Claims

1. A manufacturing method of a glass substrate for a magnetic disk including a chemical reinforcement treatment step of immersing a disk-shaped glass substrate with a circular hole formed at a center portion thereof in a chemical reinforcement treatment solution, causing ion exchange for replacing relatively small ions contained in a surface of the glass substrate with relatively large ions contained in the chemical reinforcement treatment solution, and thereby creating a compressive stress layer in the surface of the glass substrate,

wherein the chemical reinforcement treatment is performed so that a deformation amount of the circular hole formed at the center portion of the disk-shaped glass substrate is within 0.05% of the diameter of the circular hole, and that the transverse strength of the disk-shaped glass substrate is 98 N or more, and

wherein glass forming the disk-shaped glass substrate with the circular hole formed at the center portion contains in expression of percent by mass:

SiO_2 57 to 75%;

Al_2O_3 5 to 20%;

(where the total amount of $SiO_2+Al_2O_3$ is 74% or more)

the total of ZrO_2, HfO_2, Nb_2O_5, Ta_2O_5, La_2O_3, Y_2O_3, and TiO_2 exceeding 0% to 6% or less;

(where the amount of ZrO_2 is 5.5% or less)

Li_2O exceeding 1% to 9% or less;

Na_2O 5 to 18%;

(where the mass ratio Li_2O/Na_2O is 0.5 or less)

K_2O 0 to 6%;

MgO 0 to 4%;

CaO exceeding 0% to 5% or less;

(where the total amount of MgO and CaO is 5% or less, and the content of CaO is higher than the content of MgO) and

SrO+BaO 0 to 3%.

2. A manufacturing method of a glass substrate for a magnetic disk, the glass substrate being a disk-shaped glass substrate for a magnetic disk, and having a circular hole at a center portion thereof,

wherein when diameters of circular holes of 500 to 1000 glass substrates that are arbitrarily selected are measured and an average diameter of the circular holes of the glass substrates is A, a rate (%) of glass substrates of which each circular-hole diameters depart from a range of $\pm 5 \times 10^{-4} \times A$ relative to A to all measured glass

substrates is 4 % or less, the transverse strength of each of the glass substrates is 98 N or more, and control is thus performed, and

wherein glass forming the disk-shaped glass substrate with the circular hole formed at the center portion contains in expression of percent by mass:

SiO_2 57 to 75%;

Al_2O_3 5 to 20%;

(where the total amount of $SiO_2+Al_2O_3$ is 74% or more)

the total of ZrO_2, HfO_2, Nb_2O_5, Ta_2O_5, La_2O_3, Y_2O_3, and TiO_2 exceeding 0% to 6% or less;

(where the amount of ZrO_2 is 5.5% or less)

Li_2O exceeding 1% to 9% or less;

Na_2O 5 to 18%;

(where the mass ratio Li_2O/Na_2O is 0.5 or less)

K_2O 0 to 6%;

MgO 0 to 4%;

CaO exceeding 0% to 5% or less;

(where the total amount of MgO and CaO is 5% or less, and the content of CaO is higher than the content of MgO) and

SrO+BaO 0 to 3%.

3. The manufacturing method of a glass substrate for a magnetic disk according to claim 2, wherein the control is performed as a chemical reinforcement treatment.

4. A manufacturing method of a glass substrate for a magnetic disk including a chemical reinforcement treatment step of immersing a disk-shaped glass substrate with a circular hole formed at a center portion thereof in a chemical reinforcement treatment solution, causing ion exchange for replacing relatively small ions contained in a surface of the glass substrate with relatively large ions contained in the chemical reinforcement treatment solution, and thereby creating a compressive stress layer in the surface of the glass substrate,

wherein the chemical reinforcement treatment is performed by selecting a glass material of the disk-shaped glass substrate and treatment conditions of the chemical reinforcement treatment so that a deformation amount of the circular hole formed at the center portion of the disk-shaped glass substrate is within 0.05% of the diameter of the circular hole, and that the transverse strength of the disk-shaped glass substrate is 98 N or more, and

wherein glass forming the disk-shaped glass substrate with the circular hole formed at the center portion contains in expression of percent by mass:

SiO_2 57 to 75%;
Al_2O_3 5 to 20%;
(where the total amount of $SiO_2+Al_2O_3$ is 74% or more)
the total of ZrO_2, HfO_2, Nb_2O_5, Ta_2O_5, La_2O_3, Y_2O_3, and TiO_2 exceeding 0% to 6% or less;
(where the amount of ZrO_2 is 5.5% or less)
Li_2O exceeding 1% to 9% or less;
Na_2O 5 to 18%;
(where the mass ratio Li_2O/Na_2O is 0.5 or less)
K_2O 0 to 6%;
MgO 0 to 4%;
CaO exceeding 0% to 5% or less;
(where the total amount of MgO and CaO is 5% or less, and the content of CaO is higher than the content of MgO) and
SrO+BaO 0 to 3%.

5. A manufacturing method of a glass substrate for a magnetic disk including a chemical reinforcement treatment step of immersing a disk-shaped glass substrate with a circular hole formed at a center portion thereof in a chemical reinforcement treatment solution, causing ion exchange for replacing relatively small ions contained in a surface of the glass substrate with relatively large ions contained in the chemical reinforcement treatment solution, and thereby creating a compressive stress layer in the surface of the glass substrate,

wherein a deformation amount due to the chemical reinforcement treatment of the circular hole formed at the center portion of the disk-shaped glass substrate is beforehand grasped for each glass, a glass material is selected so that the deformation amount is within 0.05% of the diameter of the circular hole, and that the transverse strength of the disk-shaped glass substrate due to the chemical reinforcement treatment is 98 N or more, the selected glass material is processed in disk form, while the circular hole is formed at the center portion, and the chemical reinforcement treatment is performed, and

wherein glass forming the disk-shaped glass substrate with the circular hole formed at the center portion contains in expression of percent by mass:
SiO_2 57 to 75%;
Al_2O_3 5 to 20%;
(where the total amount of $SiO_2+Al_2O_3$ is 74% or more)
the total of ZrO_2, HfO_2, Nb_2O_5, Ta_2O_5, La_2O_3, Y_2O_3, and TiO_2 exceeding 0% to 6% or less;

(where the amount of ZrO_2 is 5.5% or less)
Li_2O exceeding 1% to 9% or less;
Na_2O 5 to 18%;
(where the mass ratio Li_2O/Na_2O is 0.5 or less)
K_2O 0 to 6%;
MgO 0 to 4%;
CaO exceeding 0% to 5% or less;
(where the total amount of MgO and CaO is 5% or less, and the content of CaO is higher than the content of MgO) and
SrO+BaO 0 to 3%.

6. The manufacturing method of a glass substrate for a magnetic disk according to any one of claims 1, 3 to 5, wherein the chemical reinforcement treatment is performed using the chemical reinforcement treatment solution having a composition with 60 percent to 80 percent by mass KNO_3 and 40 percent to 20 percent by mass $NaNO_3$ (where 100 percent by mass in total) at a temperature ranging from 350°C to 420°C.

7. The manufacturing method of a glass substrate for a magnetic disk according to any one of claims 1, 3 to 6, wherein a thickness of the compressive stress layer in the disk-shaped glass substrate subjected to the chemical reinforcement treatment ranges from 10 μm to 150 μm.

8. The manufacturing method of a glass substrate for a magnetic disk according to any one of claims 1, 3 to 6, wherein a thickness of the compressive stress layer in the disk-shaped glass substrate subjected to the chemical reinforcement treatment ranges from 100 μm to 150 μm.

9. The manufacturing method of a glass substrate for a magnetic disk according to claim 1, 4 or 5, wherein the glass substrate for a magnetic disk is a 2.5-inch substrate, and the diameter of the circular hole of each glass substrate is within A±10 μm.

10. The manufacturing method of a glass substrate for a magnetic disk according to any one of claims 1 to 9, wherein the glass substrate supports a magnetic disk in which a track density of information to record is at least 100-gigabit TPI.

11. The manufacturing method of a glass substrate for a magnetic disk according to any one of claims 1 to 10, wherein the glass substrate supports a perpendicular magnetic recording system.

Claims

1. A manufacturing method of a glass substrate for a magnetic disk including a chemical reinforcement treatment step of immersing a disk-shaped glass substrate with a circular hole formed at a center portion thereof in a chemical reinforcement treatment solution, causing ion exchange for replacing relatively small ions contained in a surface of the glass substrate with relatively large ions contained in the chemical reinforcement treatment solution, and thereby creating a compressive stress layer in the surface of the glass substrate,

wherein the chemical reinforcement treatment is performed so that a deformation amount of the circular hole formed at the center portion of the disk-shaped glass substrate is within 0.05% of the diameter of the circular hole, and that the transverse strength of the disk-shaped glass substrate is 98 N or more, and

wherein glass forming the disk-shaped glass substrate with the circular hole formed at the center portion contains in expression of percent by mass:

SiO_2 57 to 75%;

Al_2O_3 5 to 20%;

where the total amount of SiO_2+Al_2O_3 is 74% or more ;

the total of ZrO_2, HfO_2, Nb_2O_5, Ta_2O_5, La_2O_3, Y_2O_3, and TiO_2 exceeding 0% to 6% or less; where the amount of ZrO_2 is 5.5% or less ;

Li_2O exceeding 1% to 9% or less;

Na_2O 5 to 18%;

where the mass ratio Li_2O/Na_2O is 0.5 or less ;

K_2O 0 to 6%;

MgO 0 to 4%;

CaO exceeding 0% to 5% or less;

where the total amount of MgO and CaO is 5% or less, and the content of CaO is higher than the content of MgO ; and

SrO+BaO 0 to 3%.

2. A manufacturing method of a glass substrate for a magnetic disk, the glass substrate being a disk-shaped glass substrate for a magnetic disk, and having a circular hole at a center portion thereof,

wherein when diameters of circular holes of 500 to 1000 glass substrates that are arbitrarily selected are measured and an average diameter of the circular holes of the glass substrates is A, a rate (%) of glass substrates of which each circular-hole diameters depart from a range of $\pm 5 \times 10^{-4} \times A$ relative to A to all measured glass substrates is 4 % or less, the transverse strength of each of the glass substrates is 98 N or more, and control is thus performed, and

wherein glass forming the disk-shaped glass substrate with the circular hole formed at the center portion contains in expression of percent by mass:

SiO_2 57 to 75%;

Al_2O_3 5 to 20%;

where the total amount of $SiO_2+Al_2O_3$ is 74% or more ;

the total of ZrO_2, HfO_2, Nb_2O_5, Ta_2O_5, La_2O_3, Y_2O_3, and TiO_2 exceeding 0% to 6% or less;

where the amount of ZrO_2 is 5.5% or less ;

Li_2O exceeding 1% to 9% or less;

Na_2O 5 to 18%;

where the mass ratio Li_2O/Na_2O is 0.5 or less ;

K_2O 0 to 6%;

MgO 0 to 4%;

CaO exceeding 0% to 5% or less;

where the total amount of MgO and CaO is 5% or less, and the content of CaO is higher than the content of MgO ; and

SrO+BaO 0 to 3%.

3. The manufacturing method of a glass substrate for a magnetic disk according to claim 2, wherein the control is performed as a chemical reinforcement treatment.

4. A manufacturing method of a glass substrate for a magnetic disk including a chemical reinforcement treatment step of immersing a disk-shaped glass substrate with a circular hole formed at a center portion thereof in a chemical reinforcement treatment solution, causing ion exchange for replacing relatively small ions contained in a surface of the glass substrate with relatively large ions

contained in the chemical reinforcement treatment solution, and thereby creating a compressive stress layer in the surface of the glass substrate,

wherein the chemical reinforcement treatment is performed by selecting a glass material of the disk-shaped glass substrate and treatment conditions of the chemical reinforcement treatment so that a deformation amount of the circular hole formed at the center portion of the disk-shaped glass substrate is within 0.05% of the diameter of the circular hole, and that the transverse strength of the disk-shaped glass substrate is 98 N or more, and

wherein glass forming the disk-shaped glass substrate with the circular hole formed at the center portion contains in expression of percent by mass:

SiO_2 57 to 75%;

Al_2O_3 5 to 20%;

where the total amount of SiO_2+Al_2O_3 is 74% or more ;

the total of ZrO_2, HfO_2, Nb_2O_5, Ta_2O_5, La_2O_3, Y_2O_3, and TiO_2 exceeding 0% to 6% or less;

where the amount of ZrO_2 is 5.5% or less ;

Li_2O exceeding 1% to 9% or less;

Na_2O 5 to 18%;

where the mass ratio Li_2O/Na_2O is 0.5 or less ;

K_2O 0 to 6%;

MgO 0 to 4%;

CaO exceeding 0% to 5% or less;

where the total amount of MgO and CaO is 5% or less, and the content of CaO is higher than the content of MgO ; and

SrO+BaO 0 to 3%.

5. A manufacturing method of a glass substrate for a magnetic disk including a chemical reinforcement treatment step of immersing a disk-shaped glass substrate with a circular hole formed at a center portion thereof in a chemical reinforcement treatment solution, causing ion exchange for replacing relatively small ions contained in a surface of the glass substrate with relatively large ions contained in the chemical reinforcement treatment solution, and thereby creating a compressive stress layer in the surface of the glass substrate,

wherein a deformation amount due to the chemical reinforcement treatment of the circular hole formed at the center portion of the disk-shaped glass substrate is beforehand grasped for each glass, a glass material is selected so that the deformation amount is within 0.05% of the diameter of the circular hole, and that the transverse strength of the disk-shaped glass substrate due to the chemical reinforcement treatment is 98 N or more, the selected glass material is processed in disk form, while the circular hole is formed at the center portion, and the chemical reinforcement treatment is performed, and

wherein glass forming the disk-shaped glass substrate with the circular hole formed at the center portion contains in expression of percent by mass:

SiO_2 57 to 75%;

Al_2O_3 5 to 20%;

where the total amount of SiO_2+Al_2O_3 is 74% or more ;

the total of ZrO_2, HfO_2, Nb_2O_5, Ta_2O_5, La_2O_3, Y_2O_3, and TiO_2 exceeding 0% to 6% or less;

where the amount of ZrO_2 is 5.5% or less ;

Li_2O exceeding 1% to 9% or less;

Na_2O 5 to 18%;

where the mass ratio Li_2O/Na_2O is 0.5 or less ;

K_2O 0 to 6%;

MgO 0 to 4%;

CaO exceeding 0% to 5% or less;

where the total amount of MgO and CaO is 5% or less, and the content of CaO is higher than the content of MgO ; and

SrO+BaO 0 to 3%.

6. The manufacturing method of a glass substrate for a magnetic disk according to any one of claims 1, 3 to 5, wherein the chemical reinforcement treatment is performed using the chemical reinforcement treatment solution having a composition with 60 percent to 80 percent by mass KNO_3 and 40 percent to 20 percent by mass $NaNO_3$, wherein the total mass of KNO_3 and $NaNO_3$ is 100 percent, at a temperature ranging from 350°C to 420°C.

7. The manufacturing method of a glass substrate for a magnetic disk according to any one of claims 1, 3 to 6, wherein a thickness of the compressive stress layer in the disk-shaped glass substrate subjected to the chemical reinforcement treatment ranges from 10 μm to 150 μm.

8. The manufacturing method of a glass substrate for a magnetic disk according to any one of claims 1, 3 to 6, wherein a thickness of the compressive stress layer in the disk-shaped glass substrate subjected to the chemical reinforcement treatment ranges from 100 μm to 150 μm.

9. The manufacturing method of a glass substrate for a magnetic disk according to claim 1, 4 or 5, wherein the glass substrate for a magnetic disk is a 2.5-inch substrate, and the diameter of the circular hole of each glass substrate is within A±10 μm.

10. The manufacturing method of a glass substrate for a magnetic disk according to any one of claims 1 to 9, wherein the glass substrate supports a magnetic disk in which a track density of information to record is at least 100-gigabit TPI.

11. The manufacturing method of a glass substrate for a magnetic disk according to any one of claims 1 to 10, wherein the glass substrate supports a perpendicular magnetic recording system.