R_i is an i th difference between the shape profile and a least-square-approximated circle of the shape profile on a line drawn to the least-square-approximated circle of the shape profile from a center of a circle calculated by a least-square approximation of the shape profile of the inside hole, and σ is a standard deviation.

4. The glass substrate for a magnetic disk as recited in any one of claims 1 to 3, wherein a circularity is 5.5 μm or less.

5. The glass substrate for a magnetic disk as recited in any one of claims 1 to 4, wherein the glass substrate is used for a magnetic disk having a storage capacity of at least 80 GBytes per one 2.5-inch disk.

6. The glass substrate for a magnetic disk as recited in any one of claims 1 to 5, wherein a value of AC calculated by using a value of Sk_{ID} calculated from the shape profile over the whole circumference of the inside hole, a value of Sk_{OD} calculated from a shape profile of an outer circumference of the glass substrate for a magnetic disk, and a value of a concentricity C is 9.6 μm or less,

AC is given by

$$AC = C \left(1 + \frac{Sk_{OD}}{Sk_{ID}} \right) \quad \dots(4)$$

Sk_{ID} is given by

$$Sk_{ID} = \sum_{i=1}^n \frac{R_i^3}{n\sigma^3} \quad \dots(5)$$

where n is the number of samples, R_i is an i th difference between the shape profile and a least-square-approximated circle of the shape profile on a line drawn to the least-square-approximated circle of the shape profile from a center of a circle calculated by a least-square approximation of the shape profile over the whole circumference of the inside hole, and σ is a standard deviation, and

Sk_{OD} is given by

$$Sk_{OD} = \sum_{i=1}^n \frac{R_i^3}{n\sigma^3} \quad \dots(6)$$

where n is the number of samples, R_i is an i th difference between the shape profile and a least-square-approximated circle of the shape profile on a line drawn to the least-square-approximated circle of the shape profile with the smallest value of the shape profile from a center of a circle calculated by a least-square approximation of the shape profile of the outer circumference, and σ is a standard deviation.

7. The glass substrate for a magnetic disk as recited in any one of claims 1 to 6, wherein an M-value calculated from a relationship between a radial position from a center of the glass substrate for a magnetic disk and a thickness at that radial position is within $20 \times 10^6 \text{ mm}^3$, and the M-value is given by

$$M = \sum_{i=0}^n r_i^2 \Delta t_i \quad \dots(7)$$

$$\Delta t_i = t_i - t_0 \quad \dots(8)$$

where n is the number of samples, r_i is a radius of a measurement point, t_i is a thickness at the measurement point, and t_0 is a thickness at an initial

measurement point (thickness of an inner circumferential edge).

8. A magnetic recording medium comprising:

the glass substrate for a magnetic disk as recited in any one of claims 1 to 7; and

an underlayer, a magnetic layer, a protective layer, and a lubricating layer provided on a main surface of the glass substrate.

9. A glass substrate for a magnetic disk with an inside hole formed therein, wherein a value of AC calculated by using a value of Sk_{ID} calculated from a shape profile over a whole circumference of the inside hole, a value of Sk_{OD} calculated from a shape profile of an outer circumference of the glass substrate for a magnetic disk, and a value of a concentricity C is 9.6 μm or less, and AC is given by

$$AC = C \left(1 + \frac{Sk_{OD}}{Sk_{ID}} \right) \quad \dots(1)$$

Sk_{ID} is given by

$$Sk_{ID} = \sum_{i=1}^n \frac{R_i^3}{n\sigma^3} \quad \dots(2)$$

where n is the number of samples, R_i is an i th difference between the shape profile and a least-square-approximated circle of the shape profile on a line drawn to the least-square-approximated circle of the shape profile from a center of a circle calculated by a least-square approximation of the shape profile over the whole circumference of the inside hole, and σ is a standard deviation, and

Sk_{OD} is given by

$$Sk_{OD} = \sum_{i=1}^n \frac{R_i^3}{n\sigma^3} \quad \dots(3)$$

where n is the number of samples, R_i is an i th difference between the shape profile and a least-square-approximated circle of the shape profile on a line

drawn to the least-square-approximated circle of the shape profile with the smallest value of the shape profile from a center of a circle calculated by a least-square approximation of the shape profile of the outer circumference, and σ is a standard deviation.

10. The glass substrate for a magnetic disk as recited in claim 9, wherein an M-value calculated from a relationship between a radial position from a center of the glass substrate for a magnetic disk and a thickness at that radial position is within $20 \times 10^6 \text{ mm}^3$, and the M-value is given by

$$M = \sum_{i=0}^n r_i^2 \Delta t_i \quad \dots(4)$$

$$\Delta t_i = t_i - t_0 \quad \dots(5)$$

where n is the number of samples, r_i is a radius of a measurement point, t_i is a thickness at the measurement point, and t_0 is a thickness at an initial measurement point (thickness of an inner circumferential edge).

11. The glass substrate for a magnetic disk as recited in claim 9 or 10, wherein the concentricity C is $7 \text{ } \mu\text{m}$ or less.

12. The glass substrate for a magnetic disk as recited in any one of claims 9 to 11, wherein the glass substrate is used for a magnetic disk having a storage capacity of at least 80 GBytes per one 2.5-inch disk.

13. A magnetic recording medium comprising:

the glass substrate for a magnetic disk as recited in any one of claims 9 to 12; and

an underlayer, a magnetic layer, a protective layer, and a lubricating layer provided on a main surface of the glass substrate.

14. A glass substrate for a magnetic disk with an inside hole, wherein an M-value calculated from a relationship between a radial position from a

center of the glass substrate for a magnetic disk and a thickness at that radial position is within $20 \times 10^6 \text{ mm}^3$, and the M-value is given by

$$M = \sum_{i=0}^n r_i^2 \Delta t_i \quad \dots(1)$$

$$\Delta t_i = t_i - t_0 \quad \dots(2)$$

where n is the number of samples, r_i is a radius of a measurement point, t_i is a thickness at the measurement point, and t_0 is a thickness at an initial measurement point (thickness of an inner circumferential edge).

15. The glass substrate for a magnetic disk as recited in claim 14, wherein the glass substrate is used for a magnetic disk having a storage capacity of at least 80 GBytes per one 2.5-inch disk.

16. A magnetic recording medium comprising:
the glass substrate for a magnetic disk as recited in claim 14 or 15; and
an underlayer, a magnetic layer, a protective layer, and a lubricating layer provided on a main surface of the glass substrate.

What is claimed is:

[Claim 1]

A glass substrate for a magnetic disk with an inside hole formed therein,
wherein:

the inside hole has a circularity of $5.5\ \mu\text{m}$ or less; and

a value of S_k calculated from a shape profile over a whole circumference
of the inside hole and given by the following formula (A) is in a range of 0.55 to
-0.55.

[EQ1]

$$S_k = \sum_{i=1}^{n_{Sk}} \frac{R_i^3}{n_{Sk} \sigma^3} \quad \dots (A)$$

In the above formula (A), n_{Sk} is the number of samples, R_i is an i th
difference between the shape profile and a least-square-approximated circle of
the shape profile on a line drawn to the least-square-approximated circle of the
shape profile from a center of the circle calculated by a least-square
approximation of the shape profile over the whole circumference of the inside
hole, and σ is a standard deviation.

[Claim 2]

A glass substrate for a magnetic disk with an inside hole formed therein,
wherein:

the inside hole has a circularity of $5.5\ \mu\text{m}$ or less; and

a value (Ku-3) obtained by subtracting 3 from Ku calculated from a
shape profile over a whole circumference of the inside hole and given by the
following formula (B) is in a range of 1.6 to -1.6.

[EQ2]

$$K_u = \sum_{i=1}^{n_{Ku}} \frac{R_i^4}{n_{Ku} \sigma^4} \quad \dots(B)$$

In the formula (B), n_{Ku} is the number of samples, R_i is an i th difference between the shape profile and a least-square-approximated circle of the shape profile on a line drawn to the least-square-approximated circle of the shape profile from a center of the circle calculated by a least-square approximation of the shape profile of the inside hole, and σ is a standard deviation.

[Claim 3]

The glass substrate for a magnetic disk as recited in claim 1, wherein a value (Ku-3) obtained by subtracting 3 from Ku calculated from the shape profile over the whole circumference of the inside hole and given by the following formula (B) is in a range of 1.6 to -1.6.

[EQ3]

$$K_u = \sum_{i=1}^{n_{Ku}} \frac{R_i^4}{n_{Ku} \sigma^4} \quad \dots(B)$$

In the formula (B), n_{Sk} is the number of samples, R_i is an i th difference between the shape profile and a least-square-approximated circle of the shape profile on a line drawn to the least-square-approximated circle of the shape profile from a center of the circle calculated by a least-square approximation of the shape profile of the inside hole, and σ is a standard deviation.

[Claim 4]

The glass substrate for a magnetic disk as recited in any one of claims 1 to 3, wherein the glass substrate is used for a magnetic disk having a storage capacity of at least 80 GBytes per one 2.5-inch disk.

[Claim 5]

The glass substrate for a magnetic disk as recited in any one of claims 1 to 4, wherein a value of AC which is calculated by using a value of Sk_{ID} calculated from the shape profile over the whole circumference of the inside

hole and shown in the following formula (C), a value of Sk_{OD} calculated from a shape profile of an outer circumference of the glass substrate for a magnetic disk and shown in the following formula (C), and a value of a concentricity C and which is given by the following formula (C) is $9.6 \mu\text{m}$ or less,

[EQ4]

$$AC = C \left(1 + \frac{Sk_{OD}}{Sk_{ID}} \right) \quad \dots (C)$$

The value of Sk_{ID} shown in the formula (C) is calculated by the formula (D) and the value of Sk_{OD} shown in the formula (C) is calculated by the formula (E).

[EQ5]

$$Sk_{ID} = \sum_{i=1}^{n_{ID}} \frac{R_i^3}{n_{ID} \sigma^3} \quad \dots (D)$$

In the formula (D), n_{ID} is the number of samples, R_i is an i th difference between the shape profile and a least-square-approximated circle of the shape profile on a line drawn to the least-square-approximated circle of the shape profile from a center of the circle calculated by a least-square approximation of the shape profile over the whole circumference of the inside hole, and σ is a standard deviation.

[EQ6]

$$Sk_{OD} = \sum_{i=1}^{n_{OD}} \frac{R_i^3}{n_{OD} \sigma^3} \quad \dots (E)$$

In the formula (E), n_{OD} is the number of samples, R_i is an i th difference between the shape profile and a least-square-approximated circle of the shape profile on a line drawn to the least-square-approximated circle of the shape profile from a center of the circle calculated by a least-square approximation of the shape profile of the outer circumference, and σ is a standard deviation.

[Claim 6]

A magnetic recording medium comprising:

the glass substrate for a magnetic disk as recited in any one of claims 1 to 5; and

an underlayer, a magnetic layer, a protective layer, and a lubricating layer provided on a main surface of the glass substrate.

[Claim 7]

A glass substrate for a magnetic disk with an inside hole formed therein, wherein:

the inside hole has a circularity of $5.5 \mu\text{m}$ or less; and

a value of AC which is calculated by using a value of Sk_{ID} calculated from a shape profile over a whole circumference of the inside hole and shown in the following formula (C), a value of Sk_{OD} calculated from a shape profile of an outer circumference of the glass substrate for a magnetic disk and shown in the following formula (C), and a value of a concentricity C and which is given by the following formula (C) is $9.6 \mu\text{m}$ or less.

[EQ7]

$$AC = C \left(1 + \frac{Sk_{OD}}{Sk_{ID}} \right) \quad \dots (C)$$

The value of Sk_{ID} shown in the formula (C) is calculated by the formula (D) and the value of Sk_{OD} shown in the formula (C) is calculated by the formula (E).

[EQ8]

$$Sk_{ID} = \sum_{i=1}^{n_{ID}} \frac{R_i^3}{n_{ID} \sigma^3} \quad \dots (D)$$

In the formula (D), n_{ID} is the number of samples, R_i is an i th difference between the shape profile and a least-square-approximated circle of the shape

profile on a line drawn to the least-square-approximated circle of the shape profile from a center of the circle calculated by a least-square approximation of the shape profile over the whole circumference of the inside hole, and σ is a standard deviation.

[EQ9]

$$S k_{\infty} = \sum_{i=1}^{n_{OD}} \frac{R_i^3}{n_{OD} \sigma^3} \quad \dots (E)$$

In the formula (E), n_{OD} is the number of samples, R_i is an i th difference between the shape profile and a least-square-approximated circle of the shape profile on a line drawn to the least-square-approximated circle of the shape profile from a center of the circle calculated by a least-square approximation of the shape profile of the outer circumference, and σ is a standard deviation.

[Claim 8]

The glass substrate for a magnetic disk as recited in claim 7, wherein the concentricity C is $7 \mu\text{m}$ or less.

[Claim 9]

The glass substrate for a magnetic disk as recited in claim 7 or 8, wherein the glass substrate is used for a magnetic disk having a storage capacity of at least 80 GBytes per one 2.5-inch disk.

[Claim 10]

A magnetic recording medium comprising:

the glass substrate for a magnetic disk as recited in any one of claims 7 to 9; and

an underlayer, a magnetic layer, a protective layer, and a lubricating layer provided on a main surface of the glass substrate.