CLAIMS

1. Glass for a magnetic recording medium substrate, which comprises:

essential components in the form of SiO_2, Li_2O, Na_2O, and one or more alkaline earth metal oxides selected from the group consisting of MgO, CaO, SrO, and BaO;

wherein a molar ratio of a content of MgO to a combined content of MgO, CaO, SrO, and BaO (MgO/(MgO + CaO + SrO + BaO)) is equal to or greater than 0.80; and which has a Young's modulus of equal to or greater than 80 GPa, and a glass transition temperature of equal to or greater than 620°C.

2. Glass for a magnetic recording medium substrate, which comprises:

essential components in the form of SiO_2, Li_2O and Na_2O, and one or more alkaline earth metal oxides selected from the group consisting of MgO, CaO, SrO, and BaO;

wherein a molar ratio of a content of CaO to a combined content of MgO, CaO, SrO, and BaO (CaO/(MgO + CaO + SrO + BaO)) is equal to or less than 0.20; and which has a Young's modulus of equal to or greater than 80 GPa, and a glass transition temperature of equal to or greater than 620°C.

3. The glass for a magnetic recording medium substrate according to claim 1 or 2, which has an average coefficient of linear expansion at 100 to 300°C of equal to or greater than 70×10^{-7}/°C.

4. Glass for a magnetic recording medium substrate, which comprises:

essential components in the form of SiO_2, Li_2O, Na_2O, and one or more alkaline earth metal oxides selected from the group consisting of MgO, CaO, SrO, and BaO;

wherein a molar ratio of a content of MgO to a combined content of MgO, CaO, SrO, and BaO (MgO/(MgO + CaO + SrO + BaO)) is equal to or greater than 0.80; and which has an average coefficient of linear expansion at 100 to 300°C of equal to or greater than 70×10^{-7}/°C, and a glass transition temperature of equal to or greater than 620°C.

5. Glass for a magnetic recording medium substrate, which comprises:

essential components in the form of SiO_2, Li_2O, Na_2O, and one or more alkaline earth metal oxides selected from the group consisting of MgO, CaO, SrO, and BaO;

wherein a molar ratio of a content of CaO to a combined content of MgO, CaO, SrO, and BaO (CaO/(MgO + CaO + SrO + BaO)) is equal to or less than 0.20; and which has an average coefficient of linear expansion at 100 to 300°C of equal to or greater than 70 x 10^{-7}/°C, and a glass transition temperature of equal to or greater than 620°C.

6. The glass for a magnetic recording medium substrate according to claim 4 or 5, which has a Young's modulus of equal to or greater than 80 GPa.

7. The glass for a magnetic recording medium substrate according to any of claims 1 to 6, which has a specific modulus of elasticity of equal to or greater than 30 MNm/kg.

8. The glass for a magnetic recording medium substrate according to any of claims 1 to 7, which is glass for chemical strengthening.

9. A magnetic recording medium substrate, which is comprised of the glass for a magnetic recording medium substrate according to any of claims 1 to 8.

10. A magnetic recording medium substrate, which is comprised of chemically strengthened glass that has been prepared by chemically strengthening the glass for a magnetic recording medium substrate according to any of claims 1 to 8.

11. The magnetic recording medium substrate according to claim 9 or 10, which is comprised of glass having a fracture toughness value of equal to or greater than 0.9 MPa·$m^{1/2}$.

12. The magnetic recording medium substrate according to claim 10, which is comprised of chemically strengthened glass in which a tensile stress distribution is convex in shape such that the convex shape does not contain indentations indenting to a compressive stress side in a stress profile in a virtual cross section perpendicular to two main surfaces as obtained by the Babinet method.

13. The magnetic recording medium substrate according to claim 10, which is comprised of chemically strengthened glass in which an average value Tav of a tensile stress obtained by the Babinet method and a maximum value Tmax of the tensile stress satisfy the following expression (1):

$$Tav/Tmax \geq 0.5.$$

14. The magnetic recording medium substrate according to any of claims 9 to 13, which is glass that has been chemically strengthened by immersion into a salt melt comprising sodium salt and potassium salt.

15. The magnetic recording medium substrate according to claim 14, which is glass that has been chemically strengthened by immersing glass which comprises equal to or greater than 0.1 mole percent of Li_2O into the salt melt.

16. The magnetic recording medium substrate according to any of claims 9 to 15, wherein an arithmetic average roughness (Ra) of a main surface of the magnetic recording medium substrate as measured at a resolution of 512 x 256 pixels for a 1 μm square by an atomic force microscope is equal to or less than 0.15 nm.

17. The magnetic recording medium substrate according to any of claims 9 to 16, which is a substrate for use in a magnetic recording medium employed in a magnetic recording apparatus in which a rate of rotation is equal to or greater than 5,000 rpm.

18. The magnetic recording medium substrate according to any of claims 9 to 17, which is a substrate for use in a magnetic recording medium employed in a magnetic recording apparatus in which a DFH (dynamic flying height) head has been mounted.

19. The magnetic recording medium substrate according to any of claims 9 to 18, which is employed in an energy-assisted magnetic recording-use magnetic recording medium.

20. A magnetic recording medium substrate blank, which is comprised of the glass for a magnetic recording medium substrate according to any of claims 1 to 8.

21. The magnetic recording medium substrate blank, which is disk-shaped.

22. A method of manufacturing a magnetic recording medium substrate, which comprises processing the magnetic recording medium substrate blank according to claim 20 or 21.

23. The method of manufacturing a magnetic recording medium substrate according to claim 22, which comprises a step of chemically strengthening glass by immersing the glass in a salt melt comprising sodium salt and potassium salt.

24. The method of manufacturing a magnetic recording medium substrate according to claim 23, wherein glass comprising equal to or more than 0.1 mole percent of Li_2O is chemically strengthened by immersion in the salt melt.

25. The method of manufacturing a magnetic recording medium substrate according to claim 23 or 24, wherein the chemical strengthening is conducted so as to yield chemically strengthened glass in which an average value Tav of a tensile stress and a

maximum value Tmax of the tensile stress obtained by the Babinet method satisfy the following expression (1):

$Tav/Tmax \geq 0.5$.

26. The method of manufacturing a magnetic recording medium substrate according to claim 23 or 24, wherein the chemical strengthening is conducted so as to yield chemically strengthened glass in which a tensile stress distribution is convex in shape such that the convex shape does not contain indentations indenting to a compressive stress side in a stress profile in a virtual cross section perpendicular to two main surfaces as obtained by the Babinet method.

27. A magnetic recording medium, which comprises a magnetic recording layer on the magnetic recording medium substrate according to any of claims 9 to 19.

28. The magnetic recording medium according to claim 27, wherein the magnetic recording layer comprises a magnetic material the principal components of which are an alloy of Fe and/or Co, and Pt, and the magnetic recording medium is an energy-assisted magnetic recording-use magnetic recording medium.

29. A method of manufacturing a magnetic recording medium, which comprises forming a film of a magnetic material the principal components of which are an alloy of Fe and/or Co, and Pt on a main surface of the magnetic recording medium substrate according to any of claims 9 to 19, and then conducting an annealing treatment to form a magnetic recording layer.

30. A magnetic recording apparatus of energy-assisted magnetic recording system, which comprises:

a heat-assisted magnetic recording head having a heat source to heat at least a main surface of a magnetic recording medium, a recording element member, and a reproduction element member; and

the magnetic recording medium according to claim 27 or 28.

31. The magnetic recording apparatus of energy-assisted magnetic recording system according to claim 30, wherein a rate of rotation of the magnetic recording medium is equal to or greater than 5,000 rpm.

32. The magnetic recording apparatus of energy-assisted magnetic recording system according to claim 30 or 31, wherein a DFH (dynamic flying height) head is mounted

CLAIMS

1. Glass for a magnetic recording medium substrate, which comprises:

essential components in the form of SiO_2, Li_2O, Na_2O, and one or more alkaline earth metal oxides selected from the group consisting of MgO, CaO, SrO, and BaO;

wherein a molar ratio of a content of MgO to a combined content of MgO, CaO, SrO, and BaO (MgO/(MgO+CaO+SrO+BaO)) is equal to or greater than 0.80; and which has a Young's modulus of equal to or greater than 80 GPa, and a glass transition temperature of equal to or greater than 620° C., and

wherein an average coefficient of linear expansion at 100 to 300° C. is equal to or greater than 70×10^{-7}/° C.

2. Glass for a magnetic recording medium substrate, which comprises:

essential components in the form of SiO_2, Li_2O and Na_2O, and one or more alkaline earth metal oxides selected from the group consisting of MgO, CaO, SrO, and BaO;

wherein a molar ratio of a content of CaO to a combined content of MgO, CaO, SrO, and BaO (CaO/(MgO+CaO+SrO+BaO)) is equal to or less than 0.20; and which has a Young's modulus of equal to or greater than 80 GPa, and a glass transition temperature of equal to or greater than 620° C., and

wherein an average coefficient of linear expansion at 100 to 300° C. is equal to or greater than 70×10^{-7}/° C.

3. Glass for a magnetic recording medium substrate, which comprises:

essential components in the form of SiO_2, Li_2O, Na_2O, and one or more alkaline earth metal oxides selected from the group consisting of MgO, CaO, SrO, and BaO;

wherein a molar ratio of a content of MgO to a combined content of MgO, CaO, SrO, and BaO (MgO/(MgO+CaO+SrO+BaO)) is equal to or greater than 0.80; and

which has an average coefficient of linear expansion at 100 to 300° C. of equal to or greater than 70×10^{-7}/° C., and a glass transition temperature of equal to or greater than 620° C., and

wherein a specific modulus of elasticity is equal to or greater than 30 MNm/kg.

4. Glass for a magnetic recording medium substrate, which comprises:

essential components in the form of SiO_2, Li_2O, Na_2O, and one or more alkaline earth metal oxides selected from the group consisting of MgO, CaO, SrO, and BaO;

wherein a molar ratio of a content of CaO to a combined content of MgO, CaO, SrO, and BaO (CaO/(MgO+CaO+SrO+BaO)) is equal to or less than 0.20; and which has an average coefficient of linear expansion at 100 to 300° C. of equal to or greater than 70×10^{-7}/° C., and a glass transition temperature of equal to or greater than 620° C., and

wherein a specific modulus of elasticity is equal to or greater than 30 MNm/kg.

5. The glass for a magnetic recording medium substrate according to claim **3**, which has a Young's modulus of equal to or greater than 80 GPa.

6. The glass for a magnetic recording medium substrate according to claim **4**, which has a Young's modulus of equal to or greater than 80 GPa.

7. Glass for a magnetic recording medium substrate, which comprises:

essential components in the form of SiO_2, Li_2O, Na_2O, and one or more alkaline earth metal oxides selected from the group consisting of MgO, CaO, SrO, and BaO;

wherein a molar ratio of a content of MgO to a combined content of MgO, CaO, SrO, and BaO (MgO/(MgO+

CaO+SrO+BaO)) is equal to or greater than 0.80; and which has a Young's modulus of equal to or greater than 80 GPa, and a glass transition temperature of equal to or greater than 620° C., and

wherein a specific modulus of elasticity is equal to or greater than 30 MNm/kg.

8. Glass for a magnetic recording medium substrate, which comprises:

essential components in the form of SiO_2, Li_2O and Na_2O, and one or more alkaline earth metal oxides selected from the group consisting of MgO, CaO, SrO, and BaO;

wherein a molar ratio of a content of CaO to a combined content of MgO, CaO, SrO, and BaO (CaO/(MgO+CaO+SrO+BaO)) is equal to or less than 0.20; and which has a Young's modulus of equal to or greater than 80 GPa, and a glass transition temperature of equal to or greater than 620° C., and

wherein a specific modulus of elasticity is equal to or greater than 30 MNm/kg.

9. A magnetic recording medium substrate, which is comprised of the glass for a magnetic recording medium substrate according to claim **1**.

10. A magnetic recording medium substrate, which is comprised of the glass for a magnetic recording medium substrate according to claim **2**.

11. A magnetic recording medium substrate, which is comprised of the glass for a magnetic recording medium substrate according to claim **3**.

12. A magnetic recording medium substrate, which is comprised of the glass for a magnetic recording medium substrate according to claim **4**.

13. A magnetic recording medium substrate, which is comprised of chemically strengthened glass that has been pre-

pared by chemically strengthening the glass for a magnetic recording medium substrate according to claim **1**.

14. A magnetic recording medium substrate, which is comprised of chemically strengthened glass that has been prepared by chemically strengthening the glass for a magnetic recording medium substrate according to claim **2**.

15. A magnetic recording medium substrate, which is comprised of chemically strengthened glass that has been prepared by chemically strengthening the glass for a magnetic recording medium substrate according to claim **3**.

16. A magnetic recording medium substrate, which is comprised of chemically strengthened glass that has been prepared by chemically strengthening the glass for a magnetic recording medium substrate according to claim **4**.

17. The magnetic recording medium substrate according to claim **9**, which is disk-shaped.

18. The magnetic recording medium substrate according to claim **10**, which is disk-shaped.

19. The magnetic recording medium substrate according to claim **11**, which is disk-shaped.

20. The magnetic recording medium substrate according to claim **12**, which is disk-shaped.

21. The magnetic recording medium substrate according to claim **13**, which is disk-shaped.

22. The magnetic recording medium substrate according to claim **14**, which is disk-shaped.

23. The magnetic recording medium substrate according to claim **15**, which is disk-shaped.

24. The magnetic recording medium substrate according to claim **16**, which is disk-shaped.

25. The magnetic recording medium substrate according to claim **13**, which is comprised of glass having a fracture toughness value of equal to or greater than 0.9 $MPa \cdot m^{1/2}$.

26. The magnetic recording medium substrate according to claim **14**, which is comprised of glass having a fracture toughness value of equal to or greater than 0.9 $MPa \cdot m^{1/2}$.

27. The magnetic recording medium substrate according to claim **15**, which is comprised of glass having a fracture toughness value of equal to or greater than 0.9 $MPa \cdot m^{1/2}$.

28. The magnetic recording medium substrate according to claim **16**, which is comprised of glass having a fracture toughness value of equal to or greater than 0.9 $MPa \cdot m^{1/2}$.

29. The magnetic recording medium substrate according to claim **13**, which is comprised of chemically strengthened glass in which a tensile stress distribution is convex in shape such that the convex shape does not contain indentations indenting to a compressive stress side in a stress profile in a virtual cross section perpendicular to two main surfaces as obtained by the Babinet method.

30. The magnetic recording medium substrate according to claim **14**, which is comprised of chemically strengthened glass in which a tensile stress distribution is convex in shape such that the convex shape does not contain indentations indenting to a compressive stress side in a stress profile in a virtual cross section perpendicular to two main surfaces as obtained by the Babinet method.

31. The magnetic recording medium substrate according to claim **15**, which is comprised of chemically strengthened glass in which a tensile stress distribution is convex in shape such that the convex shape does not contain indentations indenting to a compressive stress side in a stress profile in a virtual cross section perpendicular to two main surfaces as obtained by the Babinet method.

32. The magnetic recording medium substrate according to claim **16**, which is comprised of chemically strengthened glass in which a tensile stress distribution is convex in shape such that the convex shape does not contain indentations indenting to a compressive stress side in a stress profile in a virtual cross section perpendicular to two main surfaces as obtained by the Babinet method.

33. The magnetic recording medium substrate according to claim **13**, which is comprised of chemically strengthened glass in which an average value Tav of a tensile stress obtained by the Babinet method and a maximum value Tmax of the tensile stress satisfy the following expression (1):

$$Tav/Tmax \geq 0.5.$$

34. The magnetic recording medium substrate according to claim **14**, which is comprised of chemically strengthened glass in which an average value Tav of a tensile stress obtained by the Babinet method and a maximum value Tmax of the tensile stress satisfy the following expression (1):

$$Tav/Tmax \geq 0.5.$$

35. The magnetic recording medium substrate according to claim **15**, which is comprised of chemically strengthened glass in which an average value Tav of a tensile stress obtained by the Babinet method and a maximum value Tmax of the tensile stress satisfy the following expression (1):

$$Tav/Tmax \geq 0.5.$$

36. The magnetic recording medium substrate according to claim **16**, which is comprised of chemically strengthened glass in which an average value Tav of a tensile stress obtained by the Babinet method and a maximum value Tmax of the tensile stress satisfy the following expression (1):

$$Tav/Tmax \geq 0.5.$$

37. The magnetic recording medium substrate according to claim **13**, which is glass that has been chemically strengthened by immersion into a salt melt comprising sodium salt and potassium salt.

38. The magnetic recording medium substrate according to claim **14**, which is glass that has been chemically strengthened by immersion into a salt melt comprising sodium salt and potassium salt.

39. The magnetic recording medium substrate according to claim **15**, which is glass that has been chemically strengthened by immersion into a salt melt comprising sodium salt and potassium salt.

40. The magnetic recording medium substrate according to claim **16**, which is glass that has been chemically strengthened by immersion into a salt melt comprising sodium salt and potassium salt.

41. The magnetic recording medium substrate according to claim **37**, which is glass that has been chemically strengthened by immersing glass which comprises equal to or greater than 0.1 mole percent of Li_2O into the salt melt.

42. The magnetic recording medium substrate according to claim **38**, which is glass that has been chemically strengthened by immersing glass which comprises equal to or greater than 0.1 mole percent of Li_2O into the salt melt.

43. The magnetic recording medium substrate according to claim **39**, which is glass that has been chemically strengthened by immersing glass which comprises equal to or greater than 0.1 mole percent of Li_2O into the salt melt.

44. The magnetic recording medium substrate according to claim **40**, which is glass that has been chemically strengthened by immersing glass which comprises equal to or greater than 0.1 mole percent of Li_2O into the salt melt.

45. A magnetic recording medium substrate blank, which is comprised of the glass for a magnetic recording medium substrate according to claim **1**.

46. A magnetic recording medium substrate blank, which is comprised of the glass for a magnetic recording medium substrate according to claim **2**.

47. A magnetic recording medium substrate blank, which is comprised of the glass for a magnetic recording medium substrate according to claim **3**.

48. A magnetic recording medium substrate blank, which is comprised of the glass for a magnetic recording medium substrate according to claim **4**.

49. A magnetic recording medium, which comprises a magnetic recording layer on the magnetic recording medium substrate according to claim **9**.

50. A magnetic recording medium, which comprises a magnetic recording layer on the magnetic recording medium substrate according to claim **10**.

51. A magnetic recording medium, which comprises a magnetic recording layer on the magnetic recording medium substrate according to claim **11**.

52. A magnetic recording medium, which comprises a magnetic recording layer on the magnetic recording medium substrate according to claim **12**.

53. A magnetic recording apparatus of energy-assisted magnetic recording system, which comprises:

a heat-assisted magnetic recording head having a heat source to heat at least a main surface of a magnetic recording medium, a recording element member, and a reproduction element member; and

the magnetic recording medium according to claim **49**.

54. A magnetic recording apparatus of energy-assisted magnetic recording system, which comprises:

a heat-assisted magnetic recording head having a heat source to heat at least a main surface of a magnetic recording medium, a recording element member, and a reproduction element member; and

the magnetic recording medium according to claim **50**.

55. A magnetic recording apparatus of energy-assisted magnetic recording system, which comprises:

a heat-assisted magnetic recording head having a heat source to heat at least a main surface of a magnetic recording medium, a recording element member, and a reproduction element member; and

the magnetic recording medium according to claim **51**.

56. A magnetic recording apparatus of energy-assisted magnetic recording system, which comprises:

a heat-assisted magnetic recording head having a heat source to heat at least a main surface of a magnetic recording medium, a recording element member, and a reproduction element member; and

the magnetic recording medium according to claim **52**.