GLASSES THAT REDUCE NON-VISCOUS RELAXION FOR IMPROVED TOTAL PITCH VARIATION

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. 63/583694 filed on September 19, 2023, the content of which is relied upon and incorporated herein by reference in its entirety.

FIELD

[0002] The present disclosure relates to glass compositions, and in particular glass compositions exhibiting reduced total pitch variation.

BACKGROUND

[0003] Display panel makers rely on predictable glass properties to manage glass component manufacture and assembly, such as backplane and color filter manufacture. The glass should have minimal dimensional change during thermal cycling, such as the temperature excursions, for example those experienced by the glass during thin film forming processes. More importantly, glass substrates used for such manufacture should have minimal, consistent total pitch variation from one glass substrate to the next glass substrate.

[0004] In view of these considerations, there is a need for glass compositions exhibiting reduced non-viscous relaxation, in combination with improved total pitch variation.

SUMMARY

[0005] A glass is disclosed, comprising:

greater than or equal to 69.25 mol.% and less than or equal to 70.75 mol.% SiO_2,

greater than or equal to 12.00 mol.% and less than or equal to 13.50 mol.% Al_2O_3,

greater than or equal to 1.00 mol.% and less than or equal to 2.00 mol.% B_2O_3,

greater than or equal to 4.00 mol.% and less than or equal to 6.00 mol.% MgO,

greater than or equal to 5.00 mol.% and less than or equal to 6.50 mol.% CaO,

greater than or equal to 0.00 mol.% and less than or equal to 1.50 mol.% SrO,

greater than or equal to 2.50 mol.% and less than or equal to 4.00 mol.% BaO,

greater than or equal to 0.00 mol.% and less than or equal to 1.50 mol.% TiO_2,

greater than or equal to 0.00 mol.% and less than or equal to 0.75 mol.% ZnO,

greater than or equal to 0.00 mol.% and less than or equal to 1.00 mol.% Y_2O_3,

greater than or equal to 0.00 mol.% and less than or equal to 1.00 mol.% La_2O_3,

greater than or equal to 0.00 mol.% and less than or equal to 0.50 mol.% P_2O_5; and

wherein the glass satisfies the condition: Intercept + $\sum_{i=SiO2}^{P2O5} Xi * Yi \leq 16$, where the symbol "*" means multiplication, and

Intercept = -11.20751259,

the coefficients Xi for the component oxides are:

SiO_2 = -0.002926308,

Al_2O_3 = -0.004673511,

B_2O_3 = -0.001118634,

MgO = 1.126496816,

CaO = 1.615716878,

SrO = 3.063872526,

BaO = 1.551023535,

TiO_2 = -0.004673511,

ZnO = 0,

Y_2O_3 = -0.001118634,

La_2O_3 = -0.001118634,

P_2O_5 = -2.235863244; and

wherein,

SiO_2+Al_2O_3+B_2O_3 is in a range from 82.25 mol% to 86.25 mol%,

MgO+CaO+BaO+SnO_2 is in a range from 13.00 mol% to 17.50 mol%,

TiO_2+ZnO+La_2O_3+La_2O_3+P_2O_5 is in a range from 0.00 mol% to 4.75 mol%.

[0005a] In one aspect, a glass is disclosed, comprising a plurality of components, the glass having a composition of the components comprising, on an oxide basis:

greater than or equal to 69.25 mol.% and less than or equal to 70.75 mol.% SiO_2,

greater than or equal to 12.00 mol.% and less than or equal to 13.50 mol.% Al_2O_3,

greater than or equal to 1.00 mol.% and less than or equal to 2.00 mol.% B_2O_3,

greater than or equal to 4.00 mol.% and less than or equal to 6.00 mol.% MgO,

greater than or equal to 5.00 mol.% and less than or equal to 6.50 mol.% CaO,

greater than or equal to 0.00 mol.% and less than or equal to 1.50 mol.% SrO,

greater than or equal to 2.50 mol.% and less than or equal to 4.00 mol.% BaO,

greater than or equal to 0.00 mol.% and less than or equal to 1.50 mol.% TiO_2,

greater than or equal to 0.00 mol.% and less than or equal to 0.75 mol.% ZnO,

greater than or equal to 0.00 mol.% and less than or equal to 1.00 mol.% Y_2O_3,

greater than or equal to 0.00 mol.% and less than or equal to 1.00 mol.% La_2O_3,

greater than or equal to 0.00 mol.% and less than or equal to 0.50 mol.% P_2O_5; and

wherein the glass satisfies the condition: Intercept + $\sum_{i=SiO2}^{P2O5} Xi * Yi \leq 16$, where the symbol "*" means multiplication, Intercept = -11.20751259, the values Yi are the oxide component amounts in mol%, the coefficients Xi are,

SiO_2 = -0.002926308,

Al_2O_3 = -0.004673511,

B_2O_3 = -0.001118634,

MgO = 1.126496816,

CaO = 1.615716878,

SrO = 3.063872526,

BaO = 1.551023535,

TiO_2 = -0.004673511,

ZnO = 0,

Y_2O_3 = -0.001118634,

La_2O_3 = -0.001118634,

P_2O_5 = -2.235863244; and

wherein,

$SiO_2+Al_2O_3+B_2O_3$ is in a range from 82.25 mol% to 86.25 mol%,

MgO+CaO+BaO+SnO2 is in a range from 13.00 mol% to 17.50 mol%, and

$TiO_2+ZnO+La_2O_3+La_2O_3+P_2O_5$ is in a range from 0.00 mol% to 4.75 mol%.

[0006] A glass is disclosed, comprising:

greater than or equal to 69.25 mol.% and less than or equal to 70.75 mol.% SiO_2,

greater than or equal to 12.00 mol.% and less than or equal to 13.50 mol.% Al_2O_3,

greater than or equal to 1.00 mol.% and less than or equal to 2.00 mol.% B_2O_3,

greater than or equal to 4.00 mol.% and less than or equal to 6.00 mol.% MgO,

greater than or equal to 5.00 mol.% and less than or equal to 6.50 mol.% CaO,

greater than or equal to 0.00 mol.% and less than or equal to 1.50 mol.% SrO,

greater than or equal to 2.50 mol.% and less than or equal to 4.00 mol.% BaO,

greater than or equal to 0.00 mol.% and less than or equal to 1.50 mol.% TiO_2,

greater than or equal to 0.00 mol.% and less than or equal to 0.75 mol.% ZnO,

greater than or equal to 0.00 mol.% and less than or equal to 1.00 mol.% Y_2O_3,

greater than or equal to 0.00 mol.% and less than or equal to 1.00 mol.% La_2O_3,

greater than or equal to 0.00 mol.% and less than or equal to 0.50 mol.% P_2O_5; and

wherein the glass satisfies the condition: Intercept + $\sum_{i=SiO2}^{P2O5} Xi * Yi \leq 13$, where the symbol "*" means multiplication, Intercept = -234.7571088, the values Yi are the oxide component amounts in mol%, the coefficients Xi are:

SiO_2 = 2.232090497,

Al_2O_3 = 2.230475478,

B_2O_3 = 2.233717001,

MgO = 3.368563490,

CaO = 3.851331728,

SrO = 5.301366502,

BaO = 3.788612774,

TiO_2 = 2.230475478,

ZnO = 2.23468972,

Y_2O_3 = 2.233717001,

La_2O_3 = 2.233717001,

P_2O_5 = 0; and

wherein,

$SiO_2+Al_2O_3+B_2O_3$ is in a range from 82.25 mol% to 86.25 mol%,

$MgO+CaO+BaO+SnO_2$ is in a range from 13.00 mol% to 17.50 mol%, and

$TiO_2+ZnO+La_2O_3+La_2O_3+P_2O_5$ is in a range from 0.00 mol% to 4.75 mol%.

[0007] A glass is disclosed, comprising:

greater than or equal to 69.25 mol.% and less than or equal to 70.75 mol.% SiO_2,

greater than or equal to 12.00 mol.% and less than or equal to 13.50 mol.% Al_2O_3,

greater than or equal to 1.00 mol.% and less than or equal to 2.00 mol.% B_2O_3,

greater than or equal to 4.00 mol.% and less than or equal to 6.00 mol.% MgO,

greater than or equal to 5.00 mol.% and less than or equal to 6.50 mol.% CaO,

greater than or equal to 0.00 mol.% and less than or equal to 1.50 mol.% SrO,

greater than or equal to 2.50 mol.% and less than or equal to 4.00 mol.% BaO,

greater than or equal to 0.00 mol.% and less than or equal to 1.50 mol.% TiO_2,

greater than or equal to 0.00 mol.% and less than or equal to 0.75 mol.% ZnO,

greater than or equal to 0.00 mol.% and less than or equal to 1.00 mol.% Y_2O_3,

greater than or equal to 0.00 mol.% and less than or equal to 1.00 mol.% La_2O_3,

greater than or equal to 0.00 mol.% and less than or equal to 0.50 mol.% P_2O_5; and

wherein the glass satisfies the condition:

Intercept + $\sum_{i=SiO2}^{P2O5} Xi * Yi \leq 10$, where the symbol "*" means multiplication, Intercept = -237.7578217, the values Yi are the oxide component amounts in mol%, the coefficients Xi are:

SiO_2 = 2.25149345,

Al_2O_3 = 2.250724382,

B_2O_3 = 2.252392713,

MgO = 3.524128464,

CaO = 3.890462587,

SrO = 5.366534992,

BaO = 3.897785139,

TiO_2 = 2.250724382,

ZnO = 2.253175066,

Y_2O_3 = 2.252392713,

La_2O_3 = 2.252392713,

P_2O_5 = 0; and

wherein,

$SiO_2+Al_2O_3+B_2O_3$ is in a range from 82.25 mol% to 86.25 mol%,

$MgO+CaO+BaO+SnO_2$ is in a range from 13.00 mol% to 17.50 mol%, and

$TiO_2+ZnO+La_2O_3+La_2O_3+P_2O_5$ is in a range from 0.00 mol% to 4.75 mol%.

[0008] A glass is disclosed, comprising:

greater than or equal to 69.25 mol.% and less than or equal to 70.75 mol.% SiO_2,

greater than or equal to 12.00 mol.% and less than or equal to 13.50 mol.% Al_2O_3,

greater than or equal to 1.00 mol.% and less than or equal to 2.00 mol.% B_2O_3,

greater than or equal to 4.00 mol.% and less than or equal to 6.00 mol.% MgO,

greater than or equal to 5.00 mol.% and less than or equal to 6.50 mol.% CaO,

greater than or equal to 0.00 mol.% and less than or equal to 1.50 mol.% SrO,

greater than or equal to 2.50 mol.% and less than or equal to 4.00 mol.% BaO,

greater than or equal to 0.00 mol.% and less than or equal to 1.50 mol.% TiO_2,

greater than or equal to 0.00 mol.% and less than or equal to 0.75 mol.% ZnO,

greater than or equal to 0.00 mol.% and less than or equal to 1.00 mol.% Y_2O_3,

greater than or equal to 0.00 mol.% and less than or equal to 1.00 mol.% La_2O_3,

greater than or equal to 0.00 mol.% and less than or equal to 0.50 mol.% P_2O_5; and

wherein the glass satisfies the condition: Intercept + $\sum_{i=SiO2}^{P2O5} Xi * Yi \leq 8$, where the symbol "*" means multiplication, Intercept = -242.7132028, the values Yi are the oxide component amounts in mol%, the coefficients Xi are:

SiO_2 = 2.260131924,

Al_2O_3 = 2.260271613,

B_2O_3 = 2.26056072,

MgO = 3.878171611,

CaO = 4.168656199,

SrO = 5.552077225,

BaO = 4.212721511,

TiO_2 = 2.260271613,

ZnO = 2.259907435,

Y_2O_3 = 2.26056072,

La_2O_3 = 2.26056072,

P_2O_5 = 0; and

wherein,

SiO_2+Al_2O_3+B_2O_3 is in a range from 82.25 mol% to 86.25 mol%,

MgO+CaO+BaO+SnO2 is in a range from 13.00 mol% to 17.50 mol%, and

TiO_2+ZnO+La_2O_3+La_2O_3+P_2O_5 is in a range from 0.00 mol% to 4.75 mol%.

[0008a] In another aspect, a glass is disclosed, comprising a plurality of components, the glass having a composition of the components comprising, on an oxide basis:

greater than or equal to 69.25 mol.% and less than or equal to 70.75 mol.% SiO_2,

greater than or equal to 12.00 mol.% and less than or equal to 13.50 mol.% Al_2O_3,

greater than or equal to 1.00 mol.% and less than or equal to 2.00 mol.% B_2O_3,

greater than or equal to 4.00 mol.% and less than or equal to 6.00 mol.% MgO,

greater than or equal to 5.00 mol.% and less than or equal to 6.50 mol.% CaO,

greater than or equal to 0.00 mol.% and less than or equal to 1.50 mol.% SrO,

greater than or equal to 2.50 mol.% and less than or equal to 4.00 mol.% BaO,

greater than or equal to 0.00 mol.% and less than or equal to 1.50 mol.% TiO_2,

greater than or equal to 0.00 mol.% and less than or equal to 0.75 mol.% ZnO,

greater than or equal to 0.00 mol.% and less than or equal to 1.00 mol.% Y_2O_3,

greater than or equal to 0.00 mol.% and less than or equal to 1.00 mol.% La_2O_3,

greater than or equal to 0.00 mol.% and less than or equal to 0.50 mol.% P_2O_5; and

wherein,

$SiO_2+Al_2O_3+B_2O_3$ is in a range from 82.25 mol% to 86.25 mol%

$MgO+CaO+BaO+SnO_2$ is in a range from 13.00 mol% to 17.50 mol%, and

$TiO_2+ZnO+La_2O_3+La_2O_3+P_2O_5$ is in a range from 0.00 mol% to 4.75 mol%.

[0009] Both the foregoing general description and the following detailed description present examples intended to provide an overview or framework for understanding the nature and character of the examples disclosed herein. The accompanying drawings are included to provide further understanding and are incorporated into and constitute a part of this specification. The drawings illustrate various examples of the disclosure, and together with the description explain the principles and operations thereof.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] FIG. 1 is a plot of temperature (vertical axis) versus time (horizontal axis) for a test procedure that can be used to observe fast relaxation in a display glass. The times, temperatures, and slopes shown in this figure are not to scale. The test procedure includes a conditioning stage 10, 12, 14 and a measurement stage 16, 18, 20;