the manufacture of smaller and faster transistors, which ultimately produces brighter and faster displays. One problem with p-Si based transistors is that their manufacture requires higher process temperatures than those employed in the manufacture of a-Si transistors. These temperatures range from 450°C to 600°C compared to the 350°C peak temperatures employed in the manufacture of a-Si transistors.

[0006] The glass compositions used for display applications need to have good thermal and mechanical properties, and dimensional stability satisfying the processing and performance requirements. In addition, diffusion of meal ions into the thin film transistors may cause damages to the transistors. Such diffusion needs to be avoided.

[0007] The display technology such as TV moves toward 8K technology. 8K refers to the horizontal resolution in the order of 8,000 pixels. For example, when an 8K TV has a screen with 7,680 horizontal and 4,320 vertical pixels, such a TV may have a total of approximately 33 million pixels. 8K technology offers an ultra-high resolution. With four times more pixels than a 4K TV, which has an ultra-high definition (UHD) resolution, 8K TVs show a sharper and more detailed picture quality.

SUMMARY

[0008] The present disclosure provides aluminosilicate or aluminoborosilicate glass compositions, products comprising the same, and methods of making the same. Such glass compositions are substantially alkali-free, and include oxides of alkaline earth metals. The glass composition may include a low concentration of boron oxide.

[0009] The present disclosure provides a glass or a glass composition. In accordance with some examples, a glass or a glass composition provided herein comprises in mole percent on an oxide basis:

SiO_2: 68.86 -70.87;

Al_2O_3: 10.55-13.06;

B_2O_3: 0-2.29;

MgO: 4.82-6.4;

CaO: 5.31-7.35;

SrO: 0.3-3.74; and

BaO: 1.5-4.64.

[0010] Such a glass is an aluminosilicate glass or an aluminoborosilicate glass. The glass is substantially alkali-free defined by a combined concentration of Li_2O, Na_2O, and

K_2O less than 0.1 mol.%, for example, less than 0.05 mol.%, less than 0.02 %, less than 0.01 %, or 0%.

[0011] In some examples, B_2O_3 is in a suitable range. For example, B_2O_3 is in a range of from 0.1 to 2.29 by mole percent, from 0.1 to 1.98 by mole percent, in a range of from 0.5 to 1.90 by mole percent, or in a range of from 0.5 to 1.60 by mole percent.

[0012] In some examples, a ratio of RO/Al_2O_3 is in a range of from 1.23 to 1.83 and RO is the sum of the mole percents of MgO, CaO, SrO, and BaO. For example, the ratio of RO/Al_2O_3 is in a range of from 1.39 to 1.83 in some examples. The ratio of RO/Al_2O_3 may also be in a range of from 1.09 to 1.83. The ratio of RO/Al_2O_3 may also be in a range of from 1.47 to 1.83.

[0013] The glass may further comprise 0.01 mol.% to 0.4 mol.% of a chemical fining agent, which is selected from SnO_2, As_2O_3, Sb_2O_3, Fe_2O_3, CeO_2, MnO_2, F, Cl, Br, or any combination thereof. For example, the chemical fining agent comprises 0.08 mol.% to 0.13 mol.% of SnO_2 in some examples.

[0014] The glass has improved annealing point, for example, higher than 775ºC. In some examples, the glass has an annealing point in a range from 775 ºC to 810 ºC, for example, in a range from 780 ºC to 810 ºC, in a range from 785 ºC to 810 ºC, or in a range from 780 ºC to 791 ºC.

[0015] The glass also has improved elastic modulus (Young's modulus). For example, in some examples, the glass has an elastic modulus in a range of from 82.47 GPa to 84.90 GPa.

[0016] The glass has a desirable stress optical coefficient (SOC), which is relatively lower compared to those of existing products. For example, the glass provided in the present disclosure has a SOC in a range of from 27.70 to 29.70 in some examples.

[0016a] In one aspect, the present disclosure provides a glass comprising in mole percent on an oxide basis:

SiO_2: 68.86 -70.87;

Al_2O_3: 10.55-13.06;

B_2O_3: 0.1-2.29;

MgO: 4.82-6.4;

CaO: 5.31-7.35;

SrO: 0.3-3.74; and

BaO: 1.5-4.64,

wherein the glass is substantially alkali-free defined by a combined concentration of Li_2O, Na_2O, and K_2O less than 0.1 mol.%,

wherein a ratio of RO/Al_2O_3 is in a range of from 1.39 to 1.83, and RO is the sum of the mole percents of MgO, CaO, SrO, and BaO, and

wherein the glass has a stress optical coefficient (SOC) in a range of from 27.70 to 29.70.

[0016b] In another aspect, the present disclosure provides a glass comprising in mole percent on an oxide basis:

SiO_2: 68.86 -70.87;

Al_2O_3: 10.55-13.06;

B_2O_3: 0.1 -1.98;

MgO: 4.82-6.4;

CaO: 5.31-7.35;

SrO: 0.3-3.74; and

BaO: 1.5-4.64,

wherein the glass is substantially alkali-free defined by a combined concentration of Li_2O, Na_2O, and K_2O less than 0.1 mol.%,

wherein a ratio of RO/Al_2O_3 is in a range of from 1.39 to 1.83, and RO is the sum of the mole percents of MgO, CaO, SrO, and BaO, and

wherein the glass has an elastic modulus in a range of from 82.47 GPa to 84.90 GPa, and a stress optical coefficient (SOC) in a range of from 27.70 to 29.70.

[0017] In accordance with some examples, a glass provided in the present disclosure is an aluminoborosilicate glass, and comprises in mole percent on an oxide basis:

SiO_2: 68.86 -70.87;

Al_2O_3: 10.55-13.06;

B_2O_3: 0.1 -1.98;

MgO: 4.82-6.4;

CaO: 5.31-7.35;

SrO: 0.3-3.74; and

BaO: 1.5-4.64.

[0018] The glass is substantially alkali-free.

[0019] The glass has a ratio of RO/Al_2O_3 in a range of from 1.23 to 1.83, for example, from 1.39 to 1.83 or from 1.47 to 1.83, and RO is the sum of the mole percents of MgO, CaO, SrO, and BaO.

[0020] The glass further comprises 0.08 mol.% to 0.13 mol.% of SnO_2 as a chemical fining agent. The glass has an annealing point in a range from 775 ºC to 810 ºC, for example, in a range from 780 ºC to 810 ºC, in a range from 785 ºC to 810 ºC, or in a range from 780 ºC to 791 ºC.

[0021] The glass has an elastic modulus in a range of from 82.47 GPa to 84.90 GPa, and a stress optical coefficient (SOC) in a range of from 27.70 to 29.70.

[0022] The present disclosure provides an article comprising the glass or the glass composition described herein. For example, a substrate for liquid crystal display comprises the glass or the glass composition described here.

[0022a] In another aspect, the present disclosure provides an article comprising the glass as described herein.

[0022b] In another aspect, the present disclosure provides a substrate for liquid crystal display comprising the glass as described herein.

[0023] The present disclosure provides a device for flat panel display, which comprises at least one sheet comprising the glass as described herein. Such a device may further comprise polycrystalline silicon thin film transistors.

[0023a] In another aspect, the present disclosure provides a device for flat panel display comprising at least one sheet comprising the glass as described herein, and polycrystalline silicon thin film transistors.

[0024] A method for producing the glass or the glass composition as described herein is provided. Such a method comprises at least one step of mixing and melting raw materials in mole percent on an oxide basis so as to provide the oxides as described. Such a method may further comprise making a sheet comprising the glass composition through a downdraw sheet fabrication process or a fusion process.

[0024a] In another aspect, the present disclosure provides a method for producing the glass as described herein, comprising mixing and melting raw materials in mole percent on an oxide basis.

[0025] The glass compositions exhibit desirable physical properties and chemical properties, for example, improved annealing point (e.g., higher than 775ºC), improved elastic modulus, lowered stress optical coefficient (SOC), and desirable liquidus viscosity. The glass compositions are suitable for use as substrates in flat panel display devices such as active matrix liquid crystal displays (AMLCDs) with ultra-high resolution, for example, in the 8K display technology.

BRIEF DESCRIPTION OF THE DRAWINGS

[0026] The present disclosure is best understood from the following detailed description when read in conjunction with the accompanying drawings. It is emphasized that, according to common practice, the various features of the drawings are not necessarily to scale. On the contrary, the dimensions of the various features are arbitrarily expanded or reduced for clarity. Like reference numerals denote like features throughout specification and drawings.