Glass for Memory Recording Media

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application claims the benefit of priority under 35 U.S.C. § 119 of U.S. Provisional Application Serial No. 63/308130 filed on February 9, 2022 and Netherlands Application No. 2030965 filed on February 16, 2022, the contents of each of which are relied upon and incorporated herein by reference in their entireties.

FIELD

[0002] The present specification generally relates to glass compositions suitable for use as substrate material for electronic devices. More specifically, the present specification is directed to substrate materials for memory recording disks suitable for the Heat Assisted Magnetic Recording (HAMR) process.

BACKGROUND

[0003] The industry is continuously requiring the ability to store more and more data. In order to accommodate this need for increased data storage, the industry is having to make shifts in the way they store data on disks. In order to get around physics barriers, they have moved to a new technology called Heat Assisted Magnetic Recording (HAMR). With this technology, data storage is accomplished by heating up small areas of the magnetic memory material to write the data and rapidly cooling the magnetic memory material to store the data in a more stable phase. The substrate used to support the magnetic memory material in current magnetic disk technology is aluminum. With the transition to HAMR technology, however, aluminum will no longer be a viable substrate because it does not have the ability to function at the temperatures, such as about 700°C or greater, necessary for writing data with the HAMR technology. Therefore, a need exists for new substrate materials, such as glass, that are resistant to high temperatures, have higher rigidity and smooth, flat surfaces, and high resistance to fast cooling and heating (or thermal shock resistance), which, in turn, requires low coefficient of thermal expansion.

SUMMARY

[0004] According to an aspect of the present disclosure, a glass comprises a plurality of components, the glass having a composition of the components comprising greater than or equal to 60.0 mol.% and less than or equal to 75.0 mol.% SiO_2, greater than or equal to 10.0 mol.% and less than or equal to 18.0 mol.% Al_2O_3, greater than or equal to 0.0 mol.% and less than or equal to 10.0 mol.% Li_2O, greater than or equal to 0.0 mol.% and less than or equal to 5.0 mol.% Na_2O, greater than or equal to 0.0 mol.% and less than or equal to 3.8 mol.% B_2O_3, greater than or equal to 0.0 mol.% and less than or equal to 3.0 mol.% P_2O_5, greater than or equal to 0.0 mol.% and less than or

equal to 2.0 mol.% ZnO, greater than or equal to 0.0 mol.% and less than or equal to 0.7 mol.% La_2O_3, greater than or equal to 0.0 at.% and less than or equal to 3.0 at.% F, a sum of CaO + MgO greater than or equal to 5.0 mol.%, a sum of $Li_2O + Na_2O$ greater than or equal to 0.5 mol.% , a sum of Li_2O + MgO greater than or equal to 0.0 mol.% and less than or equal to 10.0 mol.%, a sum of MgO + ZnO greater than or equal to 0.0 mol.% and less than or equal to 10.0 mol.%, a sum of CaO + SrO greater than or equal to 0.0 mol.% and less than or equal to 9.0 mol.%, and a sum of $ZrO_2 + TiO_2 + FeO + Fe_2O_3$ greater than or equal to 0.0 mol.% and less than or equal to 1.5 mol.%, wherein the glass has an aluminum-binding parameter P_{Al} that is greater than or equal to -2.8, a modifier-binding parameter P_{mod} that is less than or equal to 2.8 and an anorthite precipitation parameter P_{anort} that is less than or equal to 10, where P_{Al} is calculated from the glass composition in terms of mol.% of the components according to the Formula (VIII):

$$P_{Al} = R_2O + RO + P_2O_5 + 1.6 * RE_mO_n - Al_2O_3, \quad \text{(VIII)}$$

P_{mod} is calculated from the glass composition in terms of mol.% of the components according to the Formula (VII):

$$P_{mod} = R_2O + RO - Al_2O_3 - P_2O_5 - RE_mO_n, \quad \text{(VII)}$$

P_{anort} is calculated from the glass composition in terms of mol.% of the components according to the Formula (I):

$$P_{anort} = \min(CaO + SrO + 0.5 * BaO + Na_2O + 0.5 * K_2O, Al_2O_3), \quad \text{(I)}$$

where R_2O is a total sum of monovalent metal oxides, RO is a total sum of divalent metal oxides, RE_mO_n is a total sum of rare earth metal oxides in all redox states present, and an asterisk (*) means multiplication.

[0005] According to another aspect of the present disclosure, a glass comprises a plurality of components, the glass having a composition of the components comprising greater than or equal to 60.0 mol.% and less than or equal to 80.0 mol.% SiO_2, greater than or equal to 10.0 mol.% and less than or equal to 18.0 mol.% Al_2O_3, greater than or equal to 0.5 mol.% and less than or equal to 7.5 mol.% Li_2O, greater than or equal to 0.0 mol.% and less than or equal to 0.5 mol.% ZrO_2, greater than or equal to 0.0 mol.% and less than or equal to 3.0 mol.% RE_mO_n, greater than or equal to 0.0 at.% and less than or equal to 0.5 at.% F and optionally comprise one or more components selected from P_2O_5, B_2O_3, MgO, CaO, BaO, ZnO, MnO, Na_2O, K_2O, Fe_2O_3, FeO, Cu_2O, Rb_2O, Ag_2O, Cs_2O, Au_2O, Hg_2O, Tl_2O, BeO, CoO, NiO, CuO, SrO, CdO, SnO, PbO and TiO_2, wherein the composition of the components satisfies the condition: $0.00 \leq \min(RE_mO_n, P_2O_5)$ [mol.%] ≤ 0.30, and wherein the glass has a cristobalite precipitation parameter P_{crist} that is less than or equal to 28, an anorthite

$$P_{spod} = \min(Li_2O, Al_2O_3 - K_2O - 0.5 * Na_2O), \quad (IV)$$

where R_2O is a total sum of monovalent metal oxides, RO is a total sum of divalent metal oxides, RE_mO_n is a total sum of rare earth metal oxides in all redox states present, and an asterisk (*) means multiplication.

[0006] According to one more aspect of the present disclosure, a glass comprises a plurality of components, the glass having a composition of the components comprising greater than or equal to 60.0 mol.% and less than or equal to 75.0 mol.% SiO_2, greater than or equal to 10.5 mol.% and less than or equal to 18.0 mol.% Al_2O_3, greater than or equal to 0.0 mol.% and less than or equal to 10.0 mol.% CaO, greater than or equal to 0.0 mol.% and less than or equal to 7.8 mol.% Li_2O, greater than or equal to 0.0 mol.% and less than or equal to 4.3 mol.% MgO, greater than or equal to 0.0 mol.% and less than or equal to 0.5 mol.% ZrO_2, greater than or equal to 0.0 mol.% and less than or equal to 5.0 mol.% RE_mO_n and optionally comprises one or more components selected from B_2O_3, P_2O_5, TiO_2, SrO, BaO, ZnO, MnO, CuO, Na_2O, K_2O, Cu_2O, Rb_2O, Ag_2O, Cs_2O, Au_2O, Hg_2O, Tl_2O, BeO, FeO, CoO, NiO, CdO, SnO, PbO and Fe_2O_3, wherein the glass has a cristobalite precipitation parameter P_{crist} that is less than or equal to 28, an anorthite precipitation parameter P_{anort} that is less than or equal to 10 and a modifier-binding parameter P_{mod} that is greater than or equal to -3.0 and the glass satisfies the condition: $P_{spm} - (92.5 - 0.05 * P_{160kP}) > 0.000$, where P_{spm} is a specific modulus parameter, calculated from the glass composition in terms of mol.% of the components according to the Formula (X):

$$P_{spm} = 32.10 + 0.47744 * SiO_2 - 1.6506 * Al_2O_3 - 0.11775 * B_2O_3 - 0.30166 * P_2O_5 + 0.20187 * TiO_2 + 0.20219 * ZrO_2 + 0.96268 * MgO + 0.83379 * CaO + 0.53685 * SrO + 0.41218 * BaO + 0.63264 * ZnO + 0.75365 * MnO + 0.62984 * CuO - 1.2496 * Na_2O - 1.5154 * K_2O + 1.4746 * Cu_2O - 0.037941 * Y_2O_3 - 0.75836 * La_2O_3 - 1.8052 * (R_2O + RO - Al_2O_3) - 0.47488 * (SiO_2 - (6 * K_2O + 6 * Na_2O + 4 * Li_2O + 2 * RO)), \quad (X)$$

P_{160kP} is a parameter predicting a temperature at which the glass has a viscosity of 160 kP, calculated from the glass composition in terms of mol.% of the components according to the Formula (XI):

$$P_{160kP} = 1058 + 2.5492 * SiO_2 - 25.725 * Al_2O_3 - 11.327 * B_2O_3 - 10.014 * P_2O_5 - 14.309 * TiO_2 - 11.594 * ZrO_2 + 30.559 * MgO + 29.290 * CaO + 30.592 * SrO + 30.079 * BaO + 23.323 * ZnO + 19.724 * MnO + 11.888 * PbO + 11.462 * CuO + 17.090 * Li_2O + 16.475 * Na_2O + 11.386 * K_2O + 14.422 * Y_2O_3 - 36.909 * La_2O_3 - 34.144 * (Fe_2O_3 + FeO) - 35.001 * (R_2O + RO - Al_2O_3), \quad (XI)$$

P_{crist} is a value of a cristobalite precipitation parameter, calculated from the glass composition in terms of mol.% of the components according to the Formula (VI):

$$P_{crist} = SiO_2 - 6 * (Na_2O + K_2O) - 4 * Li_2O - 2 * (CaO + SrO + BaO) - 2.5 * MgO, \quad (VI)$$